

Rotifera, Paranoá reservoir, Brasília, central Brazil

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ABSTRACT: This study examined rotifers from Lake Paranoá, an urban reservoir of central Brazil, within an exploratory sampling (from 1996 to 2005) on littoral and deeper areas in the lake and from the mouth of the tributaries of the lake (Torto and Bananal - north part, Gama and Riacho Fundo - south part) and registered five genera and 33 species are new records for the reservoir. This reservoir was subject to intense eutrophication at least during thirty years (1960 to 1998). Since 1999, when the lake underwent intentional flushing, shifts in species composition of rotifers were identified. Four new records were exclusives in tributary of Lake Paranoá. An expressive number of non planktonic species were registered in pelagic zone of Lake Paranoá, specially belong to Collotheceidae.

INTRODUCTION

Lake Paranoá is an urban reservoir, which was subjected to intense eutrophication due to human occupation of the catchment area and nutrients inflow derived to inadequate sewage treatment, specially since the 1970s (Mattos *et al.* 1997; Padovesi-Fonseca *et al.* 2009). During three decades, there were a dominance of detritivorous microzooplankton and a monoculture of filamentous bluegreen algae, *Cylindrospermopsis raciborskii* (Woloszynska) Seenayya & Subba Raju, 1972 as well as blooms of *Microcystis aeruginosa* (Kützing) Kützing, 1846 (Branco and Senna 1996; Padovesi-Fonseca and Philomeno 2004).

Since 1993 nutrient loading in Paranoá reservoir has been reduced, as a result of the operation of a new sewage treatment system and a water quality restoration process (Padovesi-Fonseca *et al.* 2009). Besides of this, there were no obvious changes in the zooplankton community (Cavalcanti *et al.* 1997), and the predominance of species usually related to eutrophicated systems (Padovesi-Fonseca *et al.* 2002).

Changes in the zooplankton community have been observed only since 1999, after an intentional flushing occurred in Lake Paranoá (Padovesi-Fonseca *et al.* 2001). Thus, the reoligotrophication process has intensified and there was a consequent water quality improvement (Padovesi-Fonseca *et al.* 2009).

The present study aimed to provide additional information on rotifer species composition in Lake Paranoá, including eutrophicated and restoration periods. Rotifers data of Ribeirão do Gama (a tributary of Lake Paranoá) is also reported in this paper.

MATERIALS AND METHODS

Study site

Lake Paranoá (15°48' S, 47°47' W) is a large, relatively shallow reservoir (area 38.1 km², volume 498.6 x 10⁶ m³, max. depth 40 m, mean depth 13 m), situated in the urban

region of Brasília, central Brazil. The regional climate has two well-defined periods: a cool-dry winter (from May to September) and a warm-rainy summer (from October to April).

The reservoir has an irregular form, with a central area and four extended branches, corresponding to the valleys of former tributaries. More features of the reservoir can be obtained in Padovesi-Fonseca *et al.* (2002) and Padovesi-Fonseca and Philomeno (2004).

Data collection

The samples were collected in tributary (Ribeirão do Gama) and pelagic zones of Lake Paranoá (reservoir branches formed by the ancient tributaries). Sampling in the pelagic zone was carried out in both dry (August-September, 1997-1999-2005) and rainy (January-February 1998-2000-2005) seasons at two fixed collection stations. The first station is located in the Ribeirão do Torto branch (15°44'57.7" S, 47°49'42.1" W) of the reservoir. The second one is located in the Riacho Fundo branch (15°49'81" S, 47°53'18" W) of the reservoir, and in this station samples were also taken monthly and at 1, 3, 6 and 9 m during 2005. Samples were taken by vertical hauls (in the euphotic layer) with a 68 µm mesh plankton net. Samples were taken at the depths using a 5 L Van-Dorn bottle and filtered through a 68 µm mesh plankton net. Samples from tributary (Ribeirão do Gama) were taken using a 20 L plastic pael and filtered through a 68 µm mesh plankton net. In Ribeirão do Gama sampling carried out monthly from October 1999 to October 2000. Formalin 4 % solution was added as a fixative.

Identification was based on Koste (1978), Koste and Robertson (1983), José de Paggi (1989), Segers *et al.* (1993) and Fernando (2002). Nomenclature and taxonomy were based by Segers (2007).

Selected specimens were deposited in the collections of NEL (Nucleous of Limnological Studies): Laboratory of Limnology UnB (Universidade de Brasília) and Laboratory

of Zoology UCB (Universidade Católica de Brasília).

RESULTS AND DISCUSSION

A total of five genera (*Gastropus*, *Kellicotia*, *Mytilina*, *Notholca*, *Trichotria*) and 33 species are new records for Lake Paranoá, central Brazil (Table 1).

From 1997 to 1998, four taxa were added to the rotifers list of Lake Paranoá, as four species: *Collotheca ornata ornata* (Tschugunoff, 1921), *Polyarthra euryptera* (Wierzejski, 1891), *Trichocerca chattoni* (de Beauchamp, 1907) and *Notholca* sp. In 1999-2000, there was a great species richness increase with new 21 rotifers records and in 2005 seven rotifers taxa were added. Two species were registered only at nine meters, 2005: *Brachionus calyciflorus ampiceros* (Ehrenberg, 1838) and *Filinia terminalis* (Plate, 1886).

New records were exclusives taxa for Ribeirão do Gama (tributary): four species, *Brachionus quadridentatus* Hermann, 1783, *Lecane luna* (O. F. Muller, 1776), *Mytilina mucronata* (Muller, 1773) and *Trichotria tetractis* (Ehrenberg, 1830), with two genera *Mytilina* and *Trichotria* included only in this site.

According to families, the greatest species richness increase was registered for Brachionidae (eight species), followed by Gastropodidae (five species), Collothecidae (four species), and Synchaetidae and Filiniidae (three species each). Rotifers from Gastropodidae were observed only in this study.

This present study increased rotifer diversity in Lake Paranoá from 38 taxa until 1991 (see Padovesi-Fonseca et al. 2001) to 71 taxa, referring to 33 species and five genera as new records (Table 1).

Such richness increase represented the sampling effort due to exploratory studies on different habitats (pelagic zone and stream) and spatial design (at various depths), as revealed for Cladocera in Lake Paranoá (Elmoor-Loureiro et al. 2004).

The volume filtered for zooplankton samples and the sampling frequency may also have influence to cover the rotifers diversity. While in previous studies only 5 L were filtered for samples (e.g. Branco and Senna, 1996; Cavalcanti et al. 1997), we filtered 70 L (1997 and 1998) to 210 L (1999, 2000 and 2005) of water for sampling in the pelagic zone.

A potential water quality improvement verified in Lake Paranoá may also be responsible to richness increase of Rotifera. Effects on plankton diversity have been documented and related to water quality improvement (e.g. Gaedke 1998; Jeppensen et al. 2002). When the reservoir had undergone an intense eutrophication process, zooplankton was dominated by detritivorous microzooplankton (Branco and Senna 1996; Padovesi-Fonseca et al. 2002). After the intentional flushing, large-bodied herbivorous plankton have been registered in this reservoir (Padovesi-Fonseca op. cit.; Elmoor-Loureiro et al. 2004).

Usually rotifers were considered to be cosmopolitan due to their high capacities of dispersal, resistant stages, and their mechanisms of dormancy (Fernando 2002). However, early rotifer distribution studies describe a restricted distribution ranges by many species in relation to latitudinal gradients or more defined biogeographic patterns (Dumont 1983; Green 1994).

Rotifers registered from Ribeirão do Gama (tributary) are typical species in littoral habitats and often associated with plants (Sládecek 1983), loricate and generally with retracted body. Also, a relevant number of non planktonic species were registered in pelagic zone of Lake Paranoá. From 33 new records, nine species were non planktonic, specially belong to Collothecidae in Torto branch of the lake. This fact confirms the importance to increase the sampling effort in order to cover the diversity spectrum present in aquatic ecosystems, as discussed by Starling (2000) for central Brazil.

TABLE 1. Rotifers recorded in Paranoá Lake basin, central Brazil, based on early studies (1965-1991^A) and present study (1997-2005^{B,C,D}). *= new records; A = Padovesi-Fonseca et al. 2002; B = Lake Paranoá branches: Riacho Fundo and Torto; C = Lake Paranoá branches: Riacho Fundo and Torto, Ribeirão do Gama (tributary of the lake); D = Lake Paranoá branch: Riacho Fundo.

FAMILIES / SPECIES	1965 - 1968 ^A	1983 - 1984 ^A	1988 - 1989 ^A	1991 ^A	1997 - 1998 ^B	1999 - 2000 ^C	2005 ^D
ASPLANCHNIDAE							
<i>Asplanchna girodi</i> de Guerne, 1888		+	+	+	+	+	
<i>Asplanchna</i> sp. *						+*	+
BRACHIONIDAE							
<i>Anuraeopsis fissa fissa</i> (Gosse, 1851)		+	+	+	+	+	+
<i>Anuraeopsis</i> sp. *						+*	
<i>Brachionus angularis</i> Gosse, 1851		+	+		+	+	
<i>Brachionus calyciflorus calyciflorus</i> Pallas, 1766		+	+	+	+	+	+
<i>Brachionus calyciflorus ampiceros</i> (Ehrenberg, 1838) *							+*
<i>Brachionus dolabratus</i> Haring, 1915 *							+*
<i>Brachionus falcatus</i> Zacharias, 1898		+	+		+	+	+
<i>Brachionus quadridentatus</i> Hermann, 1783 *						+*	
<i>Kellicottia bostoniensis</i> (Rousselet, 1908) *						+*	+
<i>Keratella americana</i> Carlin, 1943		+	+	+	+	+	+

TABLE 1. CONTINUED.

FAMILIES / SPECIES	1965 - 1968 ^A	1983 - 1984 ^A	1988 - 1989 ^A	1991 ^A	1997 - 1998 ^B	1999 - 2000 ^C	2005 ^D
<i>Keratella cochlearis</i> Gosse, 1851			+	+	+	+	+
<i>Keratella cochlearis</i> var. <i>tecta</i> (Gosse, 1851) *							+ *
<i>Keratella lenzi</i> Hauer, 1953 *						+ *	+
<i>Keratella tropica</i> Apstein, 1907			+	+	+	+	+
<i>Notholca</i> sp. *					+ *		
<i>Platylabus quadricornis</i> (Ehrenberg, 1832)			+				
COLLOTHECIDAE							
<i>Collothea</i> cf. <i>ambigua</i> (Hudson, 1883) *							+ *
<i>Collothea mutabilis</i> (Hudson, 1885)			+		+	+	
<i>Collothea ornata ornata</i> (Tschugunoff, 1921) *					+ *	+	+
<i>Collothea ornata cornuta</i> Ehrenberg, 1832 *						+ *	+
<i>Collothea</i> sp. *					+ *	+	
COLURELLIDAE							
<i>Colurella obtusa</i> (Gosse, 1886)			+		+		
<i>Colurella uncinata</i> (O. F. Muller, 1773)			+		+	+	
<i>Lepadella patella</i> (O. F. Muller, 1786)			+				
EPIPHANIDAE							
<i>Epiphanes</i> sp.		+					
EUCHLANIDAE							
<i>Euchlanis dilatata</i> Ehrenberg, 1832			+			+	
<i>Euchlanis</i> sp. *						+ *	
FILINIIDAE							
<i>Filinia limnetica</i> (Zacharias, 1889)		+	+		+	+	
<i>Filinia longiseta limnetica</i> (Zacharias, 1889) *							+ *
<i>Filinia opoliensis</i> (Zacharias, 1898) *							+ *
<i>Filinia pejeri</i> Hutchinson, 1964			+		+		
<i>Filinia terminalis</i> (Plate, 1886) *							+ *
FLOSCULARIIDAE							
<i>Ptygura libera</i> Myers, 1934		+	+			+	
<i>Ptygura</i> sp.1,* sp.2 *						+ *	
GASTROPODIDAE							
<i>Ascomorpha</i> cf. <i>ecaedis</i> Perty, 1850 *						+ *	+
<i>Ascomorpha ovalis</i> (Bergendal, 1892) *						+ *	
<i>Ascomorpha saltans</i> Bartsch, 1870 *						+ *	+
<i>Gastropus</i> sp.1* sp.2 *						+ *	
HEXARTHRIIDAE							
<i>Conochilus dossuarius</i> (Hudson, 1875)	+	+	+	+	+	+	+
<i>Conochilus hippocrepis</i> (Schränk, 1803) *						+ *	
<i>Conochilus unicornis</i> Rousset, 1892 *						+ *	+
<i>Hexarthra intermedia</i> Hauer, 1953		+	+		+	+	+
LECANIDAE							
<i>Lecane hamata</i> (Stokes, 1896)			+		+	+	

TABLE 1. CONTINUED.

FAMILIES / SPECIES	1965 - 1968 ^A	1983 - 1984 ^A	1988 - 1989 ^A	1991 ^A	1997 - 1998 ^B	1999 - 2000 ^C	2005 ^D
<i>Lecane leontina</i> (Turner, 1892)	+	+	+	+	+	+	
<i>Lecane luna</i> (O. F. Muller, 1776) *							+ *
MYTILINIDAE							
<i>Mytilina mucronata</i> (Muller, 1773) *							+ *
NOTOMMATIDAE							
<i>Cephalodella forticata</i> (Ehrenberg, 1832)		+	+		+	+	
PHILODINIDAE							
<i>Rotaria rotatoria</i> (Pallas, 1766)	+		+		+	+	
PEDALIACEAE							
<i>Pedalia</i> sp.	+						
SYNCHAETIDAE							
<i>Polyarthra euryptera</i> (Wierzejski, 1891) *					+	+	
<i>Polyarthra</i> cf. <i>dolichoptera</i> (Idelson, 1925) *							+ *
<i>Polyarthra vulgaris</i> Carlin, 1934	+	+	+	+	+	+	+
<i>Polyarthra vulgaris</i> f. <i>proloba</i> Wulfert *							+ *
<i>Synchaeta pectinata</i> Ehrenberg, 1832		+	+	+	+		
TESTUDINELLIDAE							
<i>Testudinella patina</i> (Hermann, 1783)			+			+	+
TRICHOCERCIDAE							
<i>Trichocerca capucina</i> (Wierzejski and Zacharias, 1893)		+	+	+	+	+	
<i>Trichocerca chattoni</i> (de Beauchamp, 1907) *					+	+	+
<i>Trichocerca pusilla</i> (Lauterborn, 1898)		+	+	+	+	+	+
<i>Trichocerca similis</i> (Wierzejski, 1893)			+	+	+	+	+
<i>Trichocerca</i> sp.		+				+	
TRICHOTRIIDAE							
<i>Trichotria tetractis</i> (Ehrenberg, 1830) *							+ *
TROCHOSPHAERIDAE							
<i>Horaella thomassoni</i> Koste, 1973			+	+		+	
<i>Trochosphaera</i> sp.		+					

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LITERATURE CITED

- Branco, C.W.C. and P.A.C. Senna. 1996. Relations among heterotrophic bacteria, chlorophyll-a, total phytoplankton, total zooplankton and physical and chemical features in Paranoá Reservoir, Brasília, Brazil. *Hydrobiologia* 337: 171-181.
- Cavalcanti, C.G.B., M.T. Pinto, H.J. Freitas and R.C.A. Moreira. 1997. Paranoá lake restoration: impact of tertiary treatment of sewage in watershed. *Verhandlungen des Internationalen Verein Limnologie* 26: 689-693.
- Dumont, H.J. 1983. Biogeography of rotifers. *Hydrobiologia* 104: 19-30.
- Elmoor-Loureiro, L.M.A., L. Mendonça-Galvão and C. Padovesi-Fonseca. 2004. New cladoceran records from Lake Paranoá, central Brazil. *Brazilian Journal of Biology* 64(3A): 415-422.
- Fernando, C.H. (ed.). 2002. *A guide to tropical freshwater zooplankton. Identification, ecology and impact on fisheries*. Leiden: Backhuys Publishers. 290 p.
- Gaede, U. 1998. The response of the pelagic food web to re-oligotrophication of large and deep lake (L. Constance): evidence for scale-dependent hierarchical patterns? *Archiv für Hydrobiologie Special Issues Advances in Limnology* 53: 317-333.
- Green, J. 1994. The temperate-tropical gradient of planktonic Protozoa and Rotifera. *Hydrobiologia* 272: 13-26.
- Jeppesen, E., J.P. Jensen and M. Sondergaard. 2002. Response of phytoplankton, zooplankton and fish to re-oligotrophication: an eleven year study of twenty-three Danish lakes. *Aquatic Ecosystem Health and Management* 5: 9-21.
- José de Paggi, S. 1989. Rotíferos de algunas provincias del noroeste argentino. *Revue d'Hydrobiologie Tropicale* 22: 223-238.
- Koste, W. 1978. *Rotatoria Die Rodertiere Mitteleuropas begründet von Max Voigt - Mongononta*. 2 vols. Stuttgart: Borntraeger. 238 p.
- Koste, W. and B. Robertson. 1983. Taxonomic studies of the Rotifera (Phylum Aschelminthes) from a Central Amazonian varzea lake, Lago Camaleão (Ilha de Marchantaria, Rio Solimões, Amazonas, Brazil). *Amazoniana* 8: 225-254.
- Mattos, S.P., V.R. Estuqui and C.G.B. Cavalcanti. 1997. Lake Paranoá (Brazil): limnological aspects with emphasis on the distribution of the zooplanktonic community (1982 to 1994). *Verhandlungen des Internationalen Verein Limnologie* 26: 542-547.
- Padovesi-Fonseca, C. and M.G. Philomeno. 2004. Effects of algicide (copper

- sulfate) application on short-term fluctuations of phytoplankton in Lake Paranoá, central Brazil. *Brazilian Journal of Biology* 64(4): 819-826.
- Padovesi-Fonseca, C., L. Mendonça-Galvão and D.L.P. Rocha. 2002. Temporal fluctuation and reproduction of *Thermocyclops decipiens* (Copepoda, Cyclopoida) in an eutrophic lake of central Brazil. *Revista de Biología Tropical* 50(1): 57-68.
- Padovesi-Fonseca, C., M.G. Philomeno and C. Andreoni-Batista. 2009. Limnological features after a flushing event in Paranoá Reservoir, central Brazil. *Acta Limnologica Brasiliensis* 21(3): 277-285.
- Padovesi-Fonseca, C., L. Mendonça-Galvão, D.F. Pereira, M.G. Philomeno and D.L.P. Rocha. 2001. O zooplâncton do Lago Paranoá; p. 115-117 In F.O. Fonseca (ed.). *Olhares sobre o Lago Paranoá*. Brasília: Secretaria do Meio Ambiente e Recursos Hídricos do Distrito Federal.
- Segers, H., C.S. Nwadiaro and H.J. Dumont. 1993. Rotifera of some lakes in the floodplain of the River Niger (Imo State, Nigeria). *Hydrobiologia* 250: 63-79.
- Segers, H. 2007. Annotated checklist of the rotifers (Phylum Rotifera) with notes on nomenclature, taxonomy and distribution. *Zootaxa* 1564: 1-104.
- Sládeček, V. 1983. Rotifers as indicators of water quality. *Hydrobiologia* 100: 169-201.
- Starling, F.L.R.M. 2000. Comparative study of the zooplankton composition of six lacustrine ecosystems in central Brazil, during the dry season. *Brazilian Journal of Biology* 60(1): 101-111.

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