Fauna structure of water mites associated with *Eichhornia azurea* in two lakes of the upper Paraná floodplain, Mato Grosso do Sul State, Brazil

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ABSTRACT. The density and distribution of mites in different sections of the stolon of *Eichhornia azurea* were studied monthly for 13 months in two upper Paraná River floodplain lakes. The fluviometric variation and consequent changes in the concentrations of dissolved oxygen in the shallow water phase were shown by PCA. DCA showed the mites distribution in the plant sections, forming 5 groups: group A formed by *Centrolimnesia*, group B formed by *Unionicola*, *Koenikea, Neumania*, *Piona* and nymphs, group C by *Arrenurus* and group E formed by *Hydrodroma* and *Hydrozetes*. The mites of groups A, C, and E presented high density in the apical and intermediary sections; therefore, the specimens were less tolerant of the low concentrations of oxygen. Groups B and D were represented by specimens adapted to the bottom and tolerant of hypoxic conditions, where high density in the basal segment was registered. The rise in the water level favored the occurrence of mites in agglomerations on *Eichhornia azurea* in function of the depletion of oxygen in deep areas of the lakes and through the increase of hosts and prey. Temporal variation in mite density was related to the density of available prey, while vertical variation in the segment was diet specific and some specimens were tolerant to hypoxic conditions.

Key words: water mites, macrophytes, floodplain lakes.

RESUMO. Estrutura da fauna de ácaros aquáticos associados a *Eichhornia azurea* em duas lagoas na planície de inundação do alto rio Paraná, Estado do Mato Grosso do Sul, Brasil. A densidade e distribuição dos ácaros em diferentes segmentos do estolão submerso de *Eichhornia azurea* foram estudadas mensalmente durante 13 meses, em duas lagoas da planície de inundação do alto rio Paraná. A variação fluviométrica e conseqüente diminuição nas concentrações de oxigênio dissolvido durante a fase de águas altas foram evidenciadas pela PCA. A DCA mostrou a distribuição dos gêneros nos segmentos da planta, formando 5 grupos: grupo A, formado por *Centrolimnesia*, grupo B, por *Unionicola*, *Koenikea, Neumania*, *Piona* e ninfas, grupo C, por *Arrenurus*, e grupo E formado por *Hydrodroma* e *Hydrozetes*. Os gêneros dos grupos A, C e E apresentaram suas maiores densidades nos segmentos apical e intermediário, pois são considerados menos tolerantes às baixas concentrações de oxigênio. Os grupos B e D foram representados por gêneros adaptados ao fundo e que toleram a hipoxia, onde se registrou maior densidade no segmento basal. A elevação do nível da água favoreceu a ocorrência dos ácaros nos bancos de *Eichhornia azurea* em função do déficit de oxigênio em regiões profundas das lagoas e através do aumento de hospedeiros e presas. A variação temporal na densidade de ácaros foi relacionada à densidade de presas disponíveis, enquanto que a distribuição nos segmentos foi a relacionada com a especificidade alimentar e a tolerância a hipoxia de alguns gêneros.

Palavras chave: ácaros aquáticos, macrófitas, planície de inundação.

Introduction

Water mites are one of the most abundant and different arthropod groups in aquatic environments. They occur at the vegetation margins of lakes and rivers (Smith and Cook, 1991) and occasionally in the water. Mites are an important group of phytophile invertebrate population of aquatic macrophytes. (Poi de Neiff, 1977; Pasporello de Amsler, 1987; Poi de Neiff and Neiff, 1988; Oertli and Lachavane, 1995; Blanco *et al.,* 1998).

Eichhornia azurea (Schwartz) Kunth is abundant macrophyte species, not only in extension but also in biomass, in most lakes of the upper Paraná floodplain. It forms floating vegetation banks that extend themselves for some meters from the coastal region. Submerged stolons harbor a great variety of invertebrates, including water mites, with rare surveys in the field research. Although the occurrence of various species (Rosso de Ferradás, 1977, 1982, 1984, 1989) in the middle of Paraná River floodplain (Argentina) was reported and described, very little is known about the taxonomy and ecology of these species from the Brazilian section of the river.

Current analysis of the mites community in two lakes of the upper Paraná floodplain aims to report the occurrence and distribution of different genus in the submerged stolon of *E. azurea* and its relationship with the fluctuation of the river water level, and the physical and chemical variables of the water establishing interactions with other phytophilous invertebrates.

Material and methods

Current research was undertaken in two lentic environments of the upper Paraná floodplain (Figure 1A). Guaraná Lake (22º 43'26" S and 53º 18'03") is linked to the Baía River by a narrow channel. Aquatic macrophytes, mainly *E. azurea*, are predominant in the lake's coastal region.

Patos Lake (22º 49'19" S and 53º 31'33") has a larger area when compare to the Guaraná lake and lies on the left margin of the Ivinhema River. A channel maintains permanent communication between the two environments. Its margins have an irregular contour and are colonized by grasses and aquatic macrophytes, chiefly *E. azurea*.

Samples of *E. azurea* were collected monthly from October 1997 to October 1998 in Patos Lake and Guaraná Lake. Sampling was undertaken by pulling the plant's stolon out of the water till the total exposure of almost all root tuffs. Stolon was segmented into three parts (Figure 1B) forming the apical (close to the water surface), intermediary, and basal (close to the bottom) sections. Roots and stalks of each segment were separated, conditioned in polyethylene flasks and conserved in methanol 80%.

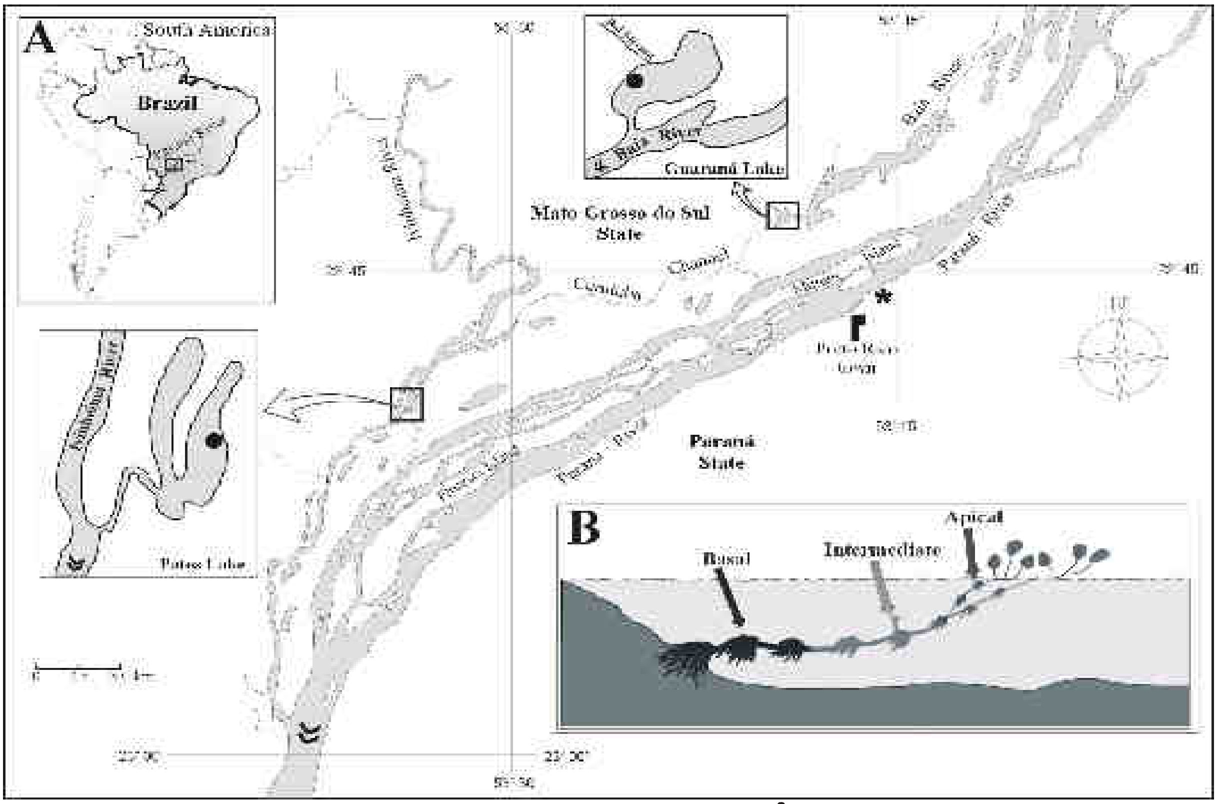

Figure 1. A: Study area and location of the sampling stations (● Sampling stations * Nupelia field laboratory « Direction of the flow). **B:** Location of the sections of *Eichhornia azurea*. Modified from Volkmer-Ribeiro et al., 1984.

Roots and stalks were slightly scraped, washed in 80% methanol (to loosen adherent particles), and dried in a buffer at 60ºC, so that density of organisms in 100 g of dry weight could be calculated.

Transparence of water column (Secchi disk), depth and temperature were measured during sampling. Water samples (surface, middle, and bottom) were collected with a Van Dorn bottle and taken to lab for pH (potentiometer) and electrical conductivity determination (conductivity digital meter). Winkler method, modified by Golterman *et al.* (1978), was used to calculate concentrations of dissolved oxygen in water.

Data on the hydrometric level of the Paraná River and Ivinhema River, from São José Port (State Paraná) and Sumeca Port (Mato Grosso do Sul State) respectively, were passed on by the National Electricity Agency (ANEEL). Mean monthly hydrometric levels prior to collection were used for statistical analyses.

Water mites were separated, fixed in Gaw liquid and bleached with acetyl acid for better visualization of their taxonomical structure. Identification was made at genus level with specialized bibliography by Rosso de Ferradás (1973a; 1973b; 1974; 1975; 1976; 1978; 1980; 1981; 1982; 1983; 1984; 1987; and 1989), Rosso de Ferradás and Fernandez (1995) and Smith and Cook (1991).

Principal components analysis (PCA) was employed for ordination of collection sites/months based on physical and chemical variables. Ordination sites/months and density of water mites was done with Detrended Correspondence Analysis (DCA)(Gauch Jr., 1982). Abiotic data were standardized and biotic ones were normalized by logarithmic transformation (log x+1). Statistica 5.0 and PC-ORD 2.0 were used for PCA and DCA, respectively.

Difference among assemblage structure in stations, in plant sections and in hydrological phases was tested by variance analysis (ANOVA two-way) with DCA axis scores. The relationship among water mites density of other invertebrates and abiotic variables was established by Spearman's rank correlation.

Results

Hydrological regime

Since the hydrological phases of Guaraná Lake were defined according to the water level of the Paraná River, November/1997-March/1998, May and October/1998 were high water months. According to Thomaz *et al.* (1992) river levels over 3.5 m mark the high water phase of the river. Patos Lake was affected by the hydrological regime of the Ivinhema River water levels over 2.5 m in November and December/1997, March to May/1998 and August to October/1998 constituted high water phase. The low water phase occurred on the other months (Figure 2).

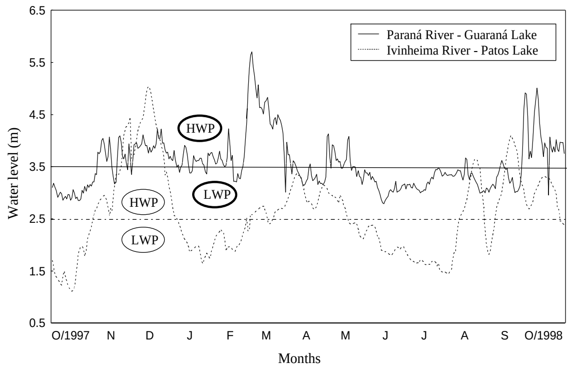

Figure 2. Monthly water level variation of the Paraná River and Ivinhema River. High water phase (HWP) and Low Water Phase (LWP) were indicated.

Physical and Chemical variables

During the period analyzed, water temperature oscillated about 10ºC, with slight differences among the surface, middle and bottom of the water column. Highest depth oscillation was reported in Patos Lake with compare to Guaraná Lake. Rate of water transparency was lower in Guaraná Lake in the two phases and highest electrical conductivity rates were reported in Patos Lake during the high water phase, with an increase in ions relationship to input of the organic material decomposition. The pH was slightly acid, with rates among 5.0 and 6.0 in the two phases. Decrease in the concentration of dissolved oxygen in water was reported during the high water phase, mainly at the bottom of the lakes (Table 1).

Limnological traits of the lakes

Abiotic variables were summarized using Principal Components Analysis (PCA). The first two axes were retained for interpretation (eigenvalues >1). These axes explained 47.82% of the total variability of the data: the first component explained 26.02%, whereas second 21.8%. Ordination separated the two lakes (Figure 3). Dissolved oxygen was negatively associated with PCA 1, whereas electrical conductivity and depth were positively associated. For PCA 2, pH and electrical conductivity presented negative correlation and water level positive.

Table 1. Physical and chemical variables of water in two lakes of the upper river Paraná floodplain during different hydrological phases.

Abiotic variables			Guaraná lake		Patos lake	
			High water	Low water	High water	Low water
Depth (m)		$\bar{x}$ (sd)	2,2 (0,4)	1,9 (0,7)	2,8 (0,7)	1,9 (0,4)
		min-max	1,8-3,0	1,2-3,0	2,0-4,0	1,2-2,4
Secchi transparence (m)		$\bar{x}$ (sd)	0,7 (0,2)	0,7 (0,2)	1,0 (0,3)	0,9 (0,1)
		min-max	0,5-0,9	0,5-1,1	0,6-1,5	0,7-1,0
pH	Surface	$\bar{x}$ (sd)	5,6 (0,3)	5,9 (0,3)	6,2 (0,3)	6,1 (0,5)
		min-max	5,1-5,8	5,6-6,4	5,8-6,8	5,5-6,7
	Middle	$\bar{x}$ (sd)	5,5 (0,3)	5,8 (0,4)	6,0 (0,2)	6,0 (0,4)
		min-max	5,1-5,9	5,4-6,4	5,6-6,3	5,3-6,5
	Bottom	$\bar{x}$ (sd)	5,5 (0,3)	5,7 (0,4)	5,9 (0,4)	6,0 (0,4)
		min-max	5,1-5,8	5,3-6,4	5,3-6,6	5,5-6,6
Electrical conductivity (μScm^{-1})	Surface	$\bar{x}$ (sd)	22,4 (4,2)	21,7 (3,8)	34,4 (4,6)	31,2 (7,6)
		min-max	16,9-29,1	17,0-36,0	28,0-41,0	23,0-41,0
	Middle	$\bar{x}$ (sd)	23,1 (4,0)	23,0 (6,9)	36,1 (5,9)	30,5 (9,7)
		min-max	17,5-29,4	17,0-36,0	28,0-45,0	17,0-41,0
	Bottom	$\bar{x}$ (sd)	24,3 (5,5)	23,5 (8,5)	36,1 (4,2)	30,1 (9,6)
		min-max	19,1-34,0	17,0-40,0	29,8-41,0	17,0-41,0
Dissolved oxygen ($mg\ L^{-1}$)	Surface	$\bar{x}$ (sd)	2,6 (1,2)	4,7 (2,5)	2,6 (0,9)	5,7 (2,0)
		min-max	0,8-4,2	1,0-7,4	1,5-4,4	3,8-8,4
	Middle	$\bar{x}$ (sd)	1,6 (1,0)	4,4 (2,4)	1,4 (0,6)	5,4 (2,1)
		min-max	0,5-3,7	0,5-7,2	0,8-2,6	2,4-7,4
	Bottom	$\bar{x}$ (sd)	1,0 (0,7)	4,4 (2,5)	1,1 (0,9)	4,6 (2,9)
		min-max	0,4-2,4	0,3-7,3	0,5-3,1	0,9-7,6
Temperature (°C)	Surface	$\bar{x}$ (sd)	28,0 (2,8)	24,2 (2,8)	27,5 (4,2)	28,2 (5,7)
		min-max	24,0-33,0	21,0-29,0	21,0-32,0	21,0-35,0
	Middle	$\bar{x}$ (sd)	28,0 (3,0)	23,6 (3,0)	25,7 (3,1)	27,4 (5,5)
		min-max	23,0-33,0	20,5-29,0	21,0-30,0	21,0-34,0
	Bottom	$\bar{x}$ (sd)	27,0 (3,4)	23,2 (3,2)	25,2 (2,6)	26,6 (4,4)
		min-max	21,0-32,0	20,0-29,0	21,0-28,5	21,0-32,0

$\bar{x}$ =mean; sd =standart desviation; min-max= minimum and maximum.

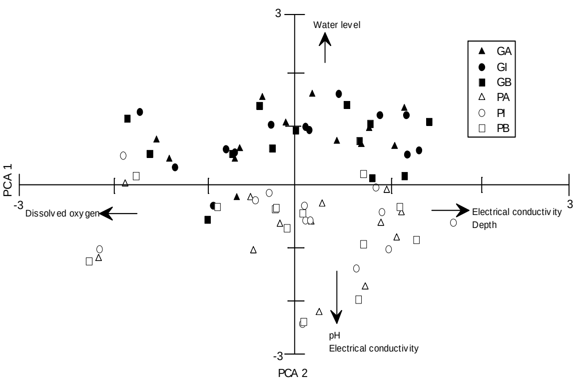

Figure 3. PCA ordination of the sampling stations - Guaraná Lake (G) and Patos Lake (P) - and sections of *Eichhornia azurea* - apical (A), intermediate (I) and basal (B). A principal component analysis was applied with the correlation matrix of water level, dissolved oxygen; electrical conductivity, water temperature, depth, pH and Secchi. Arrows indicate variables that contributed more to the two first axis.

Density of water mites

Limnesia, Koenikea, and *Neumania* were almost 80% of total acarus population in the nine genus reported in samples of *E. azurea* (Table 2). Mites densities, mainly *Neumania* and *Koenikea*, registered in Patos Lake, were relatively higher than those in Guaraná lake, due to density peaks, during the high water phase. The above two genus accounted for the highest density of water mites in the basal segment of the plant.

Although *Limnesia* was abundant in the two lakes at the plant's apical segment, it had a high density at the intermediary and basal sections of *E. azurea* during the low water phase of Guaraná Lake.

Density increase of *Unionicola* at the plant's three sections in both lakes coincided with the rise of water level. Highest density in *Unionicola* and *Hydrozetes* was reported in Patos Lake at the plant's intermediary segment. Other genus as *Hydrodroma*, *Centrolimnesia* and *Piona* had low densities and were not collected with frequency in the samples.

After DCA ordination, based on monthly density of mites, five distinct groups were formed subjectively to improve the interpretation of results that indicated the exploitation of different compartments of *E. azurea* during the hydrological phases (Figure 4).

Table 2. Density of water mites (Org./100 g D.W.) at different sections of *Eichhornia azurea* stolon reported in two lakes of the upper Paraná river floodplain.

	Guaraná Lake						Patos Lake					
	Apical segment		Intermediate segment		Basal segment		Apical segment		Intermediate segment		Basal segment	
	High water	Low water	High water	Low water	High water	Low water	High water	Low water	High water	Low water	High water	Low water
	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)	$\bar{x}$ (sd)
Hydrodromidae												
Hydrodroma Koch, 1837	-	-	-	-	-	-	-	**2** (4)	-	-	-	-
Limnesiidae												
Limnesia Koch, 1836	**149** (178)	**135** (99)	**56** (52)	**126** (142)	**21** (34)	**101** (135)	**47** (49)	**10** (8)	**24** (35)	**3** (6)	**5** (8)	-
Centrolimnesia Koch, 1837	**3** (7)	-	2 (4)	-	-	-	**2** (6)	-	-	-	-	-
Unionicolidae												
Unionicola Haldman, 1842	**15** (16)	**1** (3)	**14** (11)	-	**11** (7)	**5** (8)	**19** (40)	**15** (34)	**42** (63)	**3** (6)	**17** (27)	-
Neumania Lebert, 1879	**8** (15)	**2** (5)	**74** (128)	**4** (10)	**184** (185)	**29** (21)	**87** (151)	-	**265** (266)	**30** (61)	**541** (535)	**55** (64)
Koenikea Wolcott, 1900	**37** (48)	**8** (21)	**121** (96)	**18** (22)	**121** (62)	**53** (51)	**69** (81)	**13** (28)	**210** (264)	**12** (17)	**153** (81)	**8** (13)
Pionidae												
Piona Koch, 1842	-	-	-	-	-	-	**2** (6)	-	-	-	**3** (8)	-
Arrenuridae												
Arrenurus Dugés, 1834	**1** (3)	-	**2** (5)	-	**4** (7)	-	-	-	**4** (8)	-	**9** (14)	**3** (6)
Hydrozetidae												
Hydrozetes Berlese, 1902	**2** (5)	-	**2** (6)	-	-	**2** (5)	**2** (4)	**19** (26)	**14** (18)	**134** (286)	**18** (47)	**3** (6)
Nymphs	**3** (9)	**1** (3)	**2** (5)	**12** (14)	**5** (9)	**24** (34)	**13** (17)	-	**21** (18)	**12** (22)	**23** (46)	**12** (27)
Total	**218** (168)	**148** (99)	**272** (216)	**160** (152)	**347** (218)	**214** (208)	**240** (212)	**59** (61)	**581** (510)	**194** (265)	**769** (612)	**81** (100)

$\bar{x}$ =mean; sd=standart desviation.

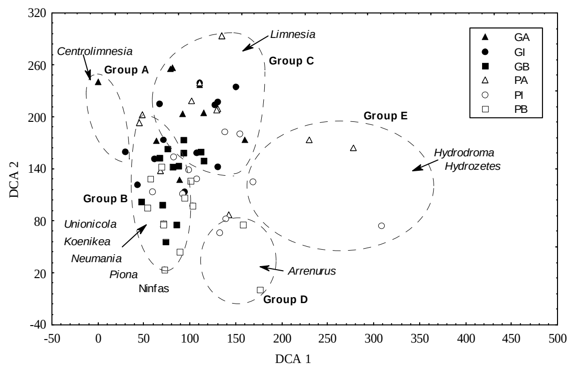

Figure 4. Ordination of scores of DCA axes 1 and 2 with regard to density of water mites - Guaraná Lake (G) and Patos Lake (P) - and sections of *Eichhornia azurea* - apical (A), intermediate (I) and basal (B). Arrows indicate water mites genus that contributed for scores ordination.

Groups A, B, and D represented genus whose highest density occurred during the high water phase. Groups B and D were reported chiefly at the plant's intermediary and basal sections. Group C grouped the greatest number of months of the low water phase of Guaraná Lake and was characterized by an abundance of *Limnesia*. Its highest density occurred at the apical segment. Group E (*Hydrodroma* and *Hydrozetes*) consisted of genus whose greatest density occurred in the low water phase in Patos Lake at the apical and intermediary sections of the stolon. DCA (0.34) axis 1 scores, tested by ANOVA, showed that mites density was significantly different in hydrological phases ($F=15.47$ and $p=0.001$). Axis 2 (0.27) scores showed significant differences between the environments ($F=14.54$ and $p=0.001$) and plant sections ($F=21.92$ and $p<0.001$).

Water mites showed a decrease in density during the low water phase. Maybe the result to be relationship at a response of water mites to population decrease of other invertebrates associated with *E. azurea* which formed an important food source (Figure 5). Density peak of acariforms coincided with high water phase when density of Nematoda, Oligochaeta, Chironomidae, Conchostraca, Cladocera, Copepoda, and Ostracoda increased. The above result suggested that the population of water mites might be also affected by the number of prey available in the vegetation of *E. azurea*.

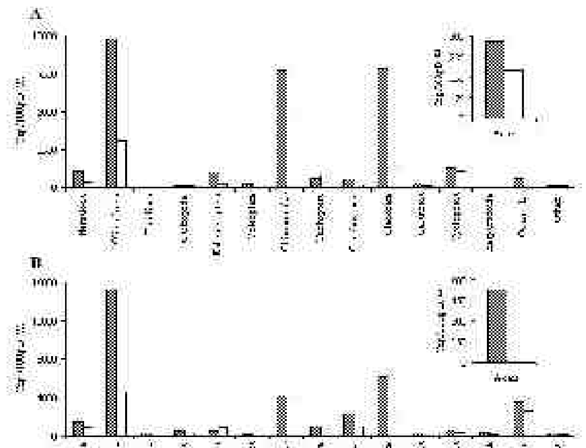

Figure 5. Mean density of invertebrates associated with *Eichhornia azurea* in two lakes of the upper river Paraná floodplain during different hydrological phases. **A.** Guaraná lake; **B.** Patos lake.

Fauna structure of water mites

Environmental variables that best explains the relationship with biological data are presented in Table 3. Depth and water level seemed to affect positively the density of water mites in the lakes. The results of Spearman's rank correlation showed this relation in the Guaraná Lake (r=0.41; p≤0.01 for depth and r= 0.42; p≤0.01 for water level) and Patos Lake (r= 0.35; p≤0.05 for depth and r= 0.45; p≤0.01 for water level). Otherwise negative correlations among mites populations and temperature (r= 0.34-; p≤0.05), pH (r= 0.35-; p≤0.05) and dissolved oxygen (r= 0.32-; p≤0.05) were found in Guaraná Lake and Patos Lake, respectively.

Despite mite interactions with other invertebrates populations the results shows that all invertebrates groups microcrustaceans are very important for explain the flutuactions in the mites populations. Microcrustaceans was positively correlated with mites in the Guaraná Lake (r= 0.45-; p≤0.01) and Patos Lake (r= 0.34-; p≤0.01). Mites density also too correlated with annelids in the Garaná Lake (r= 0.34; p≤0.01).

Table 3. Spearman's rank correlation for water mites density with physical and chemical variables and other invertebrates. p≤*0,05; p**≤0.01.

Interactions		Environments	
		Guaraná Lake	Patos Lake
Water mites	Physical and chemical variables		
	Water level	r= 0,45**	r= 0,42**
	Depth	r= 0,35*	r= 0,41**
	Secchi transparence	r= 0,11	r= 0,08
	pH	r= 0,35-*	r= 0,01
	Electrical conductivity	r= 0,06	r= 0,25
	Dissolved oxygen	r= 0,32-*	r= 0,44
	Temperature	r= 0,07-	r= 0,34-*
	Other Invertebrates		
	Nematodes	r= 0,28	r= 0,15
	Annelids	r= 0,34*	r= 0,29
	Mollusks	r= 0,14	r= 0,04
	Insects	r= 0,12-	r=0,21
	Microcrustaceans	r= 0,45**	r= 0,34*

Discussion

Axis 1 of PCA in the high water phase (depth increase and oxygen decrease) showed that abiotic changes might impair the development of mites in deep regions. Rush and Ritter (1993) showed that depth increase in a lotic environment was a negative factor for the abundance of most benthonic water mites. This result explains a positive correlation to depth increase and rise in water level with density mites associated with *E. azurea*. Several genus migrate from the deep region to the coastal one where water is more oxygenated. Invertebrates with a considerable density increase during the high water phase (including mites) had a negative correlation with dissolved oxygen. This result indicates that when supplies of oxygen dissolved in water decrease, some groups take refuge in banks of *E. azurea*. Some aquatic macrophytes species have the physiological ability to translocate oxygen into surrounding sediments, effectively creating an oxygenated boundary around the roots (Moore *et al.* 1994). Probably rhizosphere oxidation had an ecological significance to water mites and other invertebrates. Total density of acariforms associated with *E. azurea* was, thus, increased, during hypoxic conditions.

DCA showed that Limnesiidae genus (groups A and C) were sensitive to depletion of dissolved oxygen in the high water phase and distributed themselves preferentially at the apical segment. A higher density of *Limnesia* at the basal segment only occurred when there was a reasonable concentration of oxygen at the bottom of Guaraná Lake. Gerecke *et al.* (1996) reported that *Centrolimnesia* was abundant in plankton at layers close to the water surface.

The results of Spearman's rank correlation provided that pH was an important factor influencing the abundance of mites in the Guaraná Lake. Preliminary studies of physical-chemical and water mites interactions have demonstrated that acid lakes contain very few Hydrachinidia species in the benthic substrate (Pennak, 1989). The negative correlation recorded in our results indicated the mites are sensitive to changes water acidification.

Mites specimens were positively correlated with microcrustaceans associated a *E. azurea*, suggested the higher interaction between this two arthropods. The water mites increase associated to the plant coincided with the months with the highest microcrustaceans density, especially cladocerans (Chydoridae and Daphniidae specimens), and ostracods. Curiously no interaction among mites and insect populations was recorded. It seems very strange because mites are important predators of aquatic insects larvae, especially Diptera. The absence of clear relationship with mites density and insects populations was probably due to the higher density in all sampling dates or presence of species with high individual density such as chironomid larvae. Spearman's results showed a relationship among water mites and annelids was also significant too. This result support that acariforms, may be potential predators of oligochaetes, however, that interactions are not well recognized in the literature.

Since density of *Limnesia* was high in *E. azurea* banks of Guaraná Lake, there must be a relationship between this fact and the abundance of its main food items, such as Cladocera and Chironomidae larvae. Nymphs and adults of *Limnesia* in the coastal region of the lake, preferentially fed on Cladocera, Chironomidae, and other larvae of insects (Patterson, 1994). Balsiero (1992) reported that *Limnesia* consumed some 3 to 40 specimens of *Bosmina* a day.

Group B is mainly constituted of depth-adapted genus (such as *Koenikea* and *Neumania*) and mite with swimming capacity (*Unionicola* and *Piona*). Probably *Koenikea* and *Neumania* are more tolerant to smaller oxygen concentrations than the genus of the Limnesiidae family and feed on fixed organisms that live on the roots at the basal segment (such as Nematoda, Oligochaeta, Cladocera of the Chydoridae family, and larvae of Chironomidae). This fact accounts for the high density of this genus at the basal segment. Since *Unionicola* has morphological adaptations, or rather, appendages and long bristles, that give efficiency in swimming, their occurrence is feasible in the coastal and benthic regions, and at different stolon sections of *E. azurea*. The frequent occurrence of the genus in *E. azurea* banks, especially in Patos Lake, may be associated with Bivalvia and Gastropoda (Ancylidae and Planorbidae), and with larvae of Diptera. Water mites of the genus *Unionicola* are symbiotic to Bivalvia (Aboul-Dahab *et al*., 1997) and Gastropoda (Vidrine, 1986), and their life cycle includes the larva that lives in the host mollusk, and a quick parasite phase with Chironomidae larvae (Edwards and Dimock Jr., 1995).

Piona was reported once. Since this occurred, during the high water phase, it might be suggested that a rise in water level brought about some species not usually found in *E. azurea*. The occurrence of the mites coincided with high density of Cladocera in the phytophile fauna of Patos Lake. Butler and Burns (1991) suggested that *Piona exigua* was synchronized with the occurrence and migration of Cladocera (*Bosmina*, *Ceriodaphnia,* and *Chydorus*). Experiments by Matveev *et al*. (1989) in a lake showed that low-density *Piona* preyed on a great number of Cladocera.

Arrenurus (Group D) occurred, albeit in low density, during some months, at the intermediary and basal sections of the plant's stolon in Patos Lake. Specimens were probably benthic and sought preys at the plant's lower compartments. Most species of *Arrenurus* in their adult phase had a diet made up of microcrustaceans, especially Ostracoda (Smith and Cook, 1991), which were abundant at the roots of the basal segment.

Distribution of *Hydrodroma* and *Hydrozetes* (Group E) was similar. *Hydrodroma* was reported only once, at low density, in Patos Lake, during the low water phase. The genus, with great swimming ability, also occurred in the central region below or above the water surface. The description of *Hydrodroma* by Rosso de Ferradás (1983; 1984) shows that specimens have a weak sclerotization in their body, which probably favors their constant permanence at the water surface and at the apical segment. Smith (1990) suggested that nymphs remained on the water surface till they met their potential hosts out of the water.

Hydrozetes, belonging to the order Oribatida (typically land-bound), feed on detritus, algae, and fungi (Pennak, 1989). This fact may contribute towards a higher density of the genus at the apical and intermediary sections in which the development of many adherent filamentous algae was reported. It may be related to the use of atmospheric oxygen due to its respiratory system resembling that of non-water mites.

Greater water transparency in Patos Lake may have facilitated the penetration of light and the abundance of predatory mites, especially those at the basal segment. Water transparency and the degree of sub-water illumination allegedly facilitated localization of prey by predators (O'Brien, 1987).

One may conclude that a rise in water level stimulates the occurrence of mite in *E. azurea* banks owing to a fall in concentrations of dissolved oxygen in deep regions of the lakes. This suggests horizontal migration of benthic mite towards the basal segment through an increase in the number of hosts and available prey.

Time variation in water mites density is related to the life cycle and to the density of certain invertebrate groups. The exploitation of different plant sections depends on specific feeding, since acari at the apical segment preferentially feed on herbivorous or plankton invertebrates that visit the plant. Detritus-eating organisms may be a more available food source for hypoxia-tolerant genus that live at the basal segment.

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Received on December 15, 2004.
Accepted on November 22, 2005.