Diversity of chironomid larvae in a marginal fluvial wetland of the Middle Paraná River floodplain, Argentina.

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The diversity of chironomid larvae in relation to flooding and drought phases in a marginal fluvial wetland of the Middle Paraná River floodplain was analyzed. Four sampling stations in the right bank of the Tiradero Viejo River towards the interior of the marginal wetland were established: one at the riverside, and three more at 10, 30 and 40 m from the river. Bottom sediment samples were extracted during the hydrosedimentological cycle of 2001. A total of 25 taxa of Chironomidae were recorded. The values of taxonomic richness, density and diversity were higher in the marginal fluvial wetland than in the riverside, increasing when the wetland is disconnecting from the river. *Polypedilum* (*Tripodura*) spp., *Polypedilum* (*Polypedilum*) spp., *Ablabesmyia* (*Karelia*) spp., *Coelotanypus* sp., *Monopelopia* cf. *boliekae*, *Goeldichironomus holoprasinus* and *Chironomus* gr. *decorus* spp. were dominant in marginal wetlands. The results indicate that the variations in the hydrosedimentological regime, the degree of disconnection with the river and the progressive desiccation at each one of the stations of the marginal fluvial wetland are limitant factors in the distribution and abundance of aquatic chironomids. The different assemblages of Chironomidae were strongly conditioned by temporal changes related to the gradient of inundation-drought and to the hydroperiod dynamics.

Keywords: Chironomid larvae, temporal fluvial wetlands, drought tolerance, Middle Paraná River.

Introduction

In the great floodplain rivers, permanent or temporary wetlands can be limited by aquatic and terrestrial conditions in relation to the dynamics of the hydrosedimentological river regime, upon which the offer of habitats, the specific complexity and the characteristics of populations depend (Junk et al. 1989, Neiff 1999). These environments are periodically inundated by the lateral flooding of rivers and lakes, by direct precipitation, or by groundwater (Junk et al. 1989), and have been denominated as aquatic-terrestrial transition zones or ATTZ (Junk et al. 1989), marginal fluvial wetlands (Neiff et al. 1994), riparian wetlands (Mitsch 1996), etc. In these ecosystems, prolonged aquatic or terrestrial phases exert strong selective pressures on aquatic organisms in the process of colonization of the different types of habitats. During the river flooding, these environments offer opportunities of feeding and refuge to aquatic organisms (Bonetto et al. 1969, Welcome 1979).

Numerous studies analyze the importance of the lateral dimension in great floodplain rivers in function of hydrosystem dynamics (Ward 1989, Petts & Amoros 1996). This dimension includes the interchanges produced in both directions and the interactions that occur between the river and its floodplain, constituting a system with unique characteristics (Amoros & Roux 1988, Junk et al. 1989, Bayley 1995). This system presents a great spatial heterogeneity and an enormous diversity of different habitats and microhabitats for organisms.

Chironomidae is one of the best represented families of Diptera in abundance and diversity in the continental aquatic environments and their immature stages are part of the benthic communities and associated to aquatic vegetation of most continental water bodies, which motivated numerous studies on their taxonomy and biology around the world (Paggi 2001). Although it is a very diverse group in South America, there is scarce information on taxonomy of

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these organisms in Argentina (Marchese & Paggi 2004, Paggi 1998, Reiss 1977). Some of the studies on Chironomidae ecology in Argentina correspond to the Río de la Plata (César et al. 2000), to the Upper Paraná River (Paggi et al. 1998), and to some lakes of the Province of Buenos Aires (Masaferro et al. 1991, Rodriguez Capítulo et al. 1995).

Some studies have cited invertebrate species from riparian wetlands of the Amazon River flooding forest (Irlmer 1975) and temporal wetlands of the United States (Wissinger 1999) and Africa (Pacini & Harper 2001). At present, there is very scarce information on invertebrates of marginal fluvial wetlands and, particularly, there are no studies done on the diversity of Chironomidae in these temporal environments. For that reason, the objective of this study was to analyze the diversity of chironomid larvae in relation to flooding and drought phases in a marginal fluvial wetland of the Middle Paraná River floodplain.

Study area

The selected area corresponds to a marginal fluvial wetland of the Middle Paraná River floodplain, located in the transversal section of the Santa Fe-Paraná cities (32° 40' S - 60° 30' W), Argentina (Fig. 1). This wetland is inundated by the Tiradero Viejo River flooding (secondary channel of the Middle Paraná River) and extends from the levee to the interior of the wetland constituted by the lands adjacent to the river (Fig. 2). The hydrosedimentological regime of the Paraná River is generally predictable, although it can show fluctuations in amplitude and duration in each cycle (Drago 1981). The flood period occurs normally in March-April and the low water occurs in September-October. The Tiradero Viejo River flooding is produced when the Middle Paraná River exceeds 13.29 m a.s.l. (as measured al the Paraná Harbour staff gauge). During the study period, the area remained inundated from February to April 2001, when the low water began, until it remained totally dry in June 2001 (Fig. 3).

The dominant plant species in the area were: *Tessaria integrifolia* Ruiz et Pavon*, Salix humboldtiana* Willdenow*, Sesbania virgata* (Cavanilles) Person*, Thalia multiflora* Horkel*, Panicum elephantipes* Nees*, Panicum prionitis* Nees*, Paspalum repens* Bergius*, Echinochloa polystachya* (Humboldt, Bonpland et Kunth) Hitchcock*, Polygonum acuminatum* Kunth*, Eleocharis* spp.*, Eichhornia crassipes* (Martius) Solms*, Salvinia herzogii* de la Sota*, Azolla caroliniana* Willdenow and *Pistia stratiotes* Linné.

Material and methods

A transect was selected from the right bank of the Tiradero Viejo River towards the interior of the marginal wetland. Four sampling stations were established, one at the riverside, and three more at 10, 30 and 40 m from the river (Fig. 2). Bottom sediment samples were extracted during the hydrosedimentological cycle (from April to July) of 2001. Samplings were carried out every fortnight during the permanent flooding phase, and every 7 to 10 days at the beginning of the flooding and at the end of the drainage. Five replicates were taken using a coring tube of 10 cm diameter and 15 cm height at each one of the sampling stations located inside the wetland. Three replicates were extracted with a 319 cm^2 Tamura grab at the riverside. When the marginal wetland remained dry samplings continued at the different stations for 15 to 45 days. Sediment samples were fixed with formol 10%, filtered with a sieve of 100 µm mesh size and stained with erythrosin. Finally, invertebrates were separated from sediment under a stereoscopic microscope (4 x).

The following environmental variables were registered at the different stations: water temperature (standard thermometer), depth, pH (Helliger), dissolved oxygen concentration (YSI oxygen meter), transparency (Secchi) and conductivity (Beckman conductimeter). Moreover, a sample for granulometry and organic matter sediment analysis was taken at each point. The organic matter analysis was carried out in the coarse particulate fraction (CPOM): > 250 µm – 1 mm, the fine particulate fraction (FPOM): > 63 µm - 250 µm, and the ultrafine particulate fraction (UFPOM): < 63 µm. The different fractions were dried at 60 °C for 24 h, and then taken to a muffle furnace (550 °C, 2 h), and weighed in a Mettler balance of 0.01 g precision. The granulometry analysis of sediments was carried out following the methods for preparation of clastic sediments; sand granulometry was also analyzed (Wentworth's scale 1932). Humidity degree of sediments was measured as the water loss after 24 h drying at 105 ºC.

The following keys and papers were used for the taxonomic determination of Chironomidae: Coffman & Ferrington 1996, Cranston & Nolte 1996, Fonseca Mendes et al. 2003, Paggi 2001, Reiss 1974, Roback 1985, Saether & Sundal 1999, Trivinho-Strixino & Strixino 1995, Trivinho-Strixino & Strixino 2000 and Wiederholm 1983.

Classification analysis was performed using the Multivariate Statistical Package (MVSP, version 3.1 for Windows, Kovach Computing Services). Using both species and environmental data, Canonical
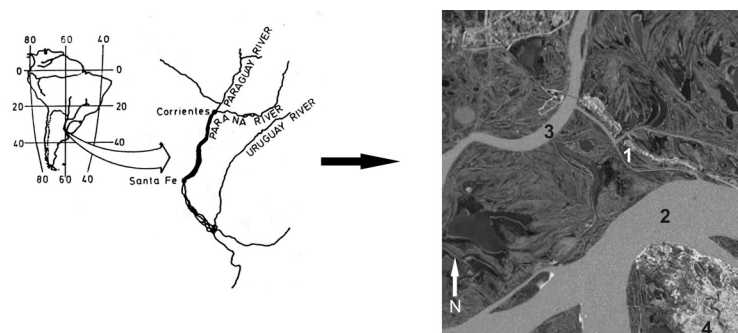
Fig. 1. Study area in the Middle Paraná River (Santa Fe-Paraná section- 32° 40´ S- 60° 30´ W) showing the sampling sites. 1: Tiradero Viejo River; 2. Middle Paraná River; 3. Colastiné River.
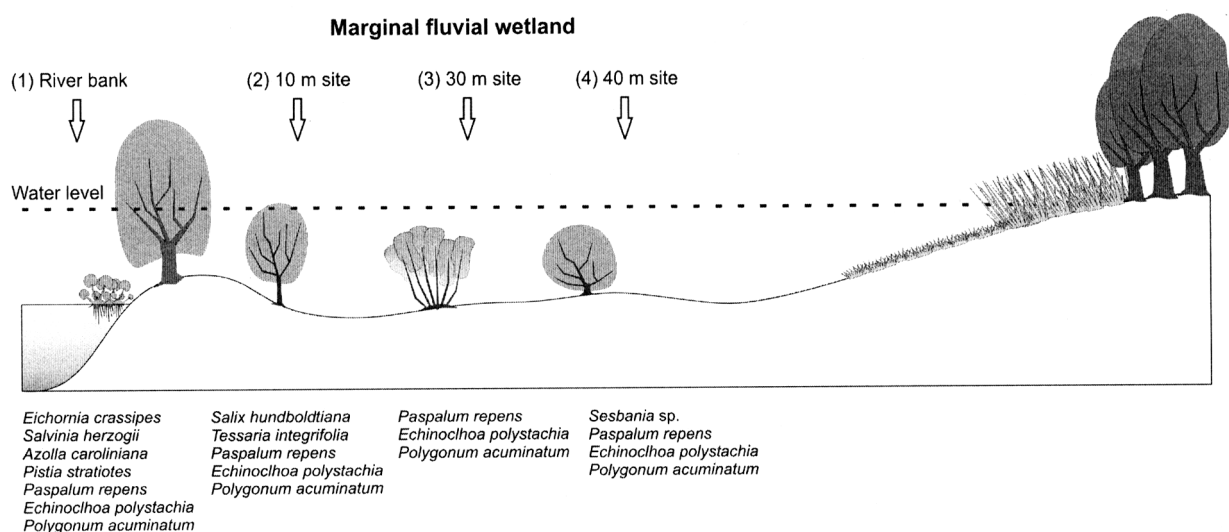

Fig. 2. Different sampling sites in the river bank (1) and marginal fluvial wetland (2-4) of Paraná River floodplain.
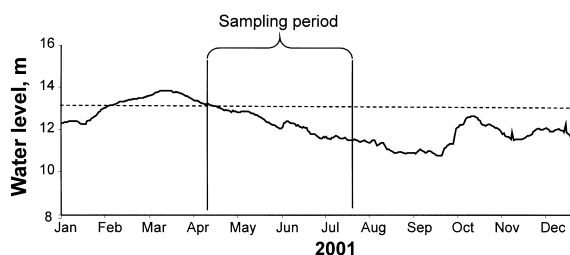

Fig. 3. Water level m. a.s.l. of the Paraná River (as measured at the Paraná harbour staff gauge) in 2001. The sampling period is indicated.

Correspondence Analysis (CCA) was performed in order to reveal the most important trends in relationship of the chironomids to the different sites. Environmental variables and species density data were transformed ($\log_{10} x + 1$) to achieve approximately normal distribution of the data. Pearson correlations calculated to represent the explanatory variables were performed with SPSS Statistical Software (version 10.0).

Results

Habitat characterization

Physical and chemical parameters recorded at the different sampling stations are detailed in Table 1. River organic matter data showed an increasing tendency in the period corresponding to the inundation, but then they decreased at the beginning of low water. In this environment, highest values corresponded to the UFPOM and CPOM values were
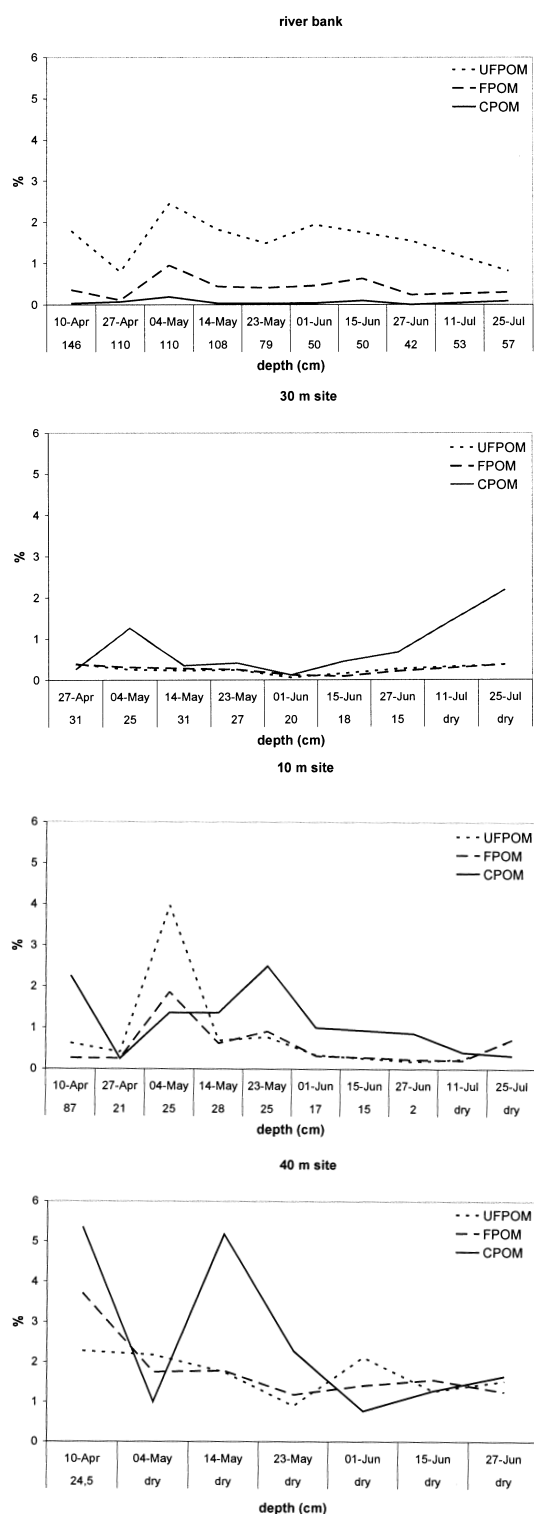
Fig. 4. Organic matter (%) of the sampling sites.

always low (Fig. 4 a). In marginal fluvial wetland values observed of CPOM were high for the different stations, being higher at 10 m and 40 m stations (at this last site, data were obtained with a few centimeters of water until the complete drought). FPOM and UFPOM showed lower values than CPOM for all stations, except at 10 m site where both fraction showed high values at the beginning of drought phase (Fig. 4 b-d).

Sediment from river samples was mostly composed of silt (38.6–59.9%). Sand proportions were higher during low water (16.47–47.66%). Clay proportions increased at the beginning of the lowest water level and decreased at the end of low water levels (12.9–26.9%) (Fig. 5 a). In wetland, sediment granulometry was very similar at 10 m and 30 m stations, showing a higher sand proportion (10 m: 51.3–88.6% and 30 m: 50.7–90.1%), that decreased as the wetland remained exposed to desiccation conditions. However, the 40 m station showed a higher proportion of silt and clay throughout the sampling period (Fig. 5 b-d).

Fine (0.9–78.3%) and ultrafine (21.4–96.9%) sand fractions predominated in the river. In the marginal wetland, the predominance of middle (41.6–76.5%) and fine (4.2–45.3%) sands was observed at the 10 m station, followed by coarse sands (4.3–14.9%), highly coarse sands (0.8– 7.1%), ultrafine gravel (0.04–8.9%) and ultrafine sands (0.4–7.9%). At the 30 m station, a predominance of middle (51.9-62.5%) and fine (23.1–30.2%) sand fractions was registered, followed by lower proportions of coarse sands (7.15-8.8%) and highly coarse sands (4.1–7.1%). Finally, at the 40 m station, the fine (33.2-39.8%), middle fine (26.3-34.9%) and ultrafine (19.3-29.9%) sand fractions predominated, followed by coarse sands (5.20-8.20%). Water content in sediments reached minimum values of 39% to 50% in drought phase.

Density, richness and diversity of Chironomidae

A total of 25 taxa of Chironomidae were recorded, 18 taxa of Chironominae and 7 of Tanypodinae (Table 2). The total number of taxa recorded in the marginal fluvial wetland was higher at the 10 m station (22 taxa), followed by the 30 m station (18 taxa) and the 40 m station (13 taxa). At the riverside, the total number of taxa was 16 (Table 2). *Polypedilum* (*Tripodura*) spp., *Polypedilum* (*Polypedilum*) spp., *Chironomus* gr. *decorus* and *Ablabesmyia* (*Karelia*) spp. were dominant at all stations, being *Polypedilum* (*Tripodura*) spp. the taxon with highest density (Table 2).

Table 1. Physical and chemical characteristics of the sampling stations. Abbreviations: RB: river bank of Tiradero Viejo River.

Date	Site	Depth (cm)	O_2 (ppm)	Temperature (°C)	pH	Conductivity ($\mu.cm^{-1}$)	Transparency (Secchi) (cm)
10/04	RB	146	4.3	23.5	7.6	105	18
	10 m	87	5.8	23	7.6	115	12.5
	40 m	25	5.5	22.5	7.6	115	8
27/4	RB	110	5.4	20.5	7.2	80	9.5
	10 m	21	4.5	18	7.6	110	21
	30 m	31	3.5	18	7.6	110	31
04/05	RB	110	8.8	18	7.2	90	15
	10 m	25	5.5	17	7.6	110	25
	30 m	25	4.9	17	7.6	110	25
	40 m	Dry	-	-	-	-	-
14/05	RB	108	7.6	17	7.2	90	12
	10 m	28	5.1	17	7.2	110	28
	30 m	31	6.7	17	7.2	110	31
23/05	40 m	Dry	-	-	-	-	-
	RB	79	8.8	17	7.2	90	18
	10 m	25	4.9	15	7.2	140	25
	40 m	Dry	-	-	-	-	-
	30 m	27	3.6	17	7.2	140	27
1/06	RB	50	7.2	22	7.2	110	16
	10 m	17	1.0	18.5	7.6	310	17
	30 m	20	2.7	19	7.2	160	20
	40 m	Dry	-	-	-	-	-
15/06	RB	50	7.2	21	7.2	110	20
	10 m	15	5.5	17	7.4	230	15
	30 m	18	2.9	18	7.6	150	18
	40 m	Dry	-	-	-	-	-
27/06	RB	42	4.4	14	7.2	130	20
	10 m	0-2	0	12.8	7.2	480	0-2
	30 m	15	4.9	12.5	7.2	120	15
	40 m	Dry	-	-	-	-	-
11/07	RB	53	9.5	15.5	7.4	110	11
	10 m	Dry	-	-	-	-	-
	30 m	Dry	-	-	-	-	-
25/07	RB	57	9.0	15	7.4	125	31
	10 m	Dry	-	-	-	-	-
	30 m	Dry	-	-	-	-	-

a   river bank

depth (cm)									
146	110	110	108	79	50	50	42	53	57
10-Apr	27-Apr	04-May	14-May	23-May	01-Jun	15-Jun	27-Jun	11-Jul	25-Jul

b   site 10 m

depth (cm)									
87	21	25	28	25	17	15	2	dry	dry
10-Apr	27-Apr	04-May	14-May	23-May	01-Jun	15-Jun	27-Jun	11-Jul	25-Jul

c   site 30 m

depth (cm)								
31	25	31	27	20	18	15	dry	dry
27-Apr	04-May	14-May	23-May	01-Jun	15-Jun	27-Jun	11-Jul	25-Jul

d   site 40 m

depth (cm)						
25	dry	dry	dry	dry	dry	dry
10-Apr	04-May	14-May	23-May	01-Jun	15-Jun	27-Jun

■ sand ■ silt □ clay
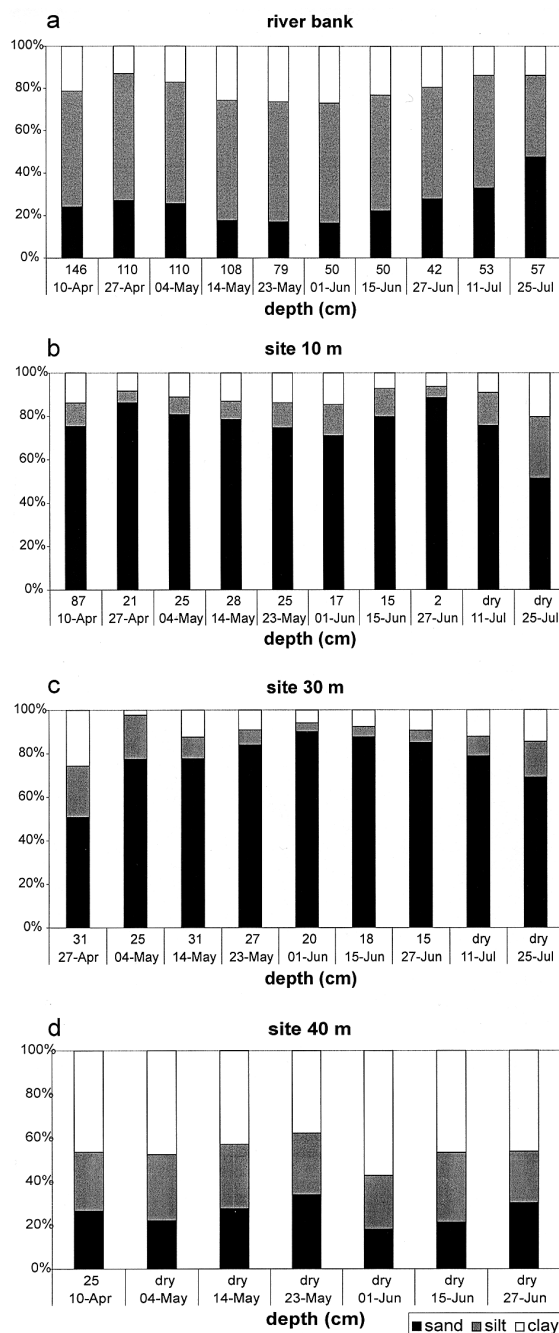
Fig. 5. Sediment granulometry of the sampling sites.

The mean densities of organisms in the marginal wetland varied between 25.4-9829.8 ind.m^{-2} at the 10 m station, 50.8-2413 ind.m^{-2} at the 30 m station, and 0-4419.6 ind.m^{-2} at the 40 m station. At the riverside, the mean densities of organisms varied between 103.3-1880.7 ind.m^{-2} (Fig. 6 a). In general, mean density values of chironomids were higher in the marginal wetland than in the riverside, where these values were lower throughout the annual cycle (Fig. 6 a). The highest mean densities were recorded at the 10 m station, mainly during the period of overflowing and inundation. At the 40 m station, high densities were observed during wetland inundation as in its complete drought (Fig. 6 a).

Taxonomic richness values ranged between 1 and 9 for sites at 10 m and 30 m and between 0 and 11 for the 40 m station. Richness values at the riverside varied between 1 and 8. In general, richness values were higher at stations located in the marginal wetland and lower in the river, decreasing during long periods of desiccation and increasing in the moments of disconnection between the wetland and the river (Fig. 6 b).

Maximum diversity values (Shannon) were 2.73 at the 10 m station, 2.66 at the 30 m station and 2.86 at the 40 m station inside the marginal fluvial wetland. At the riverside station, the highest diversity value was 1.90. Genera diversity values were higher in the wetland than in the river; inside the wetland, the highest records were observed at the 10 and 40 m sites (Fig. 6 b). In relation to the studied phases, diversity was higher in the periods of disconnection between the wetland and the river (Fig. 6 b).

Temporal variations of Chironomidae at the different stations

The dominant taxa in the river were *Polypedilum* (*Tripodura*) spp., *Ablabesmyia annulata* and *Coelotanypus* sp. (Fig. 7 a). Assemblages of chironomids present at the three periods (1: flooding and water input to the wetland, 2: disconnection with the river and beginning of desiccation and 3: phase of complete drought) varied at the stations located in the marginal fluvial wetland. The dominant taxa in this habitat were *Polypedilum* (*Polypedilum*) spp., *Polypedilum* (*Tripodura*) spp., *Ablabesmyia* (*Karelia*) spp., *Coelotanypus* sp., *Monopelopia* cf. *boliekae*, *Goeldichironomus holoprasinus* and *Chironomus* gr. *decorus* spp. *Polypedilum* was present throughout the study period, reaching high proportions during the flooding and desiccation of the wetland. The genus *Ablabesmyia* was represented in a higher proportion when the wetland began to dry, while *Coelotanypus* was present during the flooding and in the desiccation process, when the highest proportions were recorded (Fig. 7 b-d).

Table 2. Density of Chironomidae registered in the sites sampling. Density classes: 1: 1 a 100 ind.m^{-2}, 2: > 100 ind.m^{-2} – 1000 ind.m^{-2}, 3: > 1000 ind.m^{-2}. Abbreviations: **RB**: right bank of Tiradero Viejo River, **w**: wet phase, **d**: dry phase. Taxa abbreviations are included in brackets.

	River	Riparian fluvial wetland					
	RB	**10 m w**	**10 m d**	**30 m w**	**30 m d**	**40 m w**	**40 m d**
Tanypodinae							
Coelotanypus Kieffer sp. (Co)	1	1	1	1	2	1	1
Ablabesmyia annulata (Say) (Ab a)	1	1		1		1	1
Ablabesmyia (*Karelia*) Roback spp. (Ab K)	1	1	1	1	1	2	2
Labrundinia Fittkau spp. (La)	1	1		1		2	1
Monopelopia cf. *boliekae* Beck and Beck (Mo)		1		1	1		2
Djalmabatista Fittkau spp. (Dja)	1	1					1
Tanypus Meigen sp. (Ts)		1	1				
Chironominae							
Chironomini							
Beardius xylophilus Trivinho-Strixino & Strixino (Be)					1		
Chironomus Meigen gr. *decorus* spp. (Chi)	1	1	2	1	2	2	2
Parachironomus Lenz spp. (Pa)		1		1	1	1	1
Goeldichironomus holoprasinus (Goeldi) (Go)	1		1	1	2	1	
Cryptochironomus Kieffer sp. I (Cr1)	1	1		1			
Cryptochironomus Kieffer sp. II (Cr2)	1	1		1			
Dicrotendipes Kieffer sp.		1			1		
?*Endotribelos* Grodhaus sp. (En)	1	1					1
Phaenopsectra Kieffer sp. (Ph)	1	1					
Paralauterboniella Lenz sp. (Parl)	1	1		1			
Harnischia Kieffer spp. (Ha)		1		1			
Saetheria Jackson sp. (Sa)		1					
Fissimentum desiccatum Cranston & Nolte (Fi)	1	1					
Aedokritus Roback sp. (Ae)	1						
Polypedilum (*Tripodura*) Townes spp. (Po T)	2	3		1	1	2	1
Polypedilum (*Polypedilum*) Kieffer spp. (Po P)	1	2	2	2	2		2
Tanytarsini							
Rheotanytarsus Thienemann & Bause sp.				1			
Tanytarsus sp. F Epler (Ta)		1	1	1	2	1	2

At the 10 m station, *Polypedilum* (*Tripodura*) spp. was dominant during all the study period including, the flooding, the desiccation process and the wetland complete drought. *Tanytarsus sp. F*, *Monopelopia* cf. *boliekae* and *Tanypus* sp. were well represented during the phases of flooding and drought; in this last phase, a high proportion of *Chironomus* gr. *decorus* spp. was also observed (Fig. 7 b).

At the 30 m station, *Polypedilum* (*Polypedilum*) spp., *Polypedilum* (*Tripodura*) spp., *Ablabesmya* (*Karelia*) spp. and *Chironomus* gr. *decorus* spp. were
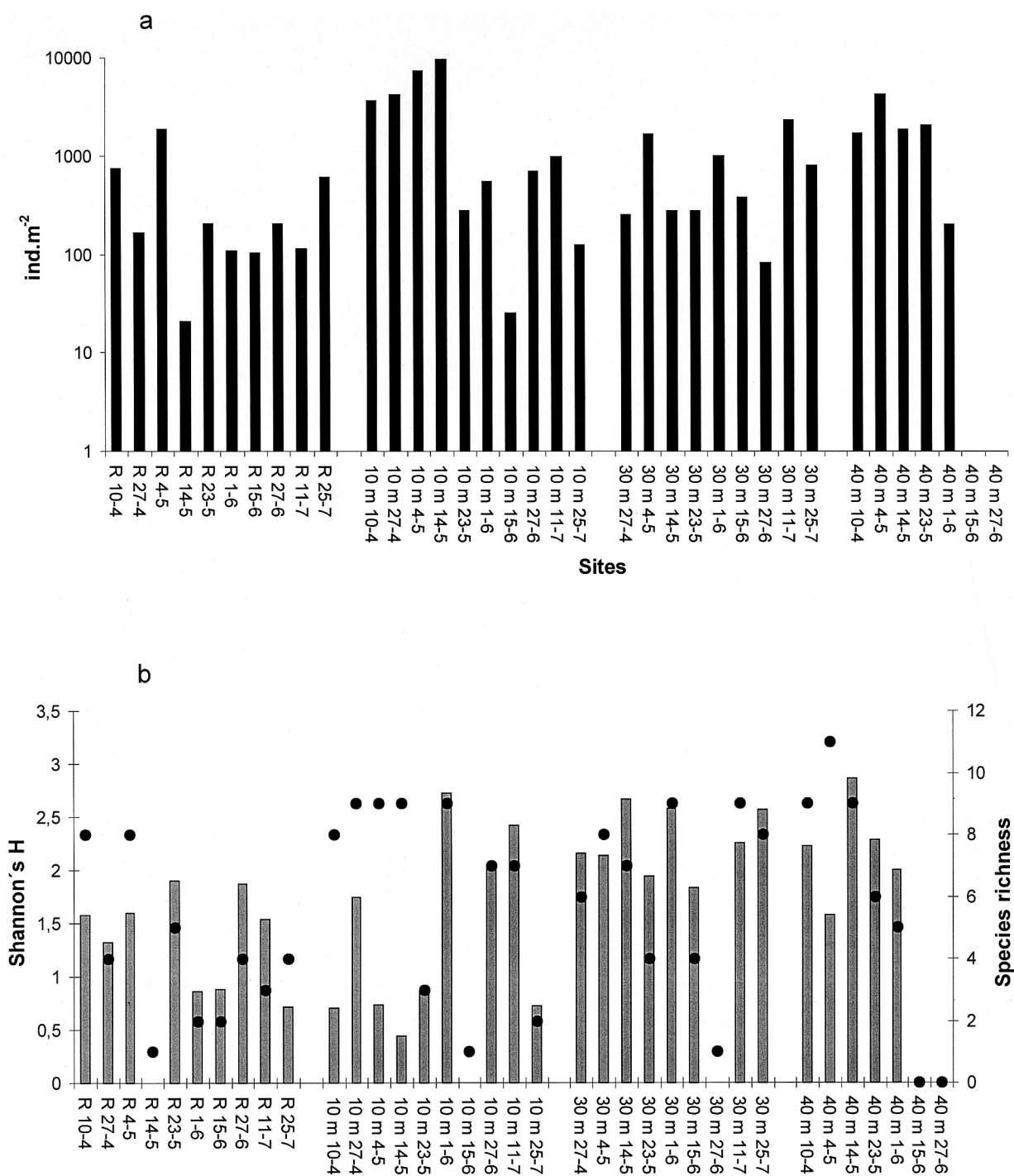
a

b

Fig. 6. (a) Density (ind. m^{-2}) of Chironomidae at the sampling sites. (b) Species richness and diversity (Shannon´s H) index at the sampling sites.
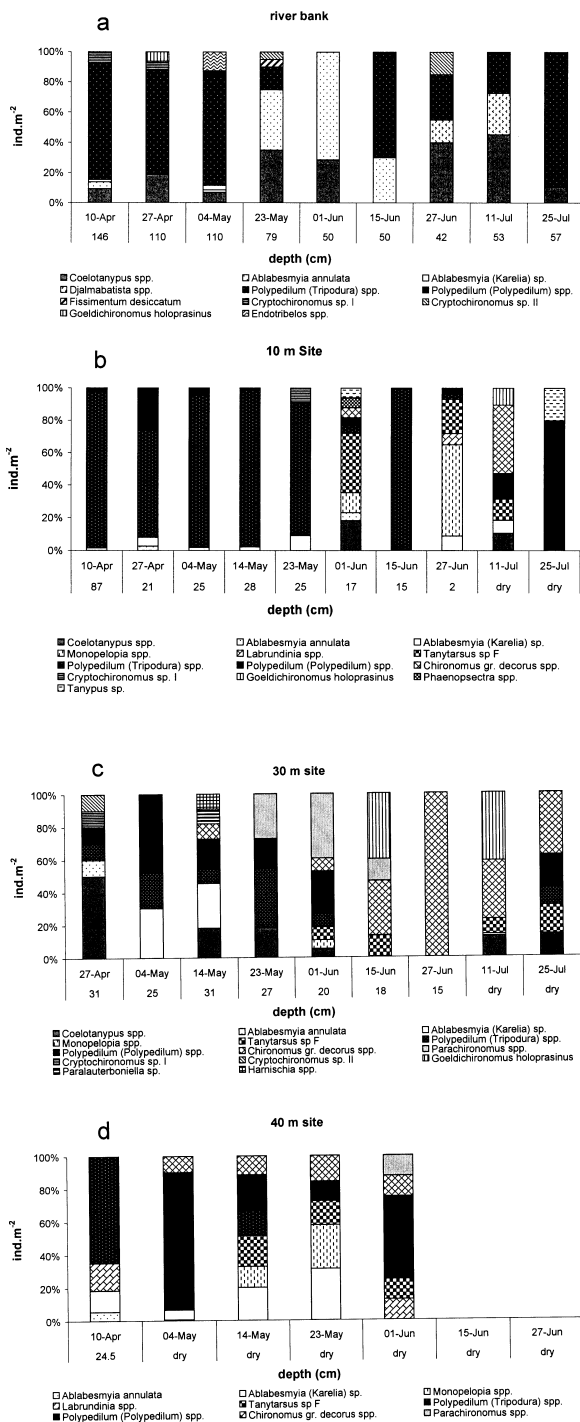
Fig. 7. Temporal fluctuations in density of Chironomidae at the sampling sites.

dominant during the three phases. The genus *Parachironomus* was only recorded during the phase of disconnection between the wetland and the river (Fig. 7 c).

At the 40 m site, where most samples were taken in the extreme drought phase, the dominant were *Polypedilum* (*Polypedilum*) spp., *Ablabesmyia* (*Karelia*) spp., *Chironomus* gr. *decorus* spp., *Tanytarsus sp. F* and *Monopelopia* cf. *boliekae*. The taxa *Polypedilum* (*Polypedilum*) spp., *Chironomus* gr. *decorus* spp., *Tanytarsus sp. F*, *Labrundinia* spp. and *Parachironomus* spp. were registered after 28 days of drought (Fig. 7 d).

The Canonical Correspondence Analysis (CCA) showed the presence of three groups in function of the gradient of inundation-desiccation of sampling stations. The first two axes of the CCA explained 61.90% of variance. Axis I scores (53.21%, eigenvalue = 0.136) were negatively correlated with depth ($r = -0.57$, $p < 0.001$), oxygen ($r = -0.77$, $p < 0.0001$), pH ($r = -0.99$, $p < 0.0001$), temperature ($r = -0.95$, $p < 0.0001$), transparency ($r = -0.82$, $p < 0.0001$) and conductivity ($r = -0.65$, $p < 0.0001$). Axis II scores (8,69%, eigenvalue = 0.022) were negatively correlated with the percentage of silt ($r = -0.49$, $p < 0.002$), clay ($r = -0.65$, $p < 0.0001$), FPOM ($r = -0.70$, $p < 0.0001$), UFPOM ($r = -0.78$, $p < 0.0001$) and CPOM ($r = -0.43$, $p < 0.009$), and positively correlated with the percentage of sand ($r = 0.68$, $p < 0.0001$) (Fig. 8 a).

Group I included all river samplings and 10 m sites at the beginning of flood period. Taxa that defined this group were *Ablabesmyia annulata*, *Cryptochironomus* sp. 1 and sp. 2, *Fissimentum desiccatum*, *Endotribelos* spp. and *Aedokritus* sp. Associated environmental parameters were Temperature, depth and oxygen. Group II is constituted by the different samplings corresponding to the 10 and 30 m stations, when the marginal wetland was inundated and in disconnection with the river. Taxa that defined this group were *Paralauterboniella* sp. and *Parachironomus* spp. Associated environmental parameters were pH, transparency and conductivity. On the other hand, towards the opposite extreme of this gradient, we find Group III, that includes the different samplings from fluvial wetland stations that were found completely dry (10, 30 and 40 m stations). Taxa that defined this group were *Chironomus* gr. *decorus*, *Tanytarsus sp. F.* *Monopelopia* cf. *boliekae*, *Ablabesmyia* (*Karelia*) spp., *Polypedilum* (*Polypedilum*) spp., *Goeldichironomus holoprasinus* and *Tanypus* sp. Environmental parameters associated with this group
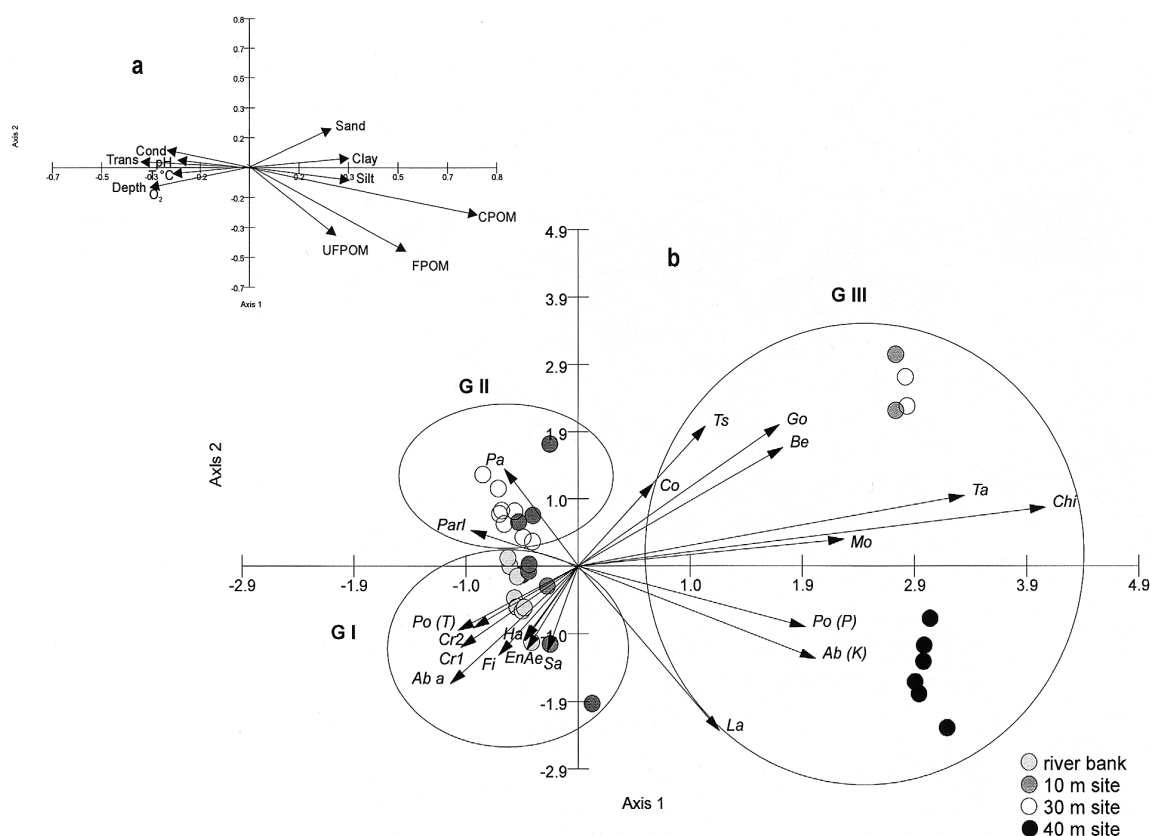
Fig. 8. Ordination of sampling sites and Chironomidae data with environmental variables by Canonical Correspondence Analysis. (a) Environmental variables that explain axis I and II. Abbreviations: cond.: conductivity; G I, II and III: Group I, II and III (b) Ordination of the sites and species. Species abbreviations as in table 2.

were the different fractions of organic matter (mainly CPOM) and sediment granulometry (Fig. 8 b).

Discussion

The results obtained in this study indicate that the variations in the hydrosedimentological regime, the degree of disconnection with the river and the progressive desiccation at each one of the stations of the marginal fluvial wetland are limitant factors in the distribution and abundance of aquatic chironomids. The different assemblages of Chironomidae found at the fluvial wetland stations are strongly conditioned to temporal changes related to the gradient of inundation-drought and to the hydroperiod dynamics. In relation to the lateral dimension, the 10 and 30 m stations showed similar sandy sediment and time of water residence, but different availability of organic matter, that was higher at the 10 m station. The 40 m station showed a different

dynamics, since the water inundates it during a brief period, the sediment granulometry is silt-clayey and there are high values of organic matter availability. In this way, the hydrosedimentological regime impacts in the local diversification of each one of the stations. These differences between adjacent wetlands influence and determine the variations in their physico-chemical characteristics, originating different microhabitats at different stages of the succesional processes and, therefore, with typical chironomid assemblages. In spite of the closeness among wetland stations, each one of them differs in their physico-chemical properties, generating a very wide niche availability and providing as well refuge possibilities in unfavourable conditions, such as desiccation, favouring thus a great biodiversity.

Following the water flooding, an important association of chironomid larvae entered and occupied this habitat diversity offered by marginal fluvial wetlands. Migration towards the new available habitats is one of the more

important escape mechanisms in terrestrial and aquatic organisms during the different phases of the hydrosedimentological cycle. This movement towards the interior of the marginal wetland follows the water line of river flooding that inundates the adjacent lands and, in this way, new habitats and microhabitats begin to be colonized. In this sense, some Oligochaeta species can migrate inside the Amazonian flooding forest up to 300 m following the stimulus of the abundant organic matter available as food source (Irmler 1989).

Invertebrates that live in these temporal wetlands are mainly adapted to withstand very fluctuating environments with rapid changes and periodical situations of desiccation. In this way, many invertebrates that inhabit these wetlands have been considered as opportunistics and generalists. According to Harper & Pacini (2001), although it is difficult to recognize wetland organisms, many invertebrates can be considered typical of this type of environments and one of their distinctive features is the presence of adaptations and physiological and behavioural strategies to survive in environments subjected to changes in the hydroperiod, including the tolerance to conditions of extreme desiccation. These authors include the family Chironomidae of African wetlands as a group in which typical wetland organisms can be found.

In this study, organisms belonging to *Chironomus* gr. *decorus*, *Polypedilum* (*Polypedilum*) spp. *Polypedilum* (*Tripodura*) spp., *Tanytarsus sp F*, *Tanypus* sp., *Parachironomus* spp., *Labrundinia* spp., *Coelotanypus* sp., *Ablabesmyia* (*Karelia*) spp., *Monopelopia* cf. *boliekae*, *Goeldichironomus holoprasinus*, *Djalmabatista* sp. were able to tolerate desiccation conditions. Moreover, species with terrestrial larvae have also been recorded within the genus *Tanytarsus*, important during the desiccation period in the marginal wetland (Wiederholm 1983). In this sense, studies on Chironomidae from temporal environments have shown the presence of certain species that resist the extreme conditions of desiccation and temperature (Dank 1971 a,b). Some of the strategies described for these species were the construction of tubes and cocoons for humidity conservation. Hinton (1960 in Wiggins 1980) observed the formation of cocoons in larvae of a species of the genus *Polypedilum* in Africa that allowed this species to persist in the dry sediment for many years. Wiggins (1980), who analyzed the adaptive strategies of invertebrates from temporal environments, observed that larval stages of Chironomidae are capable of beginning a latency period or of producing resistance eggs to survive to unfavourable conditions until these are re-established.

Fissimentum desiccatum showed drought tolerance in Brasil (Cranston & Nolte 1996).

In this study, chironomids were capable of staying completely dry for periods of more than 28 days, as was registered for the 40 m site. To be able to do this, they built tubes or used macrophytes in decomposition, when the desiccation conditions are extreme. The organisms of genera *Coelotanypus*, *Ablabesmyia*, *Polypedilum*, *Chironomus*, *Cryptochironomus*, *Tanytarsus*, among others, are capable of introducing inside the sediments for up to 15 cm as a strategy to bear these extreme conditions (Montalto pers. obs.).

Hamburger et al. (1997) analyzed some benthic species strategies to tolerate anoxia conditions. An adaptive mechanism, described by these authors, is the presence of haemoglobin, which allows them to maintain a constant aerobic metabolism in spite of the low oxygen concentrations and the gradual reduction of this metabolism until they can finally begin a latency period. *Chironomus* larvae have been described as facultative anaerobic, i.e., they can live long periods of anoxia using glycogen, that, as has been experimentally proven, allows them to survive for 20-40 days, depending on the larval stage (Hamburger et al. 1997). As was observed in this study, the genus *Chironomus* could bear extreme desiccation conditions and was as one of the taxa more clearly associated to desiccation conditions.

As Hamburger et al. (1997) indicated, the study of Chironomidae diversity in the different types of wetlands, their dynamics and adaptive strategies is essential to be able to implement strategies for conservation of these areas that are so important from the ecological and biodiversity point of view.

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