Rotifers in freshwater habitats in the Upper Tietê River Basin, São Paulo State, Brazil.

LUCINDA[1], I.; MORENO[2], I.H.; MELÃO[2], M.G.G. & MATSUMURA-TUNDISI[3], T.

[1] Programa de Pós-graduação em Ecologia e Recursos Naturais - Universidade Federal de São Carlos, Rodovia Washington Luiz Km 235, cep 13565-905, São Carlos/SP - e-mail: irenelucinda@hotmail.com

[2] Departamento de Hidrobiologia - Universidade Federal de São Carlos, Rodovia Washington Luiz Km 235, cep 13565-905, São Carlos/SP - e-mail: imoreno@power.ufscar.br; dmgm@power.ufscar.br

[3] Instituto Internacional de Ecologia – Rua Bento Carlos, 750, cep 13560-660, São Carlos/SP

ABSTRACT: Rotifers in freshwater habitats in the Upper Tietê River Basin, São Paulo State, Brazil. The composition of the Rotifera was investigated, in 19 water bodies in the Upper Tietê system (SP, Brazil), as an integral part of a survey of zooplankton across the State of São Paulo, planned to include the 22 Water Resource Management Units of the State, which forms part of the BIOTA program, the exhaustive survey of São Paulo flora and fauna organised by the state research funding agency, FAPESP. The rotifer samples were caught in a plankton net of mesh 35 mm, swept horizontally and vertically in the littoral and limnetic zones of freshwater bodies, and then fixed in 4% formaldehyde. Netted material was sorted under a stereo-microscope and the rotifers identified by optical microscopy. One hundred nine taxa belonging to 20 families in subclass Monogononta were catalogued. The families that predominated were Lecanidae, Brachionidae, Trichocercidae, Notommatidae and Lepadellidae, all of which are common in the tropics. Conochilus unicornis, Keratella cochlearis, Lecane bulla, Polyarthra aff. vulgaris and Trichocerca similis, as well as the bdelloid rotifers, were found at almost all the collection sites. The presence of certain species seemed to correlate with a higher trophic level in the water, these being: Brachionus angularis, B. calyciflorus, B. havanaensis havanaensis, Filinia opoliensis, Kellicottia bostoniensis, Keratella cochlearis var. tecta and Trichocerca capucina multicrinis. Eight novel occurrences in São Paulo State were recorded, one being novel in South America, and diagnoses and plates are provided for some of these species.
Key-words: Rotifera, zooplankton, reservoirs of Upper Tietê River.

RESUMO: Rotifera em corpos de água da bacia do alto rio Tietê, São Paulo, Brasil. A composição da fauna de Rotifera em 19 corpos de água do alto Tietê (São Paulo, Brasil) foi estudada como parte integrante de um levantamento zooplanctônico proposto para as 22 Unidades de Gerenciamento de Recursos Hídricos do Estado de São Paulo (UGRHIs), dentro do Programa BIOTA/FAPESP. As amostras para análise da fauna de rotíferos foram obtidas utilizando-se rede de plâncton de abertura de malha de 35 mm, envolvendo arrastos horizontais e verticais na área limnética e litorânea e, posteriormente, fixadas em formol 4%. O material obtido foi triado em microscópio estereoscópio e os rotíferos identificados em microscópio óptico. Foram catalogados 109 táxons pertencentes a 20 famílias da subclasse Monogononta. A composição da fauna de rotíferos foi predominantemente constituída por táxons das famílias Lecanidae, Brachionidae, Trichocercidae, Notommatidae e Lepadellidae, comuns em ambientes tropicais. Conochilus unicornis, Keratella cochlearis, Lecane bulla, Polyarthra aff. vulgaris e Trichocerca similis, além dos bdeloídeos, estiveram presentes na quase totalidade das localidades amostradas. A ocorrência de algumas espécies parece estar relacionada ao maior grau de trofia das águas, sendo elas: Brachionus angularis, B. calyciflorus, B. havanaensis havanaensis, Filinia opoliensis, Kellicottia bostoniensis, Keratella cochlearis var. tecta e Trichocerca capucina multicrinis. Foram registradas oito novas ocorrências para o Estado de São Paulo, sendo uma nova ocorrência para a América do Sul. São apresentadas pranchas e diagnoses para algumas espécies.
Palavras-chave: Rotifera, zooplâncton, reservatórios do Alto Rio Tietê.

Introduction

Rotifers are among the groups of zooplankton with the largest populations in continental waters, frequently dominating the fauna, on account of their highly opportunistic nature which derives from high rates of reproduction, consumption and assimilation of a wide variety of food sources. Apart from their great importance in the flow of energy and the cycle of nutrients in the freshwater community, since they play a fundamental role in the food chain some rotifer species have proved to be good indicators of pollution and water quality, and potentially useful in biomonitoring (Akinbuwa & Adeniyi, 1991; Nogrady et al., 1993; Bonecker & Lansac-Tôha, 1996).

In Brazil, considering the amount of research on other taxonomic groups and the complexity of Brazilian freshwater systems, knowledge of the biology of rotifers in Brazil is relatively narrow. Work on their taxonomy and ecology, carried out by either foreign or national researchers, has been concentrated mainly on the region of Amazonia (Koste & Robertson, 1983, 1990; Koste & Hardy, 1984; Koste et al., 1984; Hardy et al., 1984; Segers & Sarma, 1993; Segers et al., 1993, among others).

The first study of rotifers in São Paulo State was made by Schaden (1970 cited in Oliveira-Neto & Moreno, 1999), on the rotifer composition in the Raia Olímpica of the University of São Paulo, São Paulo city. According to these last authors, around 236 taxa have been described in this state, this representing half the number found in Brazil (457). However, this may be assumed to underestimate the species richness, as most of the sampling in practice favoured the limnetic zone over the littoral, and Segers & Dumont (1995) found that the littoral rotifers made a bigger contribution to the overall species diversity in freshwater ecosystems.

Most of the work on rotifers in São Paulo State has been carried out in large reservoirs, concentrating on the zooplankton community (Cladocera, Copepoda and Rotifera) in ecological approaches, often producing merely lists of rotifer genera (Oliveira-Neto & Moreno, 1999). Few studies focus exclusively on the ecology and/or taxonomy of Rotifera (Matsumura-Tundisi et al., 1990; Sendacz, 1993; Segers & Dumont, 1995; Rodríguez & Matsumura-Tundisi, 2000; Lucinda, 2001).

Turner & Da Silva (1992) consider it essential to compile inventories of species, not only for the information they contain on systematics and biogeography, but also to provide a base for subsequent ecological investigations into the dynamics of ecosystems and changes provoked in these by anthropic activity.

In light of the above, the main aim of the present study was to contribute to an inventory of biological diversity in São Paulo State, focussing on a rarely-studied group such as the Rotifera.

Field-study area

The present study is an integral part of the topic-centred project, "Zooplankton biodiversity and the state of degradation of the continental aquatic ecosystems in the State of São Paulo" (within the BIOTA programme of FAPESP), in which it is planned to sample a wide range of freshwater habitats, involving each of the 22 Water Resource Management Units (UGRHIs) of the State. These Units were brought into existence by State Law 7.663 in December 1991, owing to the general degradation of the environment, particularly the water, provoked by industrial enterprises exempted from environmental costs and by the lack of basic treatment for the waste generated by growing urbanisation. This law envisages decentralised, participatory and integrated water management, as well as the recognition of water as public property whose exploitation should be recompensed, in order to ensure satisfactory water quality for present users and for generations to come (Secretaria do Meio Ambiente, 1997).

For this study, 19 water bodies were chosen (Tab. I), all situated in the Upper Tietê Water Resource Unit (UGRHI-6), which ranges from the headwaters of the River Tietê to

the Pirapora Dam in the municipality of Pirapora do Bom Jesus (Fig.1). This UGRHI extends over one of the most heavily industrialised and urbanised parts of the State, including metropolitan São Paulo. In general, its rivers receive the untreated domestic and industrial effluents of the area and thus exhibit a high rate of eutrophication (CETESB, 2002).

Table I: Sampled water bodies of the Upper Tietê Water Resource Management Unit and their geographic locations and collection dates

Localities	City	Collection dates	Geographic locations
Pedro Beicht Reservoir	Cotia	08/23/1999	23° 43' 05" S 46° 57' 63" W
Cachoeira das Graças Reservoir	Cotia	08/23/1999	23° 39' 22" S 46° 58' 06" W
Lake 1 of Paiva Castro Reservoir	Mairiporã	08/24/1999	23° 20' 20" S 46° 39' 43" W
Lake 2 of Paiva Castro Reservoir	Mairiporã	08/24/1999	23° 20' 25" S 46° 38' 91" W
Lake 3 of Paiva Castro Reservoir	Mairiporã	08/24/1999	23° 20' 25" S 46° 38' 68" W
Paiva Castro Reservoir	Mairiporã	08/24/1999	23° 19' 93" S 46° 39' 24" W
Águas Claras Reservoir	Mairiporã	08/24/1999	23° 23' 91" S 46° 39' 52" W
Billings - Riacho Grande Reservoir	S. Bernardo do Campo	08/25/1999	23° 46' 82" S 46° 32' 62" W
Billings – Estoril Reservoir	S. Bernardo do Campo	08/25/1999	23° 45' 89" S 46° 30' 96" W
Lake 1 of the Tietê Ecology Park	Guarulhos	08/25/1999	23° 29' 19" S 46° 30' 80" W
Lake 2 of the Tietê Ecology Park	Guarulhos	08/25/1999	23° 29' 07" S 46° 31' 08" W
Rodrigo Pires Lake	Ribeirão Pires	08/26/1999	23° 41' 31" S 46° 22' 41" W
Jundiaí Reservoir	Mogi das Cruzes	08/26/1999	23° 39' 01" S 46° 11' 51" W
Taiaçupeba Reservoir	Mogi das Cruzes	08/26/1999	23° 34' 80" S 46° 16' 92" W
Ribeirão do Campo Reservoir	Salesópolis	08/27/1999	23° 38' 69" S 45° 49' 88" W
Aterro Lake	Salesópolis	08/27/1999	23° 38' 74" S 45° 51' 64" W
Ponte Nova Reservoir	Salesópolis	08/27/1999	23° 35' 83" S 45° 56' 78" W
Guariparanga Reservoir	São Paulo	03/21/2002	23° 40' 26" S 46° 43' 35" W
Billings – Taquacetuba Reservoir	S. Bernardo do Campo	03/21/2002	23° 50' 34" S 46° 39' 18" W

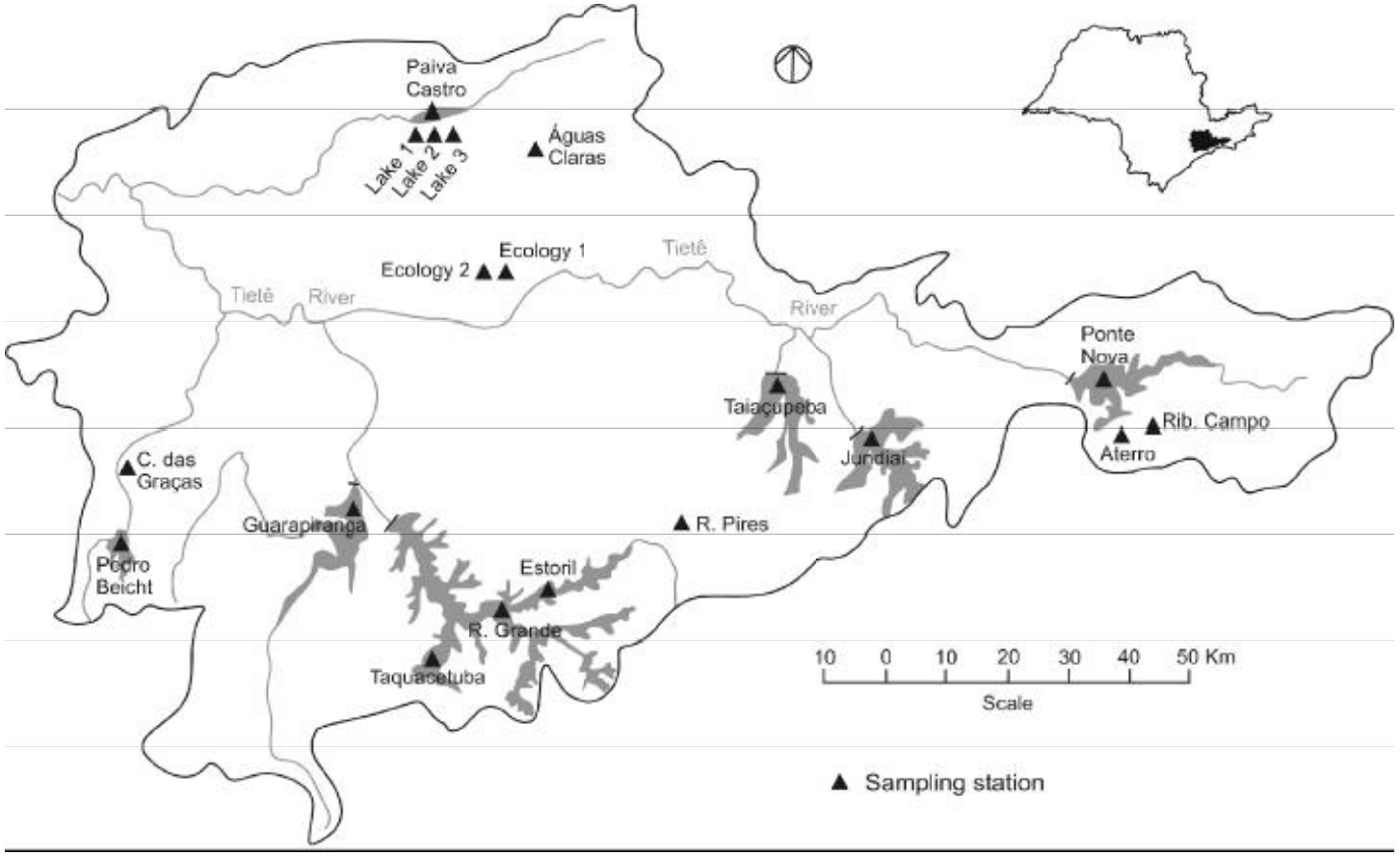

Figure 1: Sampled water bodies of the Upper Tietê Water Resource Management Unit (UGRHI-6) (Adapted from: Secretaria do Meio Ambiente, 1997).

Material and methods

Samples were taken by horizontal and vertical sweeps with 35 mm mesh plankton nets, in both limnetic zones of water bodies and littoral areas, which are mainly associated with aquatic macrophytes. Immediately after sampling, specimens were fixed in 4% formalin in 100 mL flasks, in the field.

Specimens were sorted under a stereo-microscope (Leica MZ6) and subsequently identified with a microscope (Leica DMLB). The rotifer species were identified with keys provided in the following publications, among others: Koste (1978), Nogrady et al. (1993, 1995), Paggi (1995), Segers (1995), Smet (1996), Smet & Pourriot (1997). The nomenclature and taxonomic classification used followed Segers (2002).

The bdelloid rotifers were not identified into separate taxa, because all the samples were fixed. However, they were taken into account as one group, since they exhibit similar ecological features.

Individual counts were performed on subsamples of 2 mL, to establish frequencies in relation to the dominant species, using acrylic plates with square grids under the stereo microscope. In the analysis of dominance, the 3 taxa with the highest frequencies were recorded, respectively, as Dominant 1, Dominant 2 and Dominant 3.

Relative frequency was calculated by expressing the number of specimens of a given taxon as a percentage of the total number of specimens counted.

Representative data of the chemical and physical properties of the water at the sites sampled were taken from Matsumura-Tundisi (1999).

Results and discussion

Composition and distribution of rotifers

One hundred nine taxa belonging to 20 families of subclass Monogononta were catalogued (Tab. II). Bdelloid rotifers were seen in the majority of the samples.

Referring to Turner & Da Silva (1992), the species composition observed should be considered typical of neotropical regions. The families Lecanidae, Brachionidae and Trichocercidae were the most diverse among the specimens collected; indeed, at every sample site, the species richness of these families accounted for half of all taxa catalogued (Fig. 2 and 3). This observation confirms those recorded by Dabés (1995) in oxbow lakes by the River São Francisco (MG) and by Bonecker et al. (1998) on the floodplains of the Upper River Paraná (MS).

The families Notommatidae and Lepadellidae were also well represented (10 and 8 spp, respectively). Colurella and Lepadella, both in Lepadellidae, were found chiefly in the littoral zone, among the vegetation, verifying their definition as littoral-benthic dwellers (Baribwegure & Segers, 2001).

Many authors have noted that the genera Lecane, Brachionus, Trichocerca and, often, Lepadella are present in large numbers in the tropical rotifer fauna (Medina & Vásquez, 1988; López & Ochoa, 1995; Segers & Dumont, 1995; Lucinda, 2001; Segers, 2001). According to Dumont (1983), Brachionus, Keratella and Lepadella are highly endemic to South America and Australia.

The species found most frequently in the samples were Conochilus unicornis, Keratella cochlearis, Lecane bulla, Polyarthra aff. vulgaris and Trichocerca similis, all of which are considered cosmopolitan.

Lecane bulla and the genus Euchlanis had the highest relative frequencies (i.e. were dominant) in the macrophyte zone. Bonecker et al. (1998) describe L. bulla and two of the three catalogued Euchlanis (E. incisa and E. dilatata) as non-plankton rotifers. For Paggi (1995), Euchlanis is a typical littoral genus, occasionally found among plankton.

Table II: Occurrence of Rotifera taxa at the 19 sites sampled in the Upper Tietê Water Resource Management Unit.

	Pedro Beicht	Cachoeira das Graças	Paiva Castro – L1	Paiva Castro – L2	Paiva Castro – L3	Paiva Castro	Águas Claras	Billings - Riacho Grande	Billings - Estoril	Ecology Park – L1	Ecology Park – L2	Rodrigo Pires	Jundiaí Reservoir	Taiaçupeba Reservoir	Ribeirão do Campo	Aterro Lake	Ponte Nova	Guarapiranga	Billings -Taquacetuba
Asplanchnidae																			
Asplanchna sieboldi (Leydig, 1854)														x					x
Brachionidae																			
Anuraeopsis navicula Rousselet, 1910																		x	x
Brachionus angularis Gosse, 1851											x	x						x	x
B. calyciflorus f. anuraeiformis (Brhem, 1909)													x						x
B. calyciflorus f. typ. Pallas, 1766											x		x	x					
B. dolabratus dolabratus Harring, 1915																			x
B. havanaensis havanaensis Rousselet, 1911											x							x	x
B. quadridentatus quadridentatus Hermann, 1783								x			x		x						
Kellicottia bostoniensis (Rousselet, 1908)						x	x		x	x	x		x	x				x	
Keratella americana Carlin, 1943						x	x		x	x	x		x	x			x		
K. americana f. hispida																		x	
K. cochlearis Gosse, 1851	x	x	x	x	x	x	x		x			x		x	x	x	x	x	
K. cochlearis var. tecta (Lauterborn, 1900)											x		x					x	x
K. lenzi lenzi (Hauer, 1953)									x										
K. tropica (Apstein, 1907)									x	x		x						x	x
Plationus patulus patulus (O.F.M., 1786)										x									
Platyias quadricornis (Ehrb., 1832)													x	x					

Table II: Continuation

	Pedro Beicht	Cachoeira das Graças	Paiva Castro – L1	Paiva Castro – L2	Paiva Castro – L3	Paiva Castro	Águas Claras	Billings - Riacho Grande	Billings - Estoril	Ecology Park – L1	Ecology Park – L2	Rodrigo Pires	Jundiaí Reservoir	Taiaçupeba Reservoir	Ribeirão do Campo	Aterro Lake	Ponte Nova	Guarapiranga	Billings -Taquacetuba
Collothecidae																			
Collotheca sp 1	x						x								x			x	x
Collotheca sp 2			x	x	x	x					x						x		
Collotheca sp 3								x			x								
Conochilidae																			
Conochilus coenobasis Skorikov, 1914	x	x	x		x	x												x	
C. unicornis Rousselet, 1892		x	x	x	x	x	x	x		x			x				x		
Dicranophoridae																			
Aspelta angusta Harring & Myers, 1928															x	x			
Dicranophorus epicharis Harring & Myers, 1928								x			x								
Dicranophorus sp													x						
Encentrum sp											x								
Epiphanidae																			
Epiphanes macrourus (Barrois & Daday, 1894)																			x
Euchlanidae																			
Dipleuchanis propatula (Gosse, 1886)												x		x					
Euchlanis dilatata Ehrb., 1832								x											x
E. incisa Carlin, 1939		x			x			x					x	x					
E. meneta Myers, 1930		x						x								x			
Filiniidae																			
Filinia longiseta (Ehrb., 1834)											x								
F. longiseta var. limnetica (Zacharias, 1893)																			x
F. opoliensis (Zacharias, 1891)									x									x	

Table II: Continuation

	Pedro Beicht	Cachoeira das Graças	Paiva Castro – L1	Paiva Castro – L2	Paiva Castro – L3	Paiva Castro	Águas Claras	Billings - Riacho Grande	Billings - Estoril	Ecology Park – L1	Ecology Park – L2	Rodrigo Pires	Jundiaí Reservoir	Taiaçupeba Reservoir	Ribeirão do Campo	Aterro Lake	Ponte Nova	Guarapiranga	Billings -Taquacetuba
Flosculariidae																			
Octotrocha speciosa Thorpe, 1893								x											
Ptygura cf. libera Myers, 1934	x	x											x				x		
Sinantherina sp													x						
Gastropodidae																			
Ascomorpha eucadis (Perty, 1859)										x	x								
A. saltans Bartsch, 1870								x	x		x				x		x		
Gastropus stylifer Imhof, 1891	x			x	x	x	x										x		
Hexarthridae																			
Hexarthra intermedia braziliensis (Hauer, 1953)																		x	x
Lecanidae																			
Lecane bulla (Gosse, 1886)		x	x	x			x	x	x	x	x	x	x	x	x	x			
L. clara (Bryce, 1892)		x	x					x					x						
L. closterocerca (Schmarda, 1859)								x		x								x	
L. cornuta (O.F.M., 1786)										x	x			x					
L. curvicornis (Murray, 1913)													x						
L. elsa Hauer, 1931										x									
L. flexilis (Gosse, 1886)		x																	
L. furcata (Murray, 1913)										x									
L. hamata (Stockes, 1896)		x	x					x		x									
L. hornemanni (Ehrb., 1838)		x																	
L. leontina (Turner, 1892)										x	x								
L. ludwigii f. ludwigii (Eckstein, 1893)		x						x					x						
L. ludwigii f. ohioensis (Herrick, 1885)																		x	
L. luna (O.F.M.,1776)								x											
L. lunaris (Ehrb., 1832)		x		x		x	x			x			x			x			
L. monostyla (Daday, 1905)										x									
L. papuana (Murray, 1913)																		x	

Table I: Continuation

	Pedro Beicht	Cachoeira das Graças	Paiva Castro – L1	Paiva Castro – L2	Paiva Castro – L3	Paiva Castro	Águas Claras	Billings - Riacho Grande	Billings - Estoril	Ecology Park – L1	Ecology Park – L2	Rodrigo Pires	Jundiaí Reservoir	Taiaçupeba Reservoir	Ribeirão do Campo	Aterro Lake	Ponte Nova	Guarapiranga	Billings -Taquacetuba
Lecanidae																			
L. pyriformis (Daday, 1905)																		x	
L. signifera (Jennings, 1896)		x		x	x					x				x	x	x			
L. stenroosi (Meissner, 1908)								x	x										
L. stichaea Harring, 1913			x	x	x				x	x									
L. ungulata Gosse, 1887		x																	
Lepadellidae																			
Colurella uncinata f. bicuspidata (Ehrb., 1832)								x											
Lepadella acuminata (Ehrb., 1834)		x		x															
L. cf. ovalis (O.F.M., 1786)		x								x									
L. cristata (Rousselet, 1893)	x																		
L. donneri Koste, 1972		x																	
L. patella (O.F.M., 1786)								x		x									
L. rhomboides (Gosse, 1886)											x								
Squatinella mutica (Ehrb., 1832)									x										
Mytilinidae																			
Mytilina ventralis (Ehrb., 1832)										x									
Notomamatidae																			
Cephalodella cf. gibba (Ehrb., 1838)		x																	
C. forficula (Ehrb., 1838)								x											
C. gibba (Ehrb., 1838)			x																
Monommata longiseta (O.F.M., 1786)																x			
M. maculata Harring & Myers, 1924				x															
Monommata sp		x																	
Notommata copeus (Ehrb., 1834)										x			x			x			
N. glyphura Wulfert, 1935		x																	
N. pseudoecerberus De Beauchamp, 1908														x		x			
N. saccigera Ehrb., 1832															x	x			

Table II: Continuation

	Pedro Beicht	Cachoeira das Graças	Paiva Castro – L1	Paiva Castro – L2	Paiva Castro – L3	Paiva Castro	Águas Claras	Billings - Riacho Grande	Billings - Estoril	Ecology Park – L1	Ecology Park – L2	Rodrigo Pires	Jundiaí Reservoir	Taiaçupeba Reservoir	Ribeirão do Campo	Aterro Lake	Ponte Nova	Guarapiranga	Billings -Taquacetuba
Synchaetidae																			
Ploesoma truncatum (Levander, 1984)			x		x	x	x												
Polyarthra aff. vulgaris	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x	x
Synchaeta stylata Wierzejski, 1893						x		x		x				x		x			x
Testudinellidae																			
Testudinella cf. ahlstromi Hauer, 1956		x																	
T. ohlei ohlei Koste, 1972		x																	
T. patina (Hermann, 1783)													x						
T. patina patina (Hermann, 1783)								x		x									
Pompholyx complanata Gosse, 1851								x	x									x	
Trichocercidae																			
Trichocerca bicristata (Gosse, 1887)		x	x					x		x									
T. bidens (Lucks, 1912)										x									
T. capucina Wierzejski & Zacharias, 1893											x		x	x	x		x		
T. capucina multicrinis (Kellicott, 1897)								x	x										
T. cylindrica (Imhof, 1891)			x				x		x								x		
T. elongata braziliensis (Murray, 1913)													x						
T. insignis (Herrick, 1885)				x	x														
T. porcellus (Gosse, 1886)		x												x					
T. pusilla (Lauterborn, 1898)										x			x					x	x
T. relicta Donner, 1950		x					x			x						x			
T. similis (Wierzejski, 1893)						x	x		x	x	x		x	x				x	x
Trichotriidae																			
Macrochaetus subquadratus Perty, 1850		x												x					
Trichotria tetractis (Ehrb., 1830)		x				x						x		x					

Table II: Continuation

	Pedro Beicht	Cachoeira das Graças	Paiva Castro – L1	Paiva Castro – L2	Paiva Castro – L3	Paiva Castro	Águas Claras	Billings - Riacho Grande	Billings - Estoril	Ecology Park – L1	Ecology Park – L2	Rodrigo Pires	Jundiaí Reservoir	Taiaçupeba Reservoir	Ribeirão do Campo	Aterro Lake	Ponte Nova	Guarapiranga	Billings -Taquacetuba
Trochosphaera																			
Horaella thomassoni Koste, 1973				x													x		
No identified																			
Bdelloidea	x	x	x	x	x	x	x	x		x	x		x		x	x	x	x	x
Rotifer 1							x												
Rotifer 2														x					
Rotifer 3														x					
Rotifer 4														x					

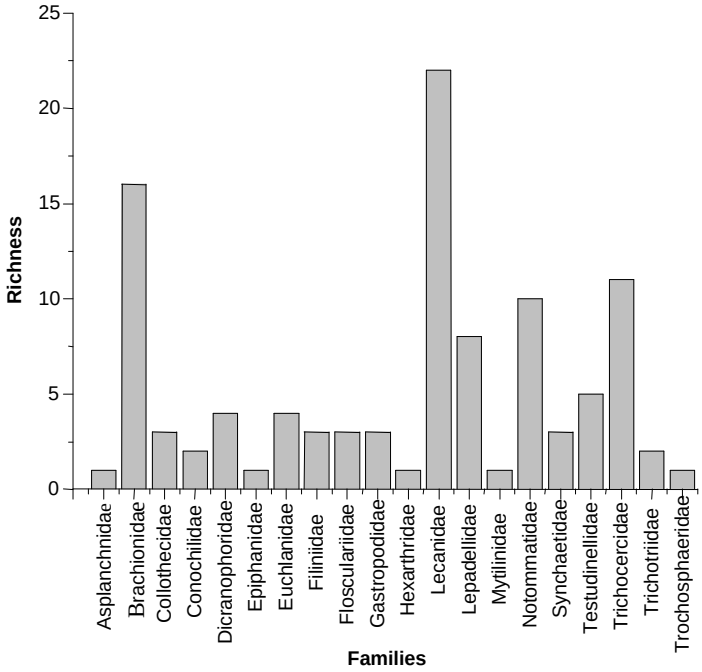

Figure 2: Richness of Rotifera families in the Upper Tietê Water Resource Management Unit.

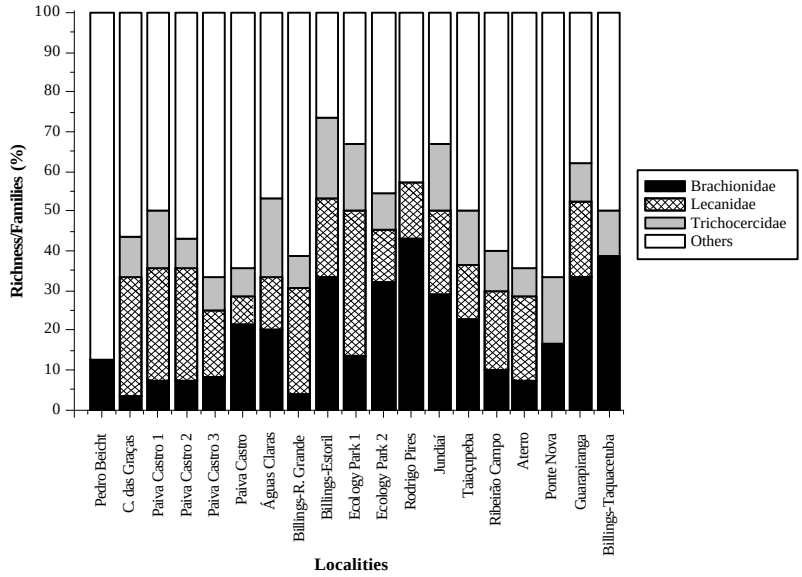

Figure 3: Taxa richness of Rotifera families (expressed in percent) at each collection site in the Upper Tietê Water Resource Management Unit.

The highest levels of taxon richness were recorded in Cachoeira das Graças Reservoir and in Lake 1 of the Tietê Ecology Park, each with 30 taxa (Fig. 4). The great diversity at these two sites is closely related to the large number of species of Lecane found in them (9 and 11 spp, respectively). This genus is widely distributed and very diverse in the tropics, especially among the littoral vegetation (Dabés, 1995; Bonecker et al., 1998). Paggi (2001), investigating the diversity of the rotifers in areas subject to flooding by the River Pilcomayo, Argentina, discovered that a quarter of the catalogued taxa belonged to the genus Lecane, most of them being tropical or cosmopolitan, while Segers (2001) has stated that rotifer diversity in Southeast Asia relates mainly to Lecane and, to a lesser degree, Brachionus and Trichocerca.

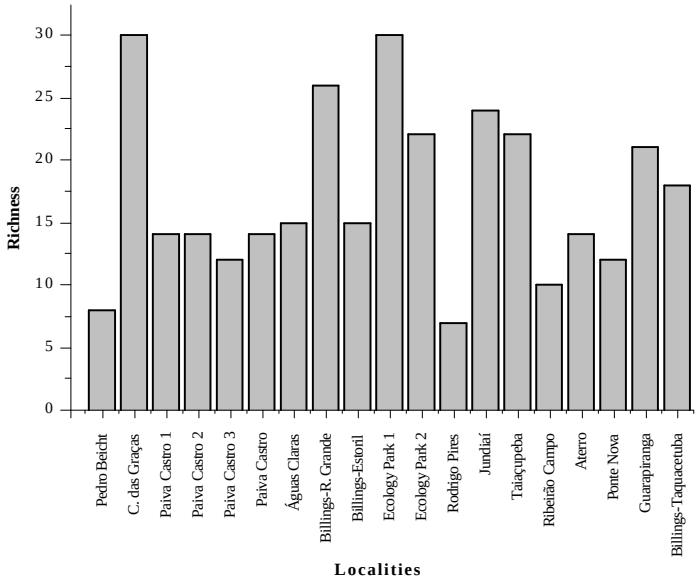

Figure 4: Richness of Rotifera collected at each site in the Upper Tietê Water Resource Management Unit.

Despite having the same richness, these two sites were found to differ in limnological features (Tab. III). Thus, the total P, total dissolved P and total N levels were higher in Lake 1 of the Ecology Park, suggesting that its water had a higher trophic level. Similarly, chlorophyll a readings were much higher in Lake 1, where the concentration was 9.94 mg L^{-1}, while Cachoeira das Graças had only 1.80 mg L^{-1}.

Table III: pH and total dissolved P (mg L^{-1}), total P (mg L^{-1}), total N (mg L^{-1}), chlorophyll a (mg L^{-1}) concentrations at each of the sites sampled in the Upper Tietê Water Resource Management Unit.

Localities	pH	Total dissolved P (mg L^{-1})	Total P (mg L^{-1})	Total N (mg L^{-1})	Chlorophyll a (mg L^{-1})
Pedro Beicht	6.03	9.12	41.19	372.14	4.29
C. das Graças	6.35	6.52	26.84	278.86	1.80
Paiva Castro	6.72	6.82	29.12	278.86	3.22
Águas Claras	7.08	7.44	32.38	372.14	2.77
Billings-R. Grande	7.61	62.90	249.01	2010.72	13.15
Billings-Estoril	8.01	69.01	229.43	1691.09	10.55
Ecology Park L1	7.87	52.21	79.36	986.60	9.94
Ecology Park L2	8.56	59.85	108.72	3621.90	40.40
Rodrigo Pires	5.18	6.67	-	-	1.63
Jundiaí	8.89	9.27	29.12	459.54	16.76
Taiaçupeba E1	6.37	17.98	26.51	501.30	6.32
Taiaçupeba E2	6.32	20.58	20.97	357.14	3.57
Ribeirão Campo	5.66	13.40	-	317.35	1.75
Aterro Lake	7.29	8.51	12.80	222.11	0.33
Ponte Nova	6.86	4.69	12.48	260.60	2.77
Guarapiranga	7.46	3.69	52.67	185.92	31.05
Guarapiranga - Litoral	7.30	3.24	27.75	697.20	33.09
Billings-Taquacetuba	9.26	12.03	51.82	790.16	5.94

The lowest degrees of richness were found in Lake Rodrigo Pires and the Pedro Beicht Reservoir, with 7 and 8 taxa, respectively. Lake Rodrigo Pires was characterised by a scarcity of zooplankton, related to the acidity of its water (pH 5,18) and a low concentration of chlorophyll a (1,63 mg L^{-1}). However, this lake also showed the highest relative frequency of Keratella cochlearis (61%), reflecting its non-specialist habit and tolerance of a wide pH range (Bertoletti, 2001). This species, according to Walz (1993), is also adapted to low food concentrations.

From these results it is evident that it would not be easy to establish a clear relation between rotifer taxon richness and the limnological variables normally associated with the trophic level. This suggests a need to study other factors, such as the presence of predators, food quality and availability, and other components of the ecosystem. Walz (1993) claims that the abundance rotifers is strongly related to the trophic level and the availability of algae. Devetter (1998), researching a reservoir in the Czech Republic, stated that abundance of Cyclops vicinus, total N, primary production, surface temperature and density of nanoplankton flagellates were all variables that strongly influenced the structure of the rotifer community, whereas no relation could be established between the latter and variations in the concentration of phosphorus.

The dominant species at each site are reported in Tab. IV. Polyarthra aff. vulgaris was highly dominant in the reservoirs Águas Claras and Paiva Castro, as well as in the lakes bordering the latter. Keratella cochlearis also showed strong dominance, at the three sampling points in the Ribeirão do Campo Reservoir.

The most eutrophic habitats, as judged by the total P and total N, viz. Billings (both Estoril and Riacho Grande), Lakes 1 and 2 in the Tietê Ecology Park, showed dominance

of the following species: Trichocerca capucina multicrinis, Kellicottia bostoniensis, Polyarthra aff. vulgaris and Brachionus havanaensis havanaensis. The high concentrations of total phosphate in the Guarapiranga Reservoir indicate its association with particulate material, probably of phytoplanktonic origin, given the high level of chlorophyll a. In this community, Filinia opoliensis and Keratella cochlearis var. tecta were seen to dominate.

Table IV: List of dominant species and their relative frequencies of occurrence at each site sampled in the Upper Tietê Water Resource Management Unit.

Localities	Dominant 1	Dominant 2	Dominant 3
Pedro Beicht	Ptygura cf. libera (53%)	Conochilus coenobasis (29%)	Polyarthra aff. vulgaris (11%)
C. das Graças	Euchlanis meneta (30%)	Bdelloidea (13%)	Polyarthra aff. vulgaris (10%)
Paiva Castro L1	Polyarthra aff. vulgaris (82%)	Conochilus coenobasis (8%)	Conochilus unicornis (3%)
Paiva Castro L2	Polyarthra aff. Vulgaris (81%)	Conochilus unicornis (12%)	Bdelloidea (2%)
Paiva Castro L3	Polyarthra aff. vulgaris (74%)	Conochilus unicornis (14%)	Collotheca sp 2 (3%)
Paiva Castro	Polyarthra aff. vulgaris (43%)	Conochilus unicornis (26%)	Ploesoma truncatum (8%)
Águas Claras	Polyarthra aff. vulgaris (55%)	Keratella cochlearis (10%)	Conochilus unicornis (7%)
Billings-R. Grande	Trichocerca capucina multicrinis (74%)	Collotheca sp 3 (9%)	Pompholyx complanata (8%)
Billings-R. Grande(Lit)*	Polyarthra aff. vulgaris (43%)	Collotheca sp 3 (23%)	Ascomorpha saltans (16%)
Billings-R. Grande(Mac)*	Bdelloidea (46%)	Euchlanis dilatata (16%)	Lecane bulla (10%)
Billings-Estoril	Kellicottia bostoniensis (67%)	Ascomorpha saltans (11%)	Keratella americana (8%)
Ecology Park L1	Polyarthra aff. vulgaris (34%)	Ascomorpha eucadis (31%)	Lecane bulla (15%)
Ecology Park L2	Brachionus havanaensis havanaensis (34%)	Brachionus angularis (30%)	Collotheca sp 3 (16%)
Rodrigo Pires	Keratella cochlearis (61%)	Polyarthra aff. vulgaris (39%)	-
Jundiaí	Keratella americana (50%)	Brachionus calyciflorus f. typ. (34%)	Brachionus calyciflorus f. anuraeiformis (10%)
Jundiaí(Mac)*	Lecane bulla (40%)	Euchlanis incisa (36%)	Brachionus calyciflorus f. typ. (5%)
Taiaçubepa-E1	Keratella americana (72%)	Kellicottia bostoniensis (17%)	Keratella cochlearis (11%)
Taiaçubepa-E2	Kellicottia bostoniensis (28%)	Keratella americana (28%)	Brachionus calyciflorus f. typ. (14%)
Ribeirão Campo-E1	Keratella cochlearis (75%)	Collotheca sp 1 (22%)	Ascomorpha saltans (3%)
Ribeirão Campo-E2	Keratella cochlearis (60%)	Collotheca sp 1 (21%)	Ascomorpha saltans (13%)
Ribeirão Campo-E3	Keratella cochlearis (80%)	Ascomorpha saltans (9%)	Collotheca sp 1 (7%)
Aterro Lake	Euchlanis meneta (72%)	Keratella cochlearis (8%)	Bdelloidea (7%)
Ponte Nova	Conochilus unicornis (25%)	Collotheca sp 2 (21%)	Ptygura cf. libera (14%)
Guarapiranga	Filinia opoliensis (30%)	Keratella cochlearis var. tecta (22%)	Anuraeopsis navicula (19%)
Guarapiranga(Lit)*	Keratella cochlearis var. tecta (23%)	Filinia opoliensis (20%)	Polyarthra aff. vulgaris (18%)
Billings-Taquacetuba	Polyarthra aff. vulgaris (38%)	Brachionus havanaensis havanaensis (20%)	Filinia longiseta var. limnetica (15%)

* Mac: macrophytes; Lit: littoral

Even without information on the density and seasonal frequency of occurrence of the species of Rotifera in the water bodies under study, it is possible to provide indications of correlations between occurrence of some species and the trophic level of the water. Brachionus angularis, B. calyciflorus, B. havanaensis havanaensis, Filinia opoliensis, Kellicottia bostoniensis, Keratella cochlearis var. tecta and Trichocerca capucina multicrinis were all associated with eutrophication.

Other species, such as Ascomorpha eucadis, Conochilus unicornis, C. coenobasis, Collotheca sp and Ptygura cf. libera may also be associated with higher trophy, but some authors consider A. eucadis and C. coenobasis typical of oligotrophic habitats (Sládecek, 1983; Bertoletti, 2001), so these species could in fact be eurytrophic.

Gannon & Stemberger (1978) considered Brachionus angularis, B. calyciflorus, Keratella cochlearis var. tecta and Trichocerca capucina multicrinis as indicators of eutrophication in temperate regions. Trichocerca capucina multicrinis was dominant in the limnetic zone of the Billings-Riacho Grande Reservoir, which suffered from advanced eutrophication (CETESB, 2002).

Pejler (1983), relating feeding habits to the trophic level, considered Brachionus angularis and B. calyciflorus to indicate eutrophication, bacteria forming an important part of their diet. Mäemets (1983), in a study of 10 Estonian lakes, found that Trichocerca capucina and Keratella cochlearis var. tecta correlated with meso-eutrophic lakes and Brachionus spp with eutrophic. Sládecek (1983), in turn, found a strong correlation between Brachionus and eutrophication, but considered Trichocerca to indicate oligotrophic habitats in temperate zones.

Regarding reservoirs in São Paulo State, a study of their zooplankton was made by Bertoletti (2001), who had results showing that Anuraeopsis fissa, Brachionus angularis, B. calyciflorus, Conochilus dossuarius, Epiphanes macrourus, Filinia opoliensis, Keratella cochlearis var. tecta, K. tropica, Trichocerca pusilla and T. similis were associated preferentially with eutrophic conditions. Moreover, Matsumura-Tundisi et al. (1990) found that Conochilus unicornis is an indicator of eutrophic conditions in the reservoir at Barra Bonita on the River Tietê, SP.

The rotifer Kellicottia bostoniensis was found in eight water bodies, viz. Paiva Castro, Águas Claras, Lakes 1 and 2 in Tietê Ecology Park, Jundiaí, Taiaçupeba, Guarapiranga and Billings-Estoril. In this last reservoir, it dominated the rotifer community (67%). All these habitats exhibited high concentrations of total P and total N, suggesting a correlation between the species and higher trophic levels.

Lucinda (2003) reported the presence of K. bostoniensis in the waters of the UGRHIs Middle Tietê/Sorocaba and Tietê/Jacaré, which have signs of eutrophication. However, in the reservoirs of the Lower Tietê, where the trophic level is reduced by natural depuration (CETESB, 2002), there was no record of this species.

Edmondson (1953) claimed that K. bostoniensis has a distribution limited to North America, although there exist records in Europe and Asia. It is likely that this species has introduced to Europe (Pejler, 1998) and Scandinavia (Dumont, 1983), but its presence in Southeast Asia is still uncertain as the identification may have been mistaken (Segers, 2001).

According to Koste & Paggi (1982) and Paggi & Koste (1995), K. bostoniensis is not included among the neotropical rotifers. In 1997, however, Lopes et al. registered this species for the first time in Segredo Reservoir, Brazil. More recently, Landa et al. (2002) and Serafim-Jr et al. (2003) recorded K. bostoniensis in Furnas Reservoir and upper Paraná River floodplain, respectively. Wider surveys of its occurrence in South America are required before further considerations can be made on its distribution and possible introduction to this continent.

In Fig. 5, the percentages of the three most frequent species found at each site (Dominant 1, Dominant 2 and Dominant 3) are shown. In all cases, the sum of these three percentages represented from 54% to, exceptionally, 100% (at Taiaçupeba E1, Ribeirão do Campo E1 and Rodrigo Pires) of all rotifers counted at the site. "Dominant 1" accounted for 23 to 82% of total rotifers in a sample. Green (1993) was of the opinion that a high degree of species dominance might indicate pollution or some other environmental stress.

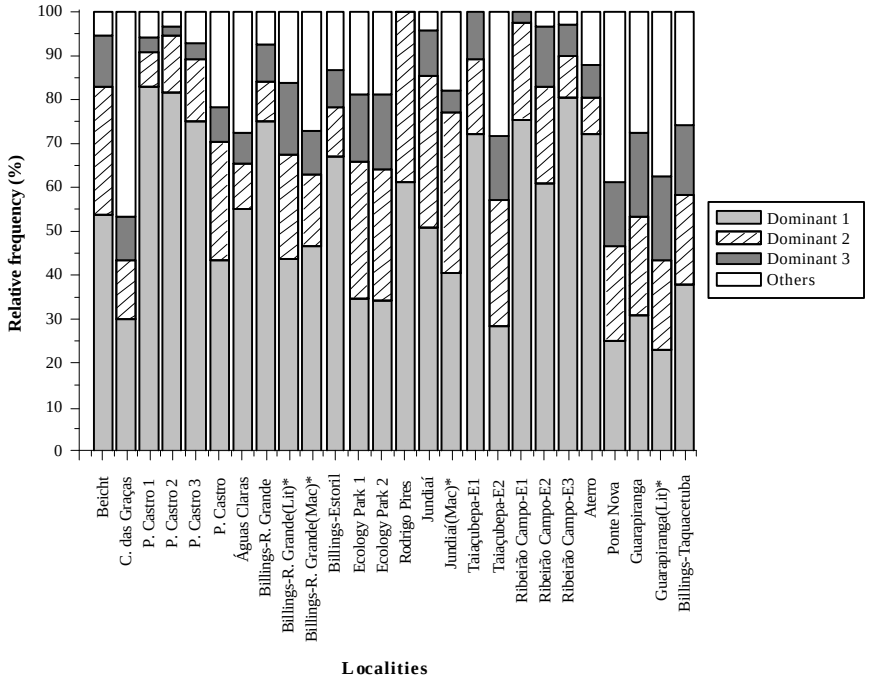

Figure 5: Relative frequencies (in percent) of the three Dominant taxa recorded at each collection site in the Upper Tietê Water Resource Management Unit. * Mac: macrophytes; Lit: littoral

Eight new occurrences for São Paulo State were recorded: Aspelta angusta, Lecane elsa, Lepadella donneri, Notommata copeus, Notommata glyphura, Notommata pseudocerberus, Octotrocha speciosa and Testudinella cf. ahlstromi.

Smet & Pourriot (1997) registered Aspelta angusta in Europe and North America, being the first recorded occurrence of this species in South America. Recently, Serafim-Jr et al. (2003) possibly found this species (Aspelta cf. angusta) in upper Paraná River floodplain.

Diagnosis of species recorded as new occurrences of Rotifera in São Paulo State

Aspelta angusta Harring & Myers, 1928 (Plate I, Fig.4)

Body very elongate and slender. Toes straight, broad at the base, tapering rapidly to long, slender, acute point. Trophi forcipate, large and asymmetrical. Fulcrum very long, somewhat longer than rami, in ventral view rod-shaped, slightly expanded posteriorly. Unci rudimentary, T-shaped. Manubrium very long, slender, straight, expanded anteriorly, sharply incurved and slightly knobbed posteriorly. Food: other rotifers (Dicranophorus, Cephalodella, Lecane). This species lives in bogs, littoral ponds. Occurrence: Ribeirão do Campo Reservoir (littoral region) and Aterro Lake. Total length (contracted specimen) = 110-150 mm, toes = 34-40 mm, trophi = 40 mm.

Lecane elsa Hauer, 1931 (Plate I, Fig.1)

Lorica without ornamentations. Dorsal plate narrower than ventral plate. Head aperture margin dorsally straight, ventrally biconvex. Ventral plate longer than wide, with complete, lunate, transverse fold. Lateral margins slightly curved. Lateral sulci deep. Foot pseudosegment trapezoidal, not projecting. Toes parallel-sided, bearing pseudoclaws and accessory claws. This species resembles L. curvicornis, but has angulate antero-lateral corners. Probably cosmopolitan; in the littoral of water bodies. Occurrence: Lake 1 of the Tietê Ecology Park. Total length = 150 mm, width = 120 mm, toes = 60 mm, claws = 10 mm.

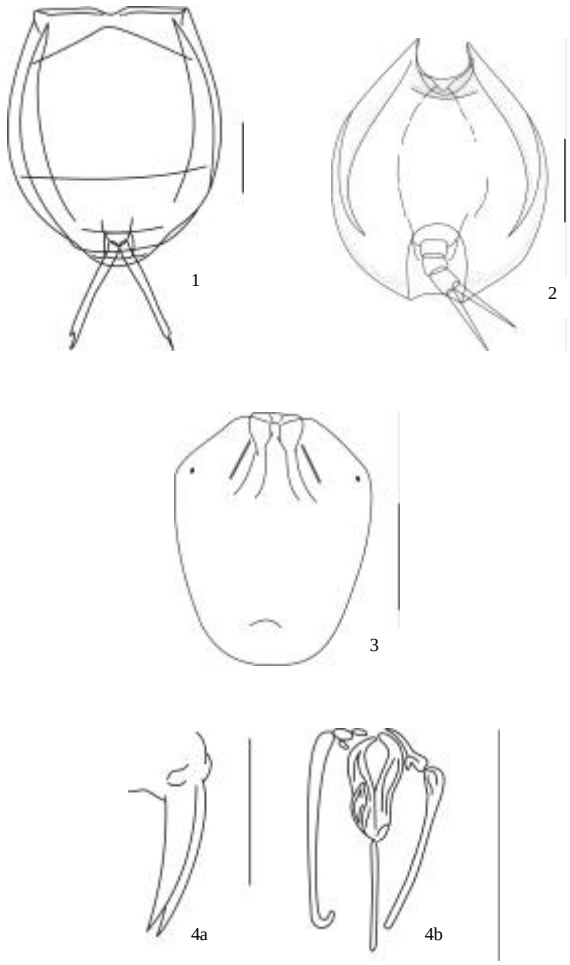

Plate I: Fig.1: L. elsa; Fig.2: Lepadella donneri; Fig.3: Testudinella cf. ahlstromi; Fig.4: a- Toes of Aspelta angusta, b- Trophi. Scale bars: 40 mm

Notommata copeus Ehrenberg, 1834 (Plate II, Fig.5)

The largest species of the genus: its size reaches about 1 mm. Foot has two joints; the terminal joint bears a small, knob-like projection with a tuft of minute setae. Toes straight and moderately long (40-65 mm). Trophi strongly asymmetric, more robust on the left side than on the right. Uncus with a very large ventral tooth followed by three much smaller teeth. Manubrium long and broad. Cosmopolitan; species common in acid water and feeding on Zygnematales. Occurrence: Lake 1 of the Tietê Ecology Park, Jundiaí Reservoir and Aterro Lake. Total length (contracted specimen) = 210-310 mm, trophi = 70-100 mm, fulcrum = 80 mm, manubrium = 60-75 mm, uncus = 32 mm.

Notommata glyphura Wulfert, 1935 (Plate II, Fig.7)

Moderate size; toes short and straight (20-24 mm). Trophi asymmetric and robust, ramus with teeth, the left alula being very large and dagger shaped. Uncus bears a moderately strong ventral tooth that may have three tiny side teeth followed by three reduced teeth. Common in Europe, reported from West Africa. This predator feeds mainly on small benthic bdelloids, or sucks out eggs or carrion. This species was recorded in Jucuruí Lake, Brazil, by Koste & Paggi (1982). Occurrence: Cachoeira das Graças Reservoir. Total length (contracted specimen) = 155 mm, trophi = 55 mm, fulcrum = 30 mm, manubrium = 32 mm, uncus = 17 mm.

Notommata pseudocerberus De Beauchamp, 1908 (Plate II, Fig.6)

Body slender and fusiform. Long two-jointed foot with two straight toes. Trophi very slender and symmetric, fulcrum long and thin, ramus lamellar without teeth, uncus with a simple slender tooth. Cosmopolitan, but rare. Food: sessile ciliates. This species was recorded in Laguna de Santarém, Brazil, by Koste & Paggi (1982). Occurrence: Taiaçupeba Reservoir and Aterro Lake. Total length (contracted specimen) = 120-210 mm, trophi = 28-30 mm, fulcrum = 18 mm, manubrium = 22 mmm.

Plate II: Fig.5: a- Notommata copeus (contracted specimen) (*), b- Manubrium (lateral view), c- Fulcrum (lateral view), d- Uncus, e- Incus (fulcrum + ramus); Fig.6: a- N. pseudocerberus (contracted specimen) (*), b- Trophi, c- Fulcrum (lateral view), d- Manubrium (lateral view); Fig.7: a- N. glyphura (contracted specimen), b- Trophi, c- Uncus, d- Manubrium (lateral view), e- Fulcrum (lateral view) Scale bars: 40 mm; (*) 50mm

Octotrocha speciosa Thorpe, 1893 (Plate III, Fig.8)

Illoricate. Elongate body and foot. Dorsal projection, dorsal antenna and lateral antenna present in anterior region ("head"). Projection with curved spines laterally, small tooth present on each spine. Small rounded projection between the spines. Trophi maleoramate. Uncus with many teeth. Teeth strongly different: three proximal robust and others reduced. Common throughout the American continents (Sarma & Manuel, 1998). This species was recorded in Laguna de Santarém, Brazil, by Koste & Paggi (1982). Occurrence: Billings-Riacho Grande Reservoir (macrophyte region). Total length (contracted specimen) = 425 mm, trophi = 40 mm.

Polyarthra aff. vulgaris (Plate III, Fig.9)

This specimen resembles Polyarthra aff. vulgaris collected in Broa Reservoir, São Paulo, Brazil, by Segers & Dumont (1995). This specimen combines the following characters: paddle length and position of lateral antennae as in P. vulgaris or P. longiremis; the shape of its accessory paddles as in P. luminosa and trophi as in P. dolichoptera or P. longiremis. Considering the unsettled taxonomy of the genus, owing to character variability, we cannot affirm this to be a new species. Total length = 65-110 mm, trophi = 35-60 mm.

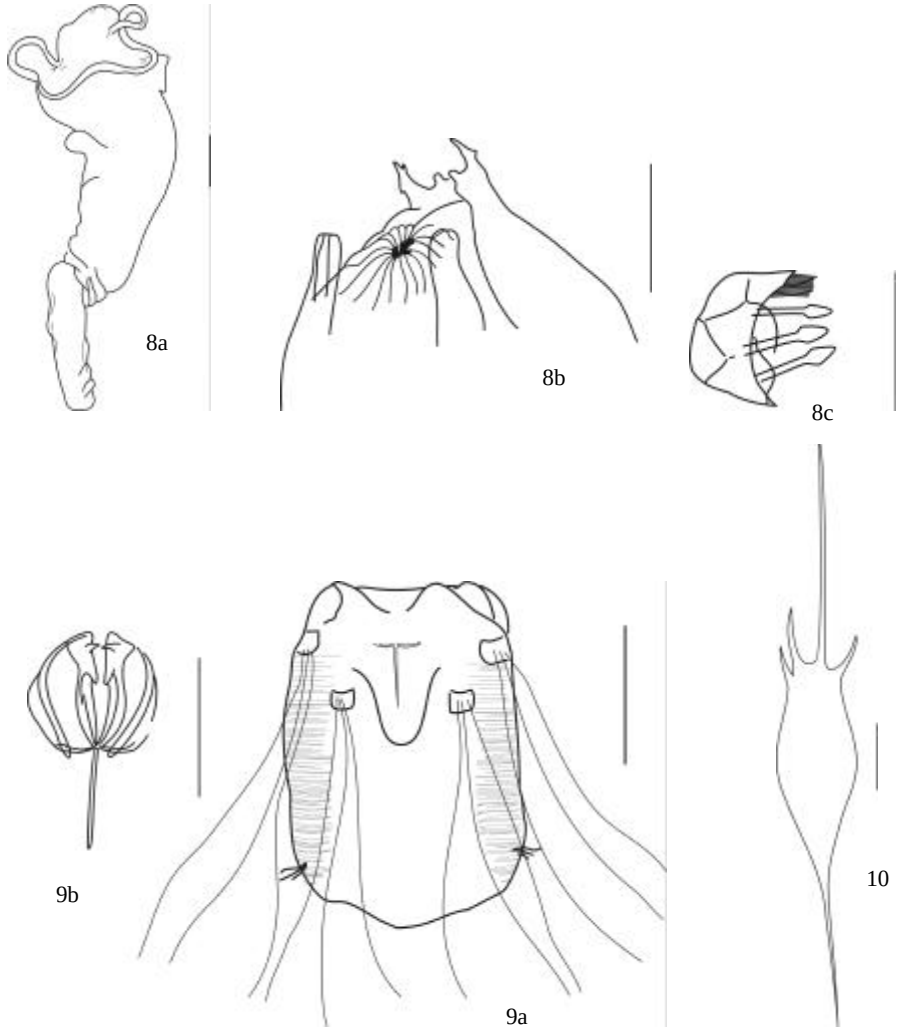

Plate III: Fig.8: a- Octotrocha speciosa (contracted specimen) (*), b- Anterior projection, c- Malleus (manubrium + uncus), Fig.9: a- Polyarthra aff. vulgaris, b- Trophi; Fig.10: Kellicottia bostoniensis. Scale bars: 40 mm; (*) 50mm

Kellicottia bostoniensis (Rousselet, 1908) (Plate III, Fig.10)

Loricate. Body ovoid-shape. The ventral plate of the lorica is narrower than the dorsal. Ventral plate with a flap-like structure used for attaching the eggs. Four spines of unequal length present on their anterior margins, two small lateral spines and a dorsal asymmetric pair. Spines with denticulate surface. Ventral anterior margin bilobate with a median sinus. Large smooth posterior spine present. Body size and length of the anterior and posterior spine are variable. Differences in the relative proportions among the anterior spines can be observed. This species is indigenous of North America (Edmondson, 1953). Total length = 270-410 mm, anterior spine = 110-160 mm, posterior spine = 60-120 mm.

Acknowledgements

This work is part of the BIOTA/FAPESP Program – The Virtual Institute of Biodiversity (www.biota.org.br).

We would to thank FAPESP and CAPES for their financial support.

References

Akinbuwa, O. & Adeniyi, I.F. 1991. The Rotifera fauna of Opa Reservoir, Ile-Ife, Nigeria. J. Afr. Zool., 105:383-391.

Baribwegure, D. & Segers, H. 2001. Rotifera from Burundi: the Lepadellidae (Rotifera: Monogononta). Hydrobiologia, 446/447:247-254.

Bertoletti, S.A.E.P. 2001. O zooplâncton dos lagos do Parque Estadual das Fontes do Ipiranga (SP) e relação entre espécies zooplanctônicas e estado trófico em corpos d'água do Estado de São Paulo. São Paulo, USP, 254p (Tese).

Bonecker, C.C. & Lansac-Tôha, F.A. 1996. Community structure of rotifers in two environments of the upper River Paraná floodplain (MS) – Brazil. Hydrobiologia, 325:137-150.

Bonecker, C.C., Lansac-Tôha, F.A. & Rossa, D.C. 1998. Planktonic and non-planktonic rotifers in two environments of the Upper Paraná River Floodplain, State of Mato Grosso do Sul, Brazil. Braz. Arch. Biol. Technol., 41:447-456.

CETESB. 2002. Relatório de Qualidade das Águas Interiores do Estado de São Paulo 2001. CETESB, São Paulo. v.1, 224p.

Dabés, M.B.G.S. 1995. Composição e descrição do zooplâncton de 5 (cinco) lagoas marginais do Rio São Francisco, Pirapora/Três Marias/Minas Gerais/Brasil. Rev. Bras. Biol., 55:831-845.

Devetter, M. 1998. Influence of environmental factors on the rotifer assemblage in an artificial lake. Hydrobiologia, 387/388:171-178.

Dumont, H.J. 1983. Biogeography of rotifers. Hydrobiologia, 104:19-30.

Edmondson, W.T. 1953. Rotifera. In: Edmondson, W.T. (ed.) Fresh-water biology. 2.ed. John Wiley & Sons, New York, p.420-494.

Gannon , J.E. & Stemberger, R.S. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Trans. Am. Microsc. Soc., 97:16-35.

Green, J. 1993. Diversity and dominance in planktonic rotifers. Hydrobiologia, 255/256:345-352.

Hardy, E.R., Robertson, B. & Koste, W. 1984. About the relationship between the zooplankton and fluctuating water levels of Lago Camaleão, a Central Amazonian varzea lake. Amazoniana, 1:43-52.

Koste, W. 1978. Rotatoria - die Rädertiere Mitteleuropas. II Tafelband. Gebrüder Borntreger, Berlin. 233p.

Koste, W. & Hardy, E.R. 1984. Taxonomic studies and new distribution records of Rotifera (Phylum Aschelminthes) from Rio Jatapú and Uatumã, Amazonas, Brazil. Amazoniana, 1:17-29.

Koste, W. & Paggi, S.J. 1982. Rotifera of the Superorder Monogononta recorded from Neotropis. Gewässer Abwäss., 68/69:71-102.

Koste, W. & Roberstson, B. 1983. Taxonomic studies of the Rotifera (Phylum Aschelminthes) from a Central Amazonian varzea lake, Lago Camaleão (Ilha de Marchantaria, Rio Solimões, Amazonas, Brazil). Amazoniana, 2:225-254.

Koste, W. & Roberstson, B. 1990. Taxonomics studies of the Rotifera from Shallow Waters on the Island of Maracá, Roraima, Brazil. Amazoniana, 2:185-200.

Koste, W., Roberstson, B. & Hardy, E. 1984. Futher taxonomical studies of the Rotifera from Lago Camaleão, a central Amazonian varzea lake (Ilha de Marchantaria, Rio Solimões, Amazonas, Brazil). Amazoniana, 4:555-576.

Landa, G.G., Del Aguila, L.M.R. & Pinto-Coelho, R.M. 2002. Distribuição espacial e temporal de Kellicottia bostoniensis (Rousselet, 1908) (Rotifera) em um grande reservatório tropical (reservatório de Furnas), Estado de Minas Gerais, Brasil. Acta Sci., 24: 313-319.

Lopes, R.M., Lansac-Tôha, F.A., Vale, R. & Serafim Jr., M. 1997. Comunidade zooplanctônica do reservatório de Segredo. In: Agostinho, A. A. & L. C. Gomes (ed.) Reservatório de segredo: bases ecológicas para o manejo. Editora da Universidade Federal de Maringá, Maringá, p.39-60.

Lucinda, I. 2001. Composição da fauna de Rotifera em pequenos corpos d'água do município de São Carlos, SP. São Carlos, UFSCar, 125p (Monografia).

Lucinda, I. 2003. Composição de Rotifera em corpos d'água da bacia do Rio Tietê – São Paulo, Brasil. São Carlos, UFSCar, 182p (Dissertação).

López, C. & Ochoa, E. 1995. Rotíferos (Monogononta) de la Cuenca Del Río Guasare-Limón, Venezuela. Rev. Biol. Trop., 43:189-193.

Mäemets, A. 1983. Rotifers as indicators of lake types in Estonia. Hydrobiologia, 104:357-361.

Matsumura-Tundisi, T. (coord.). 1999. 1ª Relatório de Avaliação do Projeto Temático Biodiversidade zooplanctônica e o estado de degradação dos ecossistemas aquáticos continentais do Estado de São Paulo (Processo: 98/5091-2). Relatório Científico.

Matsumura-Tundisi, T., Leitão, S.N., Aguena, L.S. & Miyahara, J. 1990. Eutrofização da Represa de Barra Bonita: estrutura e organização da comunidade de Rotifera. Rev. Bras. Biol., 50:923-935.

Medina, M. L. & Vásquez, E. 1988. Estúdio de los rotiferos de uma laguna de inundación de aguas negras Del Bajo Caroni, Venezuela. Mem. Soc. Cienc. Nat. La Salle, 48: 105-119.

Nogrady, T., Wallace, R.L. & Snell, T.W. 1993. Rotifera: biology, ecology and systematics. In: Dumont, H.J.F. (coord.) Guides to the identification of the microinvertebrates of the continental waters of the world. SPB Academic Publishing, Netherlands. v.1, 142p.

Nogrady, T., Pourriot, R. & Segers, H. 1995. Rotifera: the Notommatidae and the Scaridiidae. In: Dumont, H.J.F. (coord). Guides to the identification of the microinvertebrates of the continental waters of the world. SPB Academic Publishing, Netherlands. v.3, 248p.

Oliveira-Neto, A.L &. Moreno, I.H. 1999. Rotíferos. In: Joly, C.A. & Bicudo, C.E.M. (org.) Biodiversidade do Estado de São Paulo, Brasil: invertebrados de água doce. FAPESP, São Paulo. v.4, p.39-52.

Paggi, S.J. 1995. Rotifera. In: Lopretto, E.C. & Tell, G. Ecossistemas de águas continentales. Metodologías para su estudio II. Ediciones Sur, La Plata, p.643-667.

Paggi, S.J. 2001. Diversity of Rotifera (Monogononta) in wetlands of Río Pilcomayo National Park, Ramsar Site (Formosa, Argentina). Hydrobiologia, 462:25-34.

Paggi, S.J. & Koste, W. 1995. Additions to the checklist of Rotifers of the Superorder Monogononta recorded from Neotropis. Int. Rev. Gesamten Hydrobiol., 80:133-140.

Pejler, B. 1983. Zooplanktic indicators of trophy and their food. Hydrobiologia, 101:111-114

Pejler, B. 1998. History of rotifer research in northern Europe. Hydrobiologia, 387-388:1-8.

Rodríguez, M.P. & Matsumura-Tundisi, T. 2000. Variation of density, species composition and dominance of rotifers at a shallow tropical reservoir (Broa Reservoir, SP, Brazil) in a short scale time. Rev. Bras. Biol., 60:1-9.

Sarma, S.S.S. & Manuel, E.G. 1998. Rotifer diversity in a central Mexican pond. Hydrobiologia, 387/388:47-54.

Sládecek, V. 1983. Rotifers as indicators of water quality. Hydrobiologia, 100:169-201.

Secretaria do Meio Ambiente. Secretaria de Recursos Hídricos, Saneamento e Obras. 1997. Gestão das águas: 6 anos de percurso. Secretaria do Meio Ambiente, São Paulo. 77p.

Segers, H. 1995. Rotifera: the Lecanidae (Monogononta). In: Dumont, H.J.F. (coord.) Guides to the identification of the microinvertebrates of the continental waters of the world. SPB Academic Publishing, Netherlands. v.2, 226p.

Segers, H. 2001. Zoogeography of the Southeast Asian Rotifera. Hydrobiologia, 446/447:233-246.

Segers, H. 2002. The nomenclature of the Rotifera: annotated checklist of valid family- and genus-group names. J. Nat. Hist., 36:631-640.

Segers, H. & Dumont, H.J. 1995. 102+ rotifer species (Rotifera: Monogononta) in Broa reservoir (SP., Brazil) on 26 August 1994, with description of three new species. Hydrobiologia, 316:183-197.

Segers, H.; Santo-Silva, E.N. & Oliveira-Neto, A.L. 1993. New and rare species of Lecane and Lepadella (Rotifera: Lecanidae; Colurellidae) from Brazil. Belg. J. Zool., 123:113-121.

Segers, H. & Sarma, S.S.S. 1993. Notes on some new or little know Rotifera from Brazil. Rev. Hydrobiol. Trop., 26:175-1785.

Sendacz, S. 1993. Estudo da comunidade zooplanctônica de lagoas marginais do rio Paraná Superior. São Paulo, USP, 177p (Tese).

Smet, W.H. 1996. Rotifera: the Proalidae (Monogononta). In: Dumont, H.J.F. (coord.) Guides to the identification of the microinvertebrates of the continental waters of the world. SPB Academic Publishing, Netherlands. v.4, 102p.

Smet, W. H. & Pourriot, R. 1997. Rotifera: the Dicranophoridae and Ituridae (Monogononta). In: Dumont, H.J.F. (coord.) Guides to the identification of the microinvertebrates of the continental waters of the world. SPB Academic Publishing, Netherlands. v.5, 344p.

Serafim-Jr., M., Bonecker, C.C., Rossa, D.C., Lansac-Tôha, F.A. & Costa, C.L. 2003. Rotifers of the upper Paraná River floodplain: additions to the checklist. Braz. J. Biol., 63: 207-212.

Turner, P.N. & Da Silva, C. 1992. Littoral rotifers from the State of Mato Grosso, Brazil. Stud. Neotrop. Fauna Environ., 27:227-241.

Walz, N. 1993. Life history strategies of rotifers. In: Walz, N. (ed.) Plankton regulation dynamics – experiments and models in rotifer continuous cultures. Springer-Verlag, Berlin. 308p.

Received: 21 November 2003
Accepted: 20 March 2004