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Taxonomic and numeric structure of Chironomidae (Diptera) in different habitats of a Neotropical floodplain

Cristina Márcia de Menezes Butakka[1], Luiz Carlos Gomes[2] & Alice Michiyo Takeda[2]

1. Celbe (Centro de Pesquisa em Limnologia, Biodiversidade e Etnobiologia do Pantanal), Av. Santos Dumont, s/n, Cidade Universitária, Bloco II, 78200-000 Cáceres, MT, Brazil. (cristinabutakka@terra.com.br)
2. Universidade Estadual de Maringá, Departamento de Biologia (DBI), Nupelia (Núcleo de Pesquisa em Limnologia, Ictiologia e Aquicultura), Av. Colombo, 5790, 87020-900 Maringá, PR, Brazil. (alice@nupelia.uem.br)

ABSTRACT. We characterized the local benthic Chironomidae by analyzing the numerical density, biomass, diversity index of Shannon-Wiener and dominance of larvae in the main channel of the Ivinhema River, in a secondary channel, in five lakes connected to the main channel and in five lakes without connection. Of the 68 taxa identified, *Aedokritus* sp., *Tanytarsus* sp., *Chironomus strenzkei* Fittkau, 1968 and *Procladius* sp.1 were found in all sampling sites and were considered morphospecies with greater of greatest ecological plasticity. *Chironomus strenzkei* Fittkau, 1968, contributed with the greatest biomass in the central region of lakes without connection, whereas *Aedokritus* sp. dominated in the littoral of lakes. The greater values of diversity indices in the littoral region of channels were due to the greater water flow and to the higher food availability in these areas. The dominance indices, by contrast, were greater on the central region of these environments. The littoral region has exclusive characteristics, representing habitats that could play important controlling in the numerical density and index diversity on the ecosystem, whereas that the biomass of benthic invertebrates in the central region in some biotopes would have different spatial probably according organisms drift.

KEYWORDS. Chironomidae larvae, biomass, diversity, dominance, Paraná River.

RESUMO. Estrutura taxonômica e numérica de Chironomidae (Diptera) em diferentes habitats de uma várzea neotropical. As larvas de Chironomidae foram caracterizadas localmente para analisar a densidade, biomassa, índice de diversidade de Shannon-Wiener e dominância no canal principal do Rio Ivinhema, em um canal secundário, em cinco lagoas conectadas ao canal principal e cinco lagoas sem conexão. Dos 68 taxa, *Aedokritus* sp., *Tanytarsus* sp., *Chironomus strenzkei* Fittkau, 1968 e *Procladius* sp.1 foram encontrados em todos os locais de amostragem e foram consideradas as morfoespécies com a maior plasticidade ecológica. *Chironomus strenzkei* contribuiu com a maior biomassa na região central das lagoas sem conexão, enquanto que *Aedokritus* sp. dominou na região litorânea das lagoas. Os maiores valores do índice de diversidade na região litorânea dos canais foram pertinentes ao maior fluxo de água e disponibilidade de alimento nessas áreas. Os índices de dominância, em contraste, foram maiores na região central desses ambientes. A região litorânea tem características exclusivas, com habitats que apresentaram um importante papel no controle da densidade numérica e índice de diversidade no ecossistema, enquanto que a biomassa dos invertebrados bentônicos na região central em alguns biótopos pode ter diferenças espaciais de acordo com a deriva de organismos.

PALAVRAS-CHAVE. Larvas de Chironomidae, biomassa, diversidade, dominância, Rio Paraná.

The floodplain of the Upper Paraná River is made up of a great number and variety of aquatic environments, such as channels and marginal lakes (Stevaux *et al*., 2004), with distinct transitional habitats which aid in the maintenance of a high biodiversity (Thomaz *et al*., 2004). The diversity of water bodies of the floodplain has triggered studies on benthic invertebrates, notably Chironomidae larvae, such as the studies of Marchese *et al*. (2002, 2005), Capello *et al*. (2004), Ezcurra de Drago *et al*. (2004) and Bletter & Marchese (2005). Higuti & Takeda (2002) concentrate on the distribution and numerical densities of genera, Higuti (2004) about species richness and dominance and about trophic conditions in reservoirs (Takahashi *et al*., 2008) and in the Middle Paraná River floodplain (Galizzi *et al*., 2012)

All of these studies underline the importance of hydrodynamics as the main determining factor in the numerical fluctuations and of the spatial and temporal variation of species encountered in the floodplain of the Upper Paraná River.

The family Chironomidae is extraordinarily rich in species and occurs in a broad variety of habitats, defining a variable role in the ecosystems and the possibility of interactions with different types of organisms (McKie & Pearson, 2006). Its success in the adaptation to diverse types of environments is due to a broad limit of trophic exploration and of micro-spatial aspects of the systems where it occurs (Dimitriadis & Cranston, 2007).

In Brazil, a major part of the studies are of taxonomic inventories (Stur *et al*., 2006; Correia *et al*., 2005, 2006; Correia & Trivinho-Strixino, 2007; Trivinho-Strixino & Strixino, 2005, 2008), association with habitats types (Suriano & Fonseca-Gessner, 2004; Sanseverino & Nessimian, 2008) or deal with the distribution of larvae in different habitats (Henriques-Oliveira *et al*., 2003; Amorim *et al*., 2004) and larval biomass (Callisto *et al*., 2002).

Studies about the attributes of groups are indispensable to complement the understanding of community structure, as well as the functioning of aquatic ecosystems (Clarke *et al*., 2008; Rose *et al*., 2008; Hahn & Fuchs, 2009).

This study had as main objective to characterize and differentiate, on a local scale, the habitats (littoral region and central region) and the different types of environments and seasons (main channel, secondary channel, lakes with and without connection to the river), from estimations of the numerical density, of the biomass, of the diversity indices and of the dominance index of benthic Chironomidae.

We expected that (i) the values of biomass and of the diversity indices can be greater in the littoral region than in the central region, and (ii) greater in lakes wit connection to the river than in those without connection.

MATERIALS AND METHODS

Study area. The study area is situated in the state of Mato Grosso do Sul, in the Upper Paraná River floodplain. The Ivinhema River is one of the main tributaries of the right bank of the river. The Curutuba channel connects the Ivinhema River to the Baía River, and the channel Ipoitã connects directly the Ivinhema River to the Paraná River (Souza Filho *et al*., 2004; Souza Filho & Stevaux, 2004).

The inundated areas of the Upper Paraná River are influenced by the main channel, including the floodplain which is an important source of energy for lacustrine environments. The Paraná River itself, the islands, secondary channels and floodplains, as the marginal lagoons, are systems that are structurally and functionally directly dependent on the horizontal water flow, which form a functional ecological connection with the main course of the river.

In this stretch of river four types of environments were sampled at twelve sampling sites (Fig. 1): CAP, main channel; CAS, secondary channel; LCC, lakes with connection to the river; LSC, lakes without such a connection. The main channel is formed by the Ivinhema River (RI); the secondary channel by the Canal Ipoitã (CI); the lakes with connection to the main river are: Patos (PA), Sumida (SU), Finado Raimundo (FR), Boca do Ipoitã (BI) and Peroba (PE). Lakes without connection are: Cervo (CE), Jacaré (JA), Capivara (CA), Zé do Paco (ZP) and Ventura (VE).

The main and secondary channels are different from the lakes in having greater oxygen content. Temperature, pH (slightly neutral) and the electric conductivity of the water have similar mean values in the environments, with little variability (Tab. I).

Data sample. Samples of larvae were taken every three months, resulting in three replicas for each station. The sediment was collected with a modified Petersen grab (0.0189 m^2), between February 2000 and May 2001. In the field the samples were washed and collected, using a set of sieves with mesh size of 2.0 mm, 1.0 mm and 0.2 mm. Organisms picked from the first two sieves were collected and immediately fixed in 70% alcohol. The sampled taken from the last sieve was store in flasks with 70% alcohol for later selection in the laboratory. After the selection the larvae were determined to the genera level, and, whenever possible, to specific level. For identification were used the keys of Coffman & Ferrington (2008) and Trivinho-Strixino & Strixino (2011).

The larvae from the different sieves were counted as an estimation of their numerical density, and measured separately, after being mounted on slides, for a later determination of their biomass. For the estimation of biomass, 3,508 individuals were examined, about 40% of the total sample. Chironomidae larvae have a cylindrical and elongated body, which allows the determination of their biovolume. Starting from this, a geometric

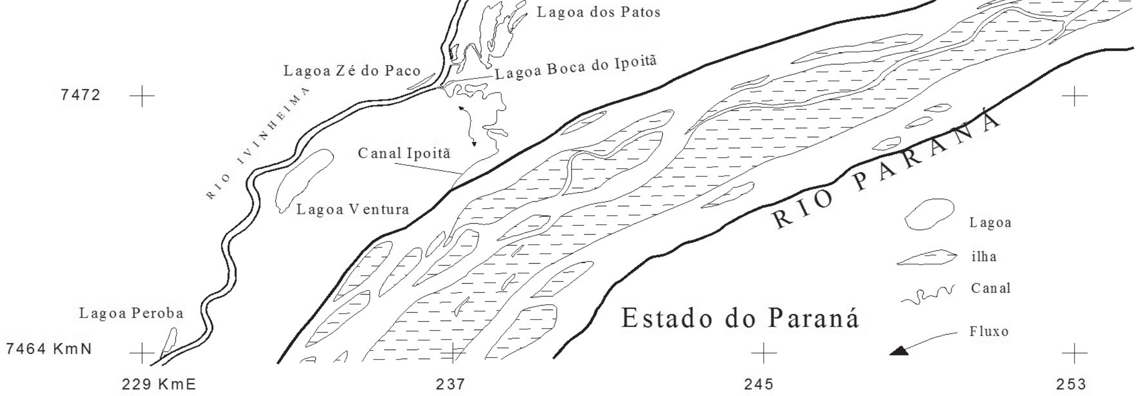


Fig. 1. Localization of the study area and the sampling sites.

Tab. I. Mean values and standard deviation of abiotic variables in the habitats of the four types of environments of the Invinhema River [CAP, main channel; CAS, secondary channel; LCC, lakes with connection to the river; LSC, lakes without connection; Depth (m); Temp, temperature (°C); Cond, electric conductivity; DO, dissolved oxygen].

Environments	Habitats	depth (m)	Temp (°C)	pH	Cond (µS/cm)	DO (mg/l)
CAP	Littoral region	1.56 (±0.63)	25.00 (±3.56)	6.72 (±0,38)	42.92 (±2.22)	6.95 (±0.87)
CAS		1.07 (±0.94)	25.24 (±3.49)	7.01 (±0,65)	52.21 (±5.64)	8.33 (±1.91)
LCC		1.01 (±0.57)	25.01 (±3.74)	6.44 (±0,46)	39.60 (±5.67)	5.74 (±1.62)
LSC		1.49 (±0.90)	24.96 (±3.58)	6.35 (±0,53)	42.69 (±14.14)	4.84 (±1.81)
CAP	Central region	4.08 (±0.34)	25.00 (±3.86)	6.80 (±0,22)	42.83 (±2.5)	7.42 (±0.94)
CAS		2.81 (±1.25)	25.23 (±3.73)	6.91 (±0,16)	51.63 (±5.25)	8.33 (±2.04)
LCC		3.27 (±0.72)	24.69 (±3.89)	6.45 (±0,43)	38.43 (±10.81)	4.89 (±1.81)
LSC		2.90 (±1.19)	24.62 (±3.47)	6.40 (±0,59)	48.53 (±22.35)	4.65 (±2.06)

model was used for the calculation of the biovolume, as an estimation of their approximate biomass, in accordance with the formula proposed by Smit *et al*. (1993). Considering the density of the larvae from previously selected points, the total biomass was calculated for each habitat, season and type of environment.

The community structure was characterized using the diversity index of Shannon-Wiener (H') (Pielou, 1975) and the dominance index from the taxonomic composition and density of the taxa. The diversity index was calculated for each type of environment and for the habitats.

The dominance index was calculated as a component of diversity using this unit minus the uniformity value (1 - U), considering only environments and habitats. The dominance index was calculated with the formula of Kownacki (1971).

The values of the index differentiate two groups: dominants ($10<d<100$) and subdominants ($1<d<9.99$).

To test the differences between the means of numerical densities, of biomass, of indices of diversity and dominance, taking as variable factors the environments, the sites and the habitats, a non-parametrical analysis of Kruskal-Wallis was used, because the requirements were not reached. LSD *a posteriori* was used for verification which of the environmental variables differs in relation to the diversity values.

RESULTS

Abiotic analyses. A total of 8,571 Chironomidae larvae were analyzed, which belong to three subfamilies, nine tribes and 68 taxa. Chironominae (47 taxa) were the most abundant, with prevailing Chironomini (43 taxa), which represent 63% of all identified tribes. Pentaneurini contributed with 12% of the sampled larvae, while larvae of Orthocladiinae contributed 7% (Fig. 2).

Of 68 sampled taxa, 12 were found exclusively in lakes without connection to the river (*Parachironomus* sp. 1, *Parachironomus* sp. 3, *Parachironomus* sp. 4, *Zavreliella* sp. 1, *Ablabesmyia (Karelia)* sp., *Dicrotendipes* sp. 3, *Corynoneura* sp. 2, *Chironomus* **gr.** *decorus* sp. II, *Gênero* C, *Lauterborniella* sp., *Thienemanniella* sp. 1 and *Microchironomus* sp.) and only three in lakes with connection (*Chironomus* **gr.** *riparius*, *Pelomus* sp. 3 e *Labrundinia* sp. 1). The larvae of *Cricotopus* sp. 2, *Endotribelos* sp. 2 and *Endotribelos* sp. 3 were exclusive in the two channels, while *Apedilum* sp. and *Larsia* sp. occurred only in the main channel of the Ivinhema River.

Aedokritus sp., *Tanytarsus* sp., *Chironomus strenzkei* Fittkau, 1968 and *Procladius* sp. 1 recorded from all sampling sites (Tab. II).

Despite the tendency of the mean numerical density to increase from the lotic environment to the more lentic

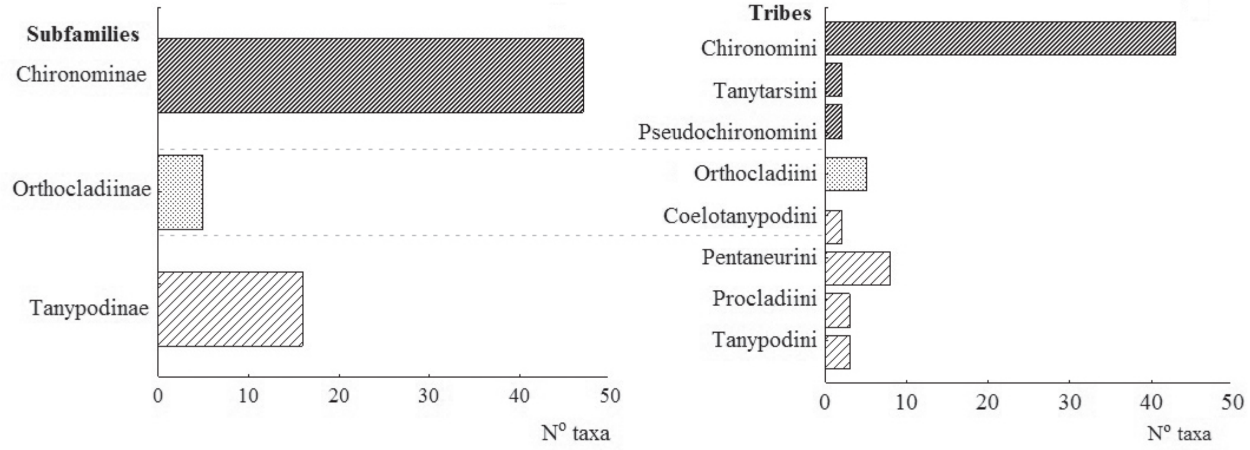
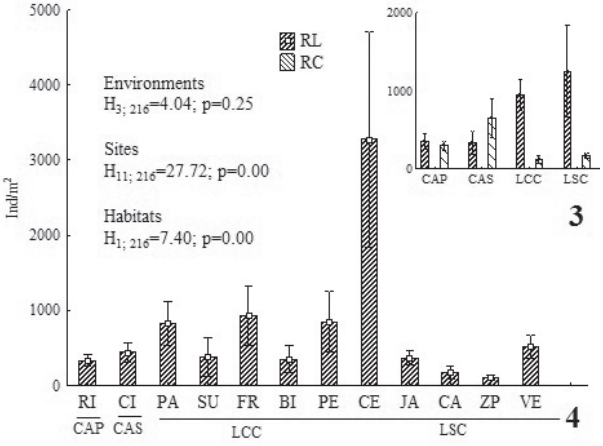
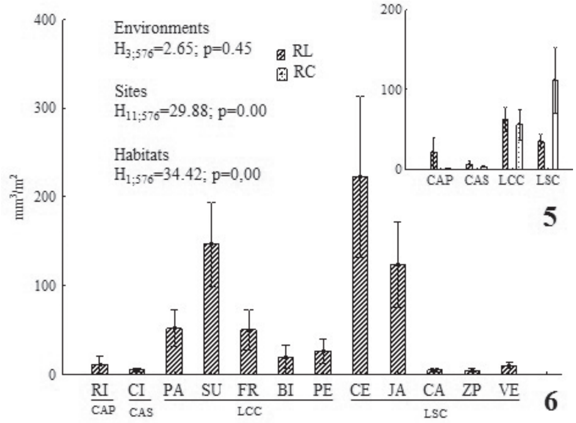


Fig. 2. Number of taxa of Chironomidae for each subfamily and tribe.



Figs 3, 4. Mean numerical densities and standard errors, resp., in four types of environments (3) and in twelfe sampling sites (4) (CAP, main channel; CAS, secondary channel; LCC, lakes with connection to the river; LSC, lakes without a connection; RI, Ivinhema River; CI, Channel Ipoitã; PA, Patos Lake; SU, Sumida Lake; FR, Finado Raimundo Lake, BI, Boca do Ipoitã Lake; PE, Peroba Lake; CE, Cervo Lake; JA, Jacaré Lake; CA, Capivara Lake; ZP, Zé do Paco Lake; VE, Ventura Lake; RL, littoral region; RC, central region).



Figs 5, 6. Mean biomass (mm^3/m^2) and standard error, resp., in four environment types (5) and in twelve sampling sites, Mato Grosso do Sul, Brazil (6), and results of the Kruskal-Wallis analysis, considering them as factors (unifactorial).

(Fig. 3), the Kruskal-Wallis test did not show significant differences, while between seasons the differences were highly significant, with the highest mean values in the Cervo Lake (Fig. 4).

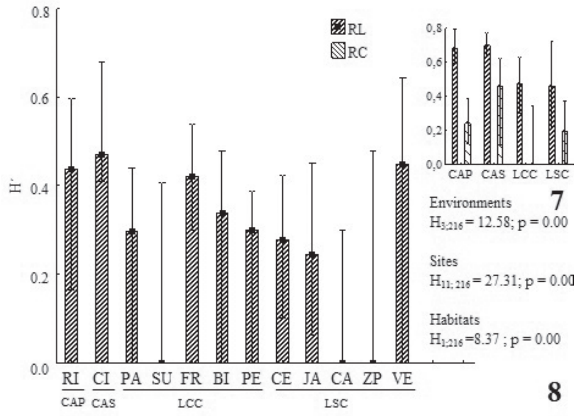
The lakes have the greatest biomass (mm^3/m^2) among the environments (due to a greater contribution of *C. strenzkei*). However, the differences are not significant (Fig. 5). The different habitats, by constrast, show highly significant variability in the mean biomass values, especially in the central region of lakes without connection. At the sampling sites, the mean biomass values were also highly significant (Fig. 6).

Differences between habitats in the diversity index were obvious (Fig. 7), with the highest values in the littoral region, especially in the main and secondary channel, showing highly significant differences (Kruskal-Wallis) for the types of environments, sampling sites (Fig. 8) and habitats.

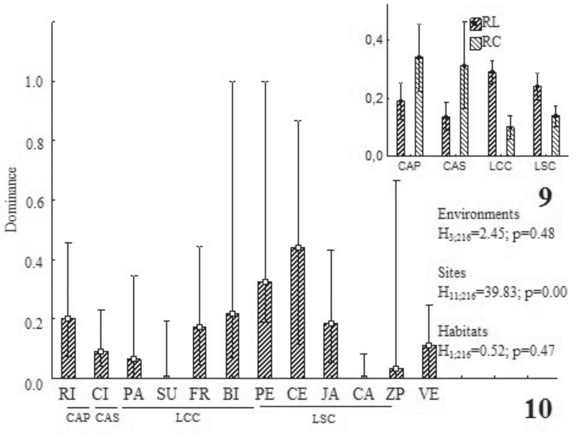
The lakes without connection and the two channels differed significantly between each other ($p<0,05$; LSD *a posteriori*), while lakes with connection differed significantly only from the secondary channel.

The dominance index (considered as a component of the diversity indices: 1-U) didn't show significant differences for environments and habitats (Kruskall-Wallis), though the values were higher in the central region of the channels and in the littoral region of the lakes (Fig. 9). Differences in the dominance index were more marked between sampling sites, showing highly significant differences, with highest values in the Cervo Lake (Fig. 10).

Chironomus strenzkei was dominant in the central region of the lakes (Patos, Sumida, Cervo, Jacaré e Capivara) (dominance index of Kownacki, 1971: 16.67-74.91), which had low taxonomic richness (1 to 10 taxa). In the littoral region of the lakes Patos, Finado Raimundo, Boca do Ipoitã, Cervo and Ventura *Aedokritus* sp. was dominant (14.48-34.07). The second dominant species in



Figs 7, 8. Mean values of diversity index, standard errors, resp., and results of the Kruskal-Wallis analysis, considering environments, habitats (7), and sampling sites, Mato Grosso do Sul, Brazil (8) as factors (unifactorial).



Figs 9, 10. Mean dominance values (1-U) and results of the Kruskal-Wallis analysis, considering environments, habitats (9) and sampling sites, Mato Grosso do Sul, Brazil (10) as factors.

Tab. II. Taxonomic composition of Chironomidae, and dominance indices of Kownacki (1971) in the twelve sampling sites (abbreviations see Fig. 3).

	CAP		CAS		LCC										LSC									
CHIRONOMIDAE	RI		CI		PA		SU		FR		BI		PE		CE		JA		CA		ZP		VE	
	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC
CHIRONOMINAE																								
Chironomini																								
Apedilum sp.	0.01	2.72																						
Axarus sp.			0.52						0.01												0.08			
Beardius phytophilus Trivinho-Strixino & Strixino, 2000	0.01										0.01				0.08		0.05							
Beardius xylophilus Trivinho-Strixino & Strixino, 2000	0.03									0.09														
Chironomus strenzkei Fittkau, 1968	0.07		0.11	0.32	3.78	26.14		56.42	0.01		0.13	3.13	0.09	0.06	1.78	56.98	0.59	74.91	10.49	**16.67**	7.81	0.09	0.01	
Chironomus gigas Reiss, 1974																	0.01	0.03						
Chironomus salinarius gr.													0.01											
Cladopelma sp.			0.24								0.01													
Cryptochironomus brasiliensis Silva *et al.*, 2010	0.52	0.05	1.14	1.90					0.01				0.01								0.08	0.27	0.62	
Dicrotendipes sp.3															0.01									
Endotribelos albatum Sublette and Sasa, 1994				0.32																				1.23
Endotribelos sp.2			0.01																					
Endotribelos sp.3		0.65	0.83																					
Fissimentum desiccatum Cranston & Nolte, 1996	0.10	0.33	0.01						0.01		0.01						0.18							
Fissimentum sp.2	0.01		0.02						0.05															
Fissimentum sp.3	0.01										0.01												0.01	
Goeldichironomus sp.1				1.27	0.05		8.58		0.62		0.32	1.39			0.29	0.06	11.85	0.03	0.02		0.75	0.71	0.11	
Goeldichironomus sp.2	0.05				0.05										0.07									
Goeldichironomus sp.3					1.59																			
G. serratus Reiss 1974										3.45									0.02					
G. maculatus Trivinho-Strixino and Strixino, 1991	0.06				0.77		8.03		0.15				2.11	0.22	0.52	0.06	0.37		0.02		0.90	0.35	0.06	0.81
G. petiolicola Trivinho-Strixino and Strixino, 2005					0.01												0.01							
Gênero C																								0.24
Pelomus sp.1	0.01								0.11		0.01	0.35	0.01						0.02			0.18	0.01	0.07
Pelomus psamophilus Trivinho-Strixino and Strixino, 2008			0.07		0.13								0.01											
Pelomus sp.3							0.01																	
Lauterboniella sp.															0.01									0.07
Microchironomus sp.																						0.06		0.02
Nilothauma sp. 1													0.01											
Parachironomus sp. 1															0.36				0.02		0.38		0.01	
Parachironomus sp. 3																	0.07							
Parachironomus sp. 4																								0.07
Paralauterborniella sp.			0.05								0.09													
Phaenopsectra sp.							0.01				0.01				0.02				0.02				0.03	
P. (Polypedilum) sp. 1	1.20		3.85	3.33					0.25		0.01	0.35			0.71		2.91						1.03	9.56
P. (Polypedilum) sp. 2	25.07		10.82	0.48					3.10		0.68		0.01	0.11	0.44				0.02					
Polypedilum (*Asheum*)	0.01				0.01				0.01		0.03	0.35			0.02		0.07				0.08			
Polypedilum (Tripodura) sp.					2.52		0.24						3.02				0.00		1.36					

Tab. II. cont.

CHIRONOMIDAE	CAP		CAS		LCC								LSC											
	RI		CI		PA		SU		FR		BI		PE		CE		JA		CA		ZP		VE	
	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC	RL	RC
Stenochironomus sp.			0.01																				0.01	
Zavreliella sp. 1															0.02									
Zavreliella sp. 2									0.01														0.01	
Pseudochironomini																								
Aedokritus sp.	0.18	11.27	0.43	0.16	22.24	8.17	3.47		33.35		15.89	2.78	14.48	23.57	**14.01**	0.74	8.60		4.17		0.08	0.62	34.07	0.07
Pseudochironomus sp.			0.01																					
Tanytarsini																								
Rheotanytarsus sp. 1			0.09						0.01								0.00							
Tanytarsus sp.	0.21		1.07		6.23		0.02		15.77		3.43		14.38	0.84	1.36		0.38		0.19		0.08	7.45	1.10	
ORTHOCLADIINAE																								
Corynoneura sp. 1													0.01		0.49									
Corynoneura sp. 2															0.01									
Thienemanniella sp.																							0.01	
Cricotopus sp. 1	0.17	10.78	0.02												0.01								0.00	
Cricotopus sp. 2			3.14																					
TANYPODINAE																								
Tanypodinae sp.		0.05		0.16									0.01	0.06	0.08	0.06			0.06					
Coelotanypodini																								
Clinotanypus sp.				0.16	0.01	0.65		0.17		0.03				0.22										
Coelotanypus sp. Kieffer, 1913	0.73		0.04								0.23	3.13	0.01	0.06	0.01	0.19	0.25	0.46	0.10			0.35	0.75	5.33
Pentaneurini																								
Ablabesmyia sp. Joahnsen, 1905	0.01								0.01		0.13				1.28	0.06	0.10						0.00	
Ablabesmyia **gr.** *annulata*					0.13		0.19		0.01	25.35			0.01			0.99	0.01		0.26		0.45	0.44	0.57	0.41
Ablabesmyia (Karelia) sp.															0.01	0.99								
Denopelopia sp.																								0.14
Labrundinia sp.1											0.01													
Labrundinia sp. 2															0.76				0.02					
Larsia sp. (parte)	0.01																							
Pentaneura sp.	0.01								0.01		0.01						0.00							0.27
Procladiini																								
Djalmabatista pulcher Joh, 1989	0.07	0.33		7.62																			0.01	9.02
Procladius sp. 1	4.20	0.05	0.23		2.93		0.13	0.69	0.47		1.02	0.35		0.06	0.07	0.19	1.55		0.02		0.08	6.65	0.06	0.07
Procladius sp. 2			0.07		0.16																			
Tanypodini																								
Tanypus sp.								1.39							0.00						0.08			
Tanypus punctipennis Meigen, 1818										2,65														
Riqueza	23	10	22	10	15	3	9	4	19	6	19	8	15	9	25	10	19	4	16	1	12	11	20	15

the lakes Finado Raimundo and Peroba was *Tanytarsus* sp. (15.77 and 14.38, resp.).

Aedokritus sp. (11.27) and *Cricotopus* sp.1 (10.78) were dominant in the central region of the Ivinhema River, while *Polypedilum (Polypedilum)* sp. 2 dominated in the littoral region of the two channels. The taxonomic richness was greater in the littoral region of the channels and lakes (Tab. II).

DISCUSSION

The distinct environmental characteristics of the sampling sites and habitats proved to be determinant for the differences in the population attributes, as well in numerical densities, biomass, and diversity and dominance indices.

Chironomidae larvae of the Ivinhema River mostly belonged to the tribe Chironomini. The abundance of this group in Neotropical regions has been noticed before (Henriques-Oliveira *et al*., 2003; Takeda *et al*., 2004).

The greater numerical densities of Chironomidae larvae in lakes without connection, especially in the Cervo Lake, are probably due to input of organic matter from aquatic macrophytes, which serve as support and shelter, and act particularly as a factor for the increase of the colonization and distribution of larvae.

Aedokritus sp., *C. strenzkei*, *Tanytarsus* sp. and *Procladius* sp.1 were recorded in all sampling sites, and may be considered species with greater ecological plasticity. Marchese *et al*. (2002), Ezcurra de Drago *et al*. (2004) and Higuti & Takeda (2002) also recorded a great abundance of these taxa in floodplain lakes, channels and rivers of the Paraná River. Generally, the numerical densities of larvae increased in response to the dry phase of inundation areas (Verberk *et al*., 2008), when they are encountered on the sediment surface of littoral regions of lenthic environments.

Lenthic environments have their distinct hydrodynamic from lotic environments, determined by the inflow from the main channel to the connected lakes, or from the local rainfall conditions, concerning lakes without connection (Wantzen *et al*., 2005).

Larvae from the central region of lakes are bigger than larvae from the littoral region. The greater biomass recorded in lakes without connection due to dominance of *C. strenzkei* in the central region of these environments (significant between habitats) suggests a fundamental role of this species in the maintenance of populations in lentic environments of not connected lakes. Besides *C. strenzkei* in the Jacaré lake and *Chironomus* **gr.** *decorus* sp. II was also recorded, which increased the biomass value.

According to Callisto *et al*. (2002), the high organic matter content in the sediment of the Imboassica Lagoon, state of Rio de Janeiro, suggests food limitation neither for biomass of the *Chironomus* larvae nor for *Polypedilum* in the littoral and limnetic zones, respectively.

The greater values of diversity index and taxonomic richness of Chironomidae larvae observed in the littoral region of the main and secondary channel may be related to the water flow, which lead to an increased oxygenation (Mokany *et al*., 2008). The velocity of the current creates a mosaic of habitats which are colonized by aquatic communities, influencing the dynamic of the distribution of the Chironomidae fauna.

Henry (2003) found similar results in the Paranapanema River in relation to marginal lakes for other communities (phytoplancton and zooplancton), confirming that the lacustrine environments have greater hydrological stability than the river. Thus the variability of the current could be a disturbing factor that causes a greater diversity of the fauna by advection of species from the central region to the littoral, which provides shelter and food.

A decisive factor for the greater diversity and species richness could also be the degree of connectivity between the river and lacustrine environment in the floodplain. Henry (2003) argued that disconnected environments should have a lower number of insect species than connected floodplain ecosystems. However, in the present study, both lakes with connection and lakes without connection reached similar diversity index values, most notably in the littoral region, which is formed by aquatic macrophytes and/or terrestrial vegetation of different physiognomies (Souza *et al*., 2004), which contributes to the greater offer of habitats and food.

In habitats with low diversity predominated species most adapted, such as *C. strenzkei*, which dominated (in mean concentrations of 4.65 a 4.89% DO) in the central region of different sampling sites. Some Chironomidae species in their aquatic stage have the ability to survive under unfavorable oxygen conditions and adjust to environmental changes. Thus, they can sometimes be the only insects present in the sediment (Solomon *et al*., 2008), as many species synthesize a respiratory pigment similar to hemoglobin, which transports and stores oxygen (Brodersen *et al*., 2008). Others, like *Aedokritus* sp., dominated in the littoral region of lakes and in the central region of lothic environments, showing also their plasticity in relation to the water current velocity.

Another decisive factor for the greater diversity values of Chironomidae larvae in the littoral region of different environments could be the lesser depth in this habitat, with greater proliferation of perifitic algae, as well as greater offer of food resources and autochthonic and allochthonic organic matter than in the central region. This difference reflects in the greater species richness verified in the littoral region of the twelve sites, favorable for the development of many taxa.

Between the twelve sites, the differences in the dominance values were obvious. In the connected lakes like Patos and Sumida, *C. strenzkei* was dominant in the central region (dominance index 26.14 e 56.42, resp.). Similarly, Higuti & Takeda (2002) encountered larvae of *Chironomus* as dominant in the central region of the Patos lake (dominance index 12.20), proving thus, that the low content of dissolved oxygen and the increase of organic matter can be important factors for the colonization of larvae of this genus.

The dominance of *Aedokritus* sp. (secondary channel and six lakes), *Polypedilum (Polypedilum)* sp.2 (main and secondary channel) and *Tanytarsus* sp. (two lakes with connection) in some sites of the littoral region is possibly due to the habitat characteristics, indicating that these places are favorable for the development of their larvae, defining a fauna more adapted to habitats with an elevated offer of particulate food. In previous studies, Takeda *et al*. (2004) showed that larvae of the genus *Polypedilum* reached high densities and were dominant in littoral regions of channels and lakes of the floodplain of the Upper Paraná River, in shallow sites with accumulation of detritus, whereas according to Montalto & Paggi (2006), the larvae increasing when the wetland is disconnecting from the river.

The larvae of Orthocladiinae are generally characteristic of lotic environments and the greater water flow in these sites lead to the dominance of *Cricotopus*, especially in the central region of the main channel. Félix dos Anjos & Takeda (2010), studied invertebrate communities in a lotic tropical environment of the Paraná River, encountered species of *Cricotopus*, and showed that the patterns of distribution of organisms is not exclusively a consequence of the water turbulence, but the organisms can aggregate in the same place as the organic matter of the substrates.

Some species of the Upper Paraná River floodplain have high ecological plasticity, as eurybiontes, and can live in a wide environmental variability, and formed populations integrated in many biotic communities. The greater diversity indices in lotic environments, besides the better oxygen conditions, can be consequence of the lateral increase of Chironomidae larvae from the hyporheic zone, which incorporates matter and organisms in the littoral habitats. Thus this zone may play an important role in the maintenance of populations in the main and secondary channel.

The population structure and distribution of Chironomidae larvae is distinct in function of the diversity and quantity of floodplain habitats of the Upper Paraná River. This study contributes to the knowledge of new attributes of the Chironomidae fauna, especially the biomass. The data show that the littoral region of the main and secondary channel and of the lakes is characterized as habitat of great importance for the floodplain ecosystem, attributed to the numerical density and diversity of Chironomidae larvae in the system. On the other side, the central region of the lakes serves as entrance for a great quantity of organic matter already processed in the littoral region, increasing the greater biomass of the benthic fauna.

We conclude that changes brought by habitats different were the main factors influencing the attributes of benthic invertebrates originating in the Ivinhema River. The proposed method complements ongoing investigations in the Paraná River including the effect of habitats different on the benthic community. The littoral region has exclusive characteristics, representing habitats that could play important controlling in the numerical density and index diversity on the ecosystem and alterations in the benthic invertebrates may be attributed to the greater heterogeneity of habitats.

The difference in main channel, secondary channel, connected and lakes without connection, may suggest that invertebrate entry into the drift is active, although differences in benthic densities may confound these patterns.

It was presumed that the biomass of benthic invertebrates in the central region in some biotopes would have different spatial probably according invertebrate drift. The reasons behind these differing results are not clear but may be related to life cycle differences among the taxa studied, and differences in the channel and flow amongst the environments.

From these studies it is obvious that the biomass of chironomids is substantially greater than attained in littoral region, and may be related to the lack of fish predators which might otherwise reduce standing crop biomass. In the Paraná River floodplain, new studies should be developed to define species composition, density and biomass benthic community structures, to better characterize habitats and evaluate subsequent aquatic biodiversity.

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