Studies on Neotropical Fauna and Environment, December 2005; 40(3): 255–265

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ORIGINAL ARTICLE

Rotifers from a humic coastal lagoon of Rio de Janeiro State, Brazil

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(Received 9 August 2002; accepted 30 May 2005)

Abstract
A four-year study of species composition of the zooplankton community was conducted at Lagoa Comprida, a Brazilian coastal lagoon. Forty-two species of rotifers were recorded and illustrated. All rotifer species, except *Lecane boettgeri* Koste, 1986 and *Macrochaetus kostei*, José de Paggi, Branco & Kozlowsky-Suzuki, 2000, have already been found in other areas of Brazil. Some factors, which probably favored the dominant richness and density of rotifers in the zooplankton community, are discussed.

Keywords: Rotifer assemblage, zooplankton, humic coastal lagoon, Comprida Lagoon, Neotropics, *Hexarthra longicornicula*

Introduction

Rotifera is a widespread and almost ubiquitous group of microscopic aquatic and semiaquatic invertebrates, the majority habitants of freshwater with some genera also occurring in brackish and marine habitats (Nogrady et al., 1993). The checklists of Monogononta rotifers recorded from the Neotropics (Koste & José de Paggi, 1982; José de Paggi & Koste, 1995) compiled a total of 651 species and subspecies. According to Rocha et al. (1994), 411 rotifer species occur in Brazil, a total that has increased with new records in the last few years (Segers & Dumont, 1995; José de Paggi et al., 2000). High rotifer richness has been found in several Brazilian aquatic ecosystems, namely the Amazon and Paraná river basins. This picture is related to some environmental features such as immense floodplains with hundreds of lakes and channels, temporary and permanent, and a high number of zooplankton specialists studying the fauna of these regions (Koste et al., 1984, Koste & Robertson, 1990; Bozelli, 1992; Lansac-Tôha et al., 1997; Bonecker at al., 1998; Rossa & Bonecker, 2003).

Along the extensive coast of Brazil (7400 km) there are many lagoons with different characteristics, either impacted by anthropogenic factors or relatively pristine. Despite their importance for recreational and fishery activities and the great variation in physical and chemical conditions among them (Esteves et al., 1984), few studies have described their plankton communities.

Rotifers have been considered a biologically informative group in lagoons of the Rio de Janeiro State. Some studies have suggested the use of rotifer species as indicators of important conditions in the aquatic ecosystem, such as trophic state, pH or salinity (Attayde & Bozelli, 1998; Branco et al., 2000a, 2000b, 2002). Despite the increasing number of studies concerning ecological features of zooplankton communities in these lagoons (Arcifa et al., 1994; Attayde & Bozelli, 1998; Branco et al., 1998; Kozlowsky-Suzuki et al., 1998), there are a limited number of reports dealing with the taxonomy of the zooplankton of these ecosystems (Reid & Esteves, 1984; Reid, 1985; Turner, 1987a, 1987b, 1990). Here we report on the rotifer assemblage richness and abundance monitored over four years in a humic coastal lagoon in northern Rio de Janeiro State.

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ISSN 0165-0521 print/ISSN 1744-5140 online © 2005 Taylor & Francis
DOI: 10.1080/01650520500250202

Materials and methods

Study site

Comprida Lagoon (22°17′S, 41°39′W) lies in a relatively undisturbed area of a former cattle farm surrounded by natural sand dunes and bush vegetation (restinga) in the recently created National Park of the Restinga de Jurubatiba located on the northern coast of the State of Rio de Janeiro. The lagoon has a surface area of 0.13 km^2 and a maximum depth of 3 m. Its littoral region is almost completely covered by aquatic macrophytes. The lagoon is separated from the sea by a 50 m wide sand barrier and has been described as a freshwater and brown-colored coastal lake which contains high concentrations of humic compounds, low water transparency and low pH values (Esteves et al., 1984). Since neither natural nor artificial rupture of the sand barrier has been observed in this ecosystem, salinity values recorded must be attributed to sporadic marine inflow during storms. Data on the water quality were recorded monthly during the study period.

Sampling of rotifers

Zooplankton samples were collected monthly May, 1992 through May, 1993 and quarterly August, 1993 through November, 1995 at one fixed station in an open area of Comprida Lagoon in order to avoid direct influences of river inflow and sea water. Water temperature, salinity (H-01474-00 digital salinity, conductivity and temperature meter) and pH (Micronal B278) were measured during the sampling procedures. A 28 cm diameter and 68 μm mesh plankton net was used, and vertical hauls were made, each time filtering a total of 100 l of water. Samples were immediately fixed with 4% buffered formaldehyde solution containing sucrose. Five 1 ml subsamples were counted in a Sedgewick-Rafter cell and the entire sample was inspected for rare rotifer species. The frequency of occurrence for each taxon was recorded considering constant the species occurring in 50% or more of the samples, common those with frequencies between 10 and 49% and rare species occurring in less than 9% of the samples. A principal component analysis (PCA) was performed with rotifer richness, density of zooplanktonic groups and environmental variables.

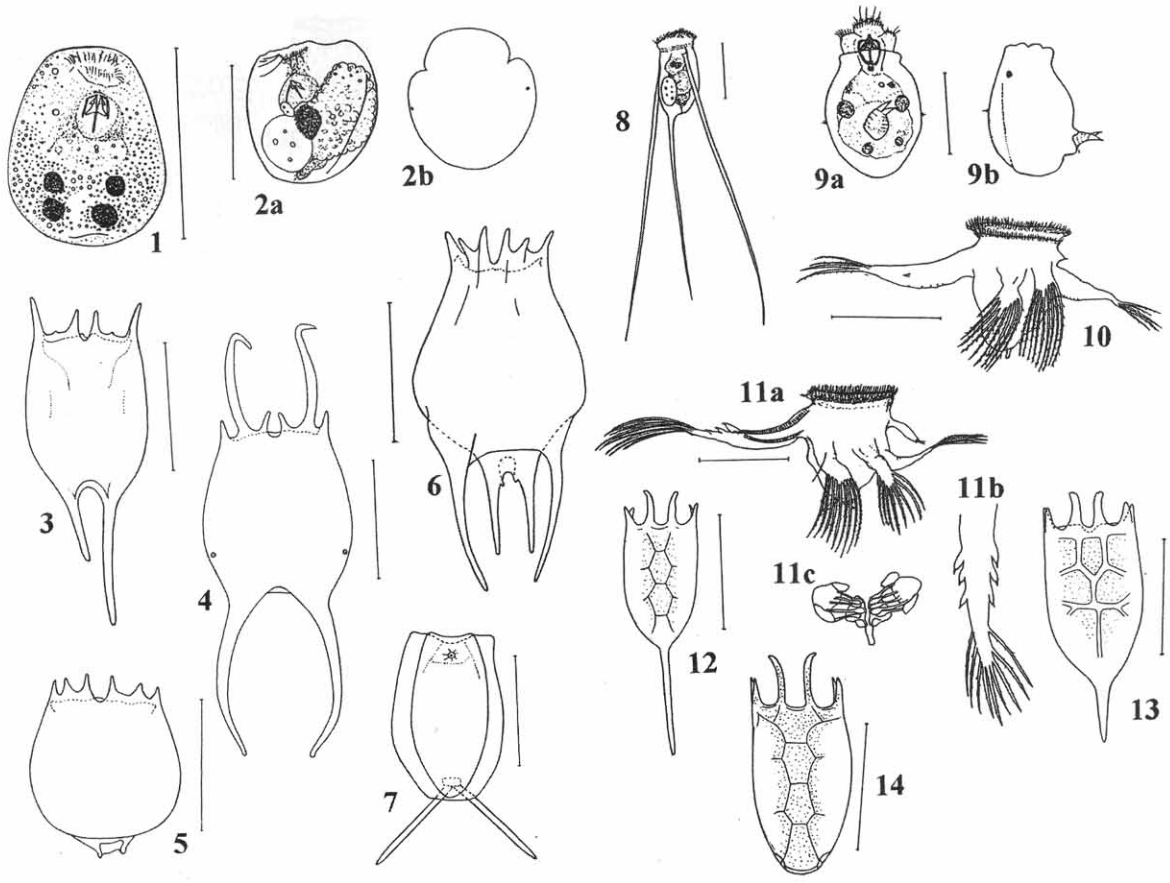
Results

Forty-two rotifer species were identified in the zooplankton community (Figures 1–42). Most of them were loricated forms with dimensions under 300 μm (Table I). Only five species (*Hexarthra longicornicula, Lecane bulla bulla, L. leontina leontina, L. lunaris* and *Testudinella ohlei ohlei*) were considered constant. Nine species have already been recorded in all the main Brazilian hydrographical basins (*Keratella americana, K. cochlearis, K. lenzi lenzi, Lecane bulla bulla, L. leontina leontina, L. papuana, L. signifera, Monommata maculata,* and *Testudinella patina patina*) and two (*Brachionus rotundiformis* and *Synchaeta bicornis*) were found in coastal lagoons in the Northeast and Southeast basins. A mean of 14 rotifer species were found per sample, a minimum of nine species was detected in November 1993 and a maximum of 19 in December 1992 and August 1995 (Figure 43). The total zooplankton abundance was mainly comprised of cladocerans and copepods (Figure 44a). However, rotifers attained more than 50% of the total abundance for several months and up to 80% of it in September 1992 and November 1993, corresponding to *H. longicornicula* population increases. The mean rotifer density was 19 132ind/m^3, ranging from 379 to 163 156 ind/m^3. Most species were found in low numbers, and only nine species (*Ascomorpha saltans, Brachionus rotundiformis, Gastropus minor, Hexarthra intermedia, H. longicornicula, Lecane bulla bulla, L. leontina leontina, Synchaeta longipes* and *Rotaria macrura*) had average densities above 100 ind/m^3. *Hexarthra longicornicula* attained the highest mean density (14 639 ind/m^3) and peaked up to 160 000 ind/m^3 (Figure 44b). Limnological variables characterized Comprida Lagoon as an oligohaline environment with low water transparency (Table II). Mean water temperature was 25.8°C; low values were registered in the winter (June, July and August) and higher in the summer (January, February and March) (Figure 45a). Values of pH were always below 6.2, with a mean 4.91 and minimum 3.27 (Figure 45b). High pH values were associated with seawater influx, and accompanied the rise of salinity most times. Salinity increases were detected from May to July 1992, in August 1993 and 1994, November 1994 and February 1994 (Figure 45c). The first three axes of the PCA accounted for 52% of the variation of data. The first factorial axis (Figure 46) was responsible for 27% of the data variance as a result of high pH, conductivity, water transparency and dissolved oxygen. Rotifer richness and water temperature had negative loadings with this first axis. The second axis was responsible for 18% of the variance. Copepod, cladoceran and rotifer abundances had positive loadings on this axis, whereas salinity had negative ones.

Discussion

Rotifer species richness in Neotropical freshwater systems

Intensive zooplankton surveys in tropical and subtropical waters of South America have found rich rotifer assemblages. Up to 230 species have been



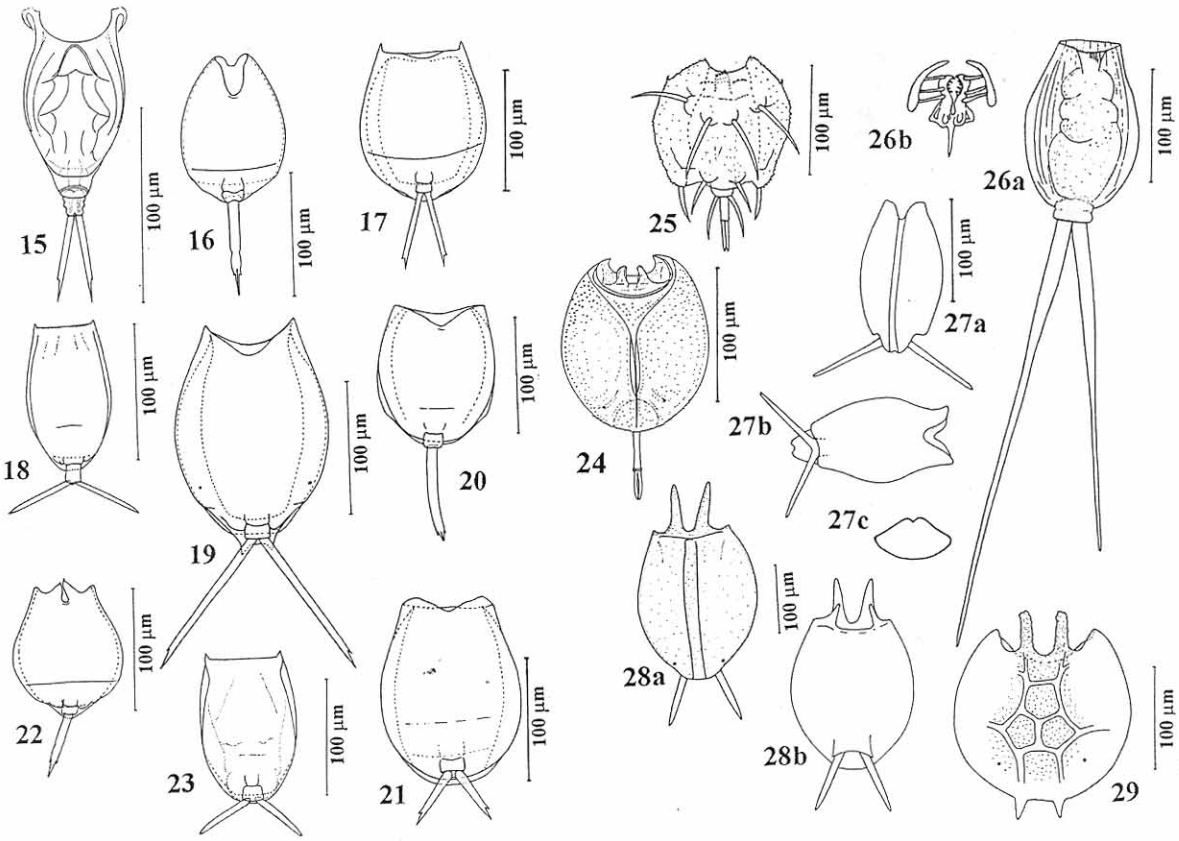
Figures 1–14. 1, *Ascomorpha ecaudis*, body contracted; 2, *Ascomorpha saltans*, body contracted, a: lateral view, b: transversal view; 3, *Brachionus caudatus*; 4, *Brachionus falcatus falcatus*; 5, *Brachionus rotundiformis*; 6, *Brachionus quadridentatus mirabilis*; 7, *Dipleuchlanis propatula*; 8, *Filinia pejleri*; 9, *Gastropus minor*, a: ventral view; b: lateral view; 10, *Hexarthra intermedia intermedia*; 11, *Hexarthra longicornicula*; a: lateral view, b: ventral arm, c: mastax; 12, *Keratella americana*; 13, *Keratella cochlearis*; 14, *Keratella lenzi lenzi*. Scale bars = 100 μm.

registered in the Paraná River floodplain (Serafim et al., 2003), 159 species were identified in a shallow water ecosystem and 148 in Camaleão lake, both in the Amazon Basin (Koste & Robertson, 1990). Turner and DaSilva (1992) found 174 species of rotifer in small water bodies in Pantanal and Paggi (2001) inventoried 114 taxa in wetlands also in the Paraguay Basin. Lower rotifer richness has been found in reservoirs, but even in these artificial systems research including pelagic and littoral areas using 40 μm mesh plankton nets revealed up to 102 species (Segers & Dumont, 1995). Shallow lakes and lagoons in coastal areas have shown low rotifer richness presenting a relative dominance of rotifers in the zooplankton abundance on several occasions. In these systems, a large proportion of cosmopolitan taxa characterize the rotifer fauna.

The high number of rotifer species found in the Neotropical region can be explained by the great diversity in climates and environments of this region. High species richness is related to high habitat heterogeneity. Decreases of this heterogeneity due to antropic influence such as in eutrophic reservoirs and coastal lagoons or due to marine influence on coastal lakes are associated with a low number of rotifer species in the zooplankton.

Considering that Comprida Lagoon is a coastal shallow small water body and that the samplings were only performed at one point in the middle of the lagoon, we found a high rotifer species richness. The presence of aquatic macrophytes and frequent water column mixing due to wind disturbance allowed the constant presence of littoral forms in the limnetic plankton. Furthermore, the region in which the lagoon is located favored a low antropic influence on the ecosystem. The main environmental change during the study period was the marine intrusion over the sand barrier caused by stormy weather. Such events, which happened mostly in the winter with low water temperature, promoted increases in pH, water conductivity and transparency. Rotifer richness was negatively correlated with these situations, which was shown by the PCA result.

Rotifer richness varied according to both environmental features and sampling effort in other nearby



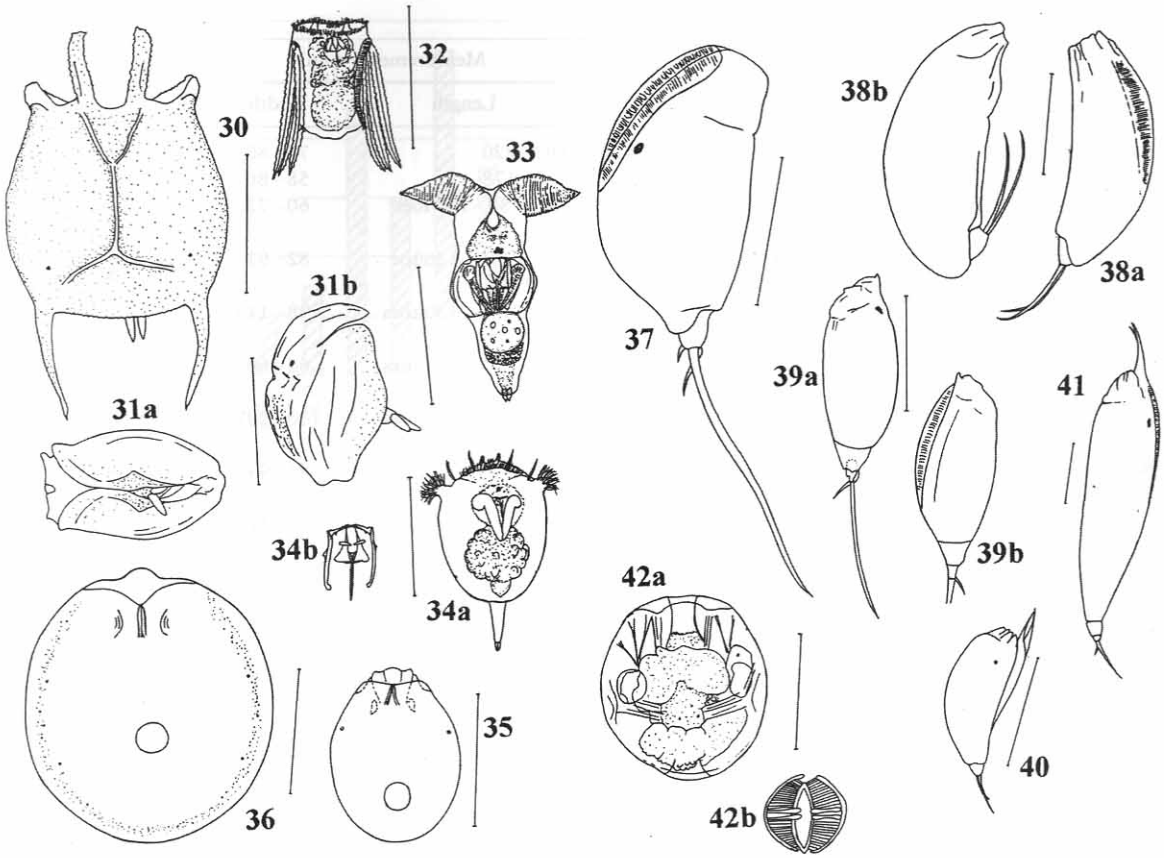
Figures 15–29. 15, *Lecane boettgeri*; 16, *Lecane bulla bulla*; 17, *Lecane curvicornis curvicornis*; 18, *Lecane deridderae*; 19, *Lecane leontina leontina*; 20, *Lecane lunaris*; 21, *Lecane papuana*; 22, *Lecane quadridentata*; 23, *Lecane signifera*; 24, *Macrochaetus kostei*, dorsal view; 25, *Macrochaetus longipes*; 26, *Monommata maculata*, a: body contracted, b: mastax; 27, *Mytilina bisulcata*, a: dorsal view, b: ventral view, c: transversal view; 28, *Mytilina macrocera*, a: dorsal view, b: ventral view; 29, *Platyias leloupi* f. *latiscapularis*. Scale bars = 100 μm.

coastal lagoons. Undisturbed larger lagoons in which more points were sampled (sampling units) such as in Cabiúnas Lagoon (s.u. = 69) (Branco, 1998) presented higher rotifer richness (61) than the Comprida Lagoon (s.u. = 23). However, a higher sampling effort at several points in larger eutrophic lagoons did not yield a significant increase in rotifer richness. In Imboassica Lagoon, 52 rotifer species were found in an almost 10-fold sampling effort (s.u. = 220, Branco, 1998), while in Carapebus Lagoon a lower number of rotifer species (27) was registered in a number of samplings similar to this study (s.u. = 25, Attayde & Bozelli, 1998). Zooplankton studies in two highly impacted coastal lagoons in the state of Rio de Janeiro, Barra Lagoon and Jacarepaguá Lagoon, registered only three and seven rotifer species, respectively. The extremely low richness of these two systems was associated with the dominance of *Brachionus* species (Arcifa et al., 1994).

Brachionus, Lecane and *Trichocerca* are genera with high diversity in tropical and subtropical environments (Rocha et al., 1995). *Brachionus* was represented by a low number of species (four) in Comprida Lagoon, which was probably related to the low pH. The similarity of the rotifer fauna of the lagoon to others in the Amazon and Paraná Basins was due to the presence of species with cosmopolitan and tropicopolitan distribution such as *Keratella cochlearis, K. americana* and *K. lenzi* (Turner, 1987a), *Lecane leontina, L. papuana, Lecane bulla, L. lunaris* and *L. signifera* (Segers, 1995). All rotifer species, except *Macrochaetus kostei* (José de Paggi et al., 2000) and *Lecane boettgeri,* have been found in other areas of Brazil.

Rotifer density

Overall rotifer density in Comprida Lagoon was lower than in other nearby coastal lagoons and in larger lakes and reservoirs in Brazil (Matsumura-Tundisi et al., 1990; Santos et al., 1994). This was probably linked to the constant low pH in Comprida Lagoon, since increases in rotifer abundance were positively correlated with high pH according to the PCA result. Long-term effects of



Figures 30–42. 30, *Platyias quadricornis* f. *brevispinus*; 31, *Ploesoma lenticulare*, a: ventral view, b: lateral view; 32, *Polyarthra dolichoptera dolichoptera*; 33, *Synchaeta bicornis*; 34, *Synchaeta longipes*, a: ventral view, b: mastax; 35, *Testudinella ohlei ohlei*; 36, *Testudinella patina patina*; 37, *Trichocerca braziliensis*; 38, *Trichocerca collaris*, a: lateral view, b: body contracted; 39, *Trichocerca elongata elongata*; a: ventral view, b: lateral view; 40, *Trichocerca similis similis*; 41, *Trichocerca similis f. grandis*. 42, *Rotaria macrura*, a: body contracted, b: mastax. Scale bars = 100 μm.

Table I. Species recorded with frequency of occurrence (Fo) and average density (Ad) during the period of study, measurements and their occurrence (+) (* = present study) in the main hydrographical basins of Brazil (A = Amazon, Pr = Paraná, N = Northeast, P = Paraguay, E = East, S = Southeast).

			Measurements (μm)		Basin					
Species	Fo (%)	Ad (ind/m^3)	Length	Width	A	Pr	N	P	E	S
Class Monogononta										
Ascomorpha ecaudis (Perty, 1850)	14	47	104–133	85–104	+	+		+	+	+
A. saltans Bartsch, 1870	<10	170	110–140	30–60	+	+		+	+	+
Brachionus caudatus Barrois & Daday, 1894	<10	<1	120–140 (without spines)	96–126	+	+		+	+	+
B. f. falcatus Zacharias, 1898	36	57	280–320	100–122	+	+	+		+	+
B.rotundiformis Tschugunoff, 1921	23	460	140–196	120–164			+			+
B. quadridentatus mirabilis (Daday, 1897)	<10	5	270–300	120–140	+	+	+			+
Dipleuchlanis propatula (Gosse, 1886)	<10	1	lorica 150–160/toes 100–105	100–125	+	+		+	+	+
Filinia pejleri Hutchinson, 1964	<10	3	120–160 caudal appendage 300–360	350–432	+	+	+			+
Gastropus minor (Rousselet, 1892)	32	357	76–160	55–65				+		+
Hexarthra i. intermedia Wiszniewski, 1929	40	1 230	100–120		+	+		+	+	+
H. longicornicula Turner, 1987	68	14 639	90–110 ventral arm without bristles 130–180							+
Keratella americana Carlin, 1943	<10	2	110–230	60	+	+	+	+	+	+

(*continued*)

Table I. (*Continued*)

Species	Fo (%)	Ad (ind/m^3)	Measurements (μm) Length	Width	Basin A	Pr	N	P	E	S
K. cochlearis (Gosse 1851)	<10	4	192–220	70–80	+	+	+	+	+	+
K. l. lenzi (Hauer 1953)	14	26	120–178	58–86	+	+	+	+	+	+
Lecane boettgeri Koste, 1986	<10	1	lorica 80–130/toes 65–72	60–72						*
L. b. bulla (Goss,e 1886)	73	154	lorica 110–126/toe 72–90	82–97	+	+	+	+	+	+
L. c. curvicornis (Murray, 1930)	<10	6	lorica 110–130/toes 55–68	98–114	+	+	+	+	+	+
L. deridderae Koste, 1972	<10	2	lorica 118–122/toes 46–48	64–66	+					+
L. l. leontina (Turner, 1892)	50	30	lorica 180–240/toes 112–190	130–207	+	+	+	+	+	+
L. lunaris (Ehrb, 1832)	59	74	lorica 102–120/toes 60–97	83–94	+	+	+		+	+
L. papuana (Murray, 1913)	14	6	lorica 100–140/toes 25–32	90–110	+	+	+	+	+	+
L. quadridentata (Ehrb, 1832)	8	3	lorica 110–149/toe 46–70	85–110	+	+		+	+	+
L. signifera (Jennings, 1896)	16	4	lorica 116–144/toes 20–48	76–102	+	+	+	+	+	+
Macrochaetus kostei José de Paggi, Branco & Kozlowsky-Suzuki, 2000	<10	2	lorica 135–145/toes 22–25	102–108						*
M. longipes Myers, 1934	<10	25	lorica 176–190/toes 29–31 second foot segment 23–25	100–122	+			+		+
Monommata maculata H. & M. 1924	32	21	140–146 right toe 400–440/left 320–330	72–80	+	+	+	+	+	+
Mytilina bisulcata (Lusks, 1912)	<10	4	lorica 150–180/toes 68–72	70–80	+					+
M. macrocera (Jennings, 1894)	<10	<1	lorica 310–360/toes 128–132	150–210	+	+				+
Platyias leloupi f. *latiscapularis* (Koste, 1974)	<10	<1	lorica 190–260 (without spines)	160–210	+			+	+	+
P. quadricornis f. *brevispinus* (Daday, 1905)	<10	<1	lorica 190–204/ (without spines)	132–140	+	+		+		+
Ploesoma lenticulare Herrick	32	2	lorica 120–140	72–90	+	+				+
Polyarthra d. dolichoptera Idelson, 1925	45	75	86–94/arms 96–112		+	+		+	+	+
Synchaeta bicornis Smith, 1904	<10	25	175–195 (body contracted)							+
S. longipes Gosse, 1887	<10	4 713	156–176 (body contracted)		+	+			+	+
Testudinella o. ohlei Koste, 1972	54	63	116–138	91–110	+	+			+	+
T. p. patina (Hermann, 1783)	23	50	199–220	179–220	+	+	+	+	+	+
Trichocerca braziliensis (Murray, 1913)	28	9	184–225/toes 160–180	92–116	+	+			+	+
T. collaris (Rousselet, 1896)	<10	<1	190–309/toe 60–90	65–95	+					+
T. e. elongata (Gosse, 1886)	<10	6	170–180 right toe 18–28/left 92–122	64–80		+	+	+		+
T. s. similis (Wierzejski, 1893)	<10	<1	130–140 right toe 26–32/left 36–50	56–60	+	+		+	+	+
T. s. f. *grandis* Hauer, 1965	<10	<1	400–460 right toe 40–45/left 15–25		+	+				+
Class Digononta										
Rotaria macrura (Ehrb.) 1832	28	139	400–450		+					+

acid conditions on the zooplankton are reduced number of offspring and reproductive capacity, and delayed reproduction (Jørgensen, 1993). In addition, the quality and quantity of the available food to the zooplankton are also affected by the low pH, since the acidity and brown color of Comprida Lagoon have a negative influence on the phytoplankton community resulting in lower densities

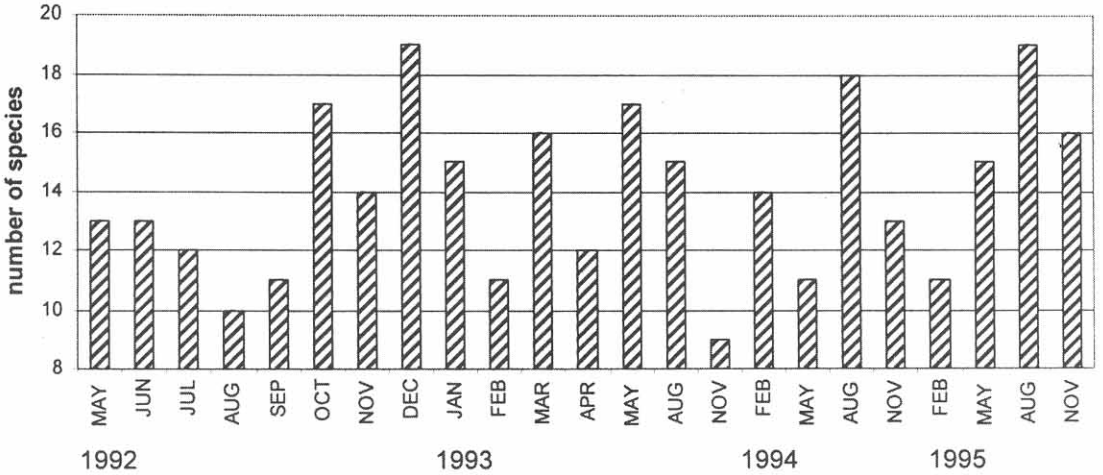


Figure 43. Rotifer richness of Comprida Lagoon during the study period.

Table II. Average, standard deviation (SD), minimum and maximum values of some of the variables measured in Comprida Lagoon during the study period, modified from Branco et al., 2000a ($n = 23$).

Parameters	x	SD	Range
Transparency (m)	0.46	0.15	0.2–0.7
Temperature (°C)	25.81	2.70	21–30.4
Conductivity (mS/cm)	0.74	0.95	0.09–3.4
Dissolved oxygen (mg/l)	6.22	1.45	3.23–8.8
pH	4.91	0.79	3.2–6.1
Alkalinity (mEq/l)	0.08	0.09	0–0.31
Salinity (u.s.)	0.59	2.29	0–10
Suspended matter (mg/l)	3.46	2.22	1.2–9.2
Chlorophyll-*a* (μg/l)	2.72	1.87	0.8–7

than in other nearby lagoons (Melo & Suzuki, 1998).

The constant species *Hexarthra longicornicula*, *Lecane bulla*, *L. leontina*, *L. lunaris* and *Testudinella ohlei* were somehow linked with such environmental conditions. Pourriot (1996) also found these five species in a reservoir with slightly acidic waters in French Guyana. In addition, *L. bulla*, which presented the highest frequency of occurrence in this study, is considered a pH-tolerant species of fresh, brackish and salt water (Koste, 1978).

In our study, noteworthy density increases of *Hexarthra longicornicula* were related to rising pH and suspended matter values, while *L. leontina* and *Testudinella ohlei*, together with *L. signifera*, *Monommata maculata* and *Ploesoma lenticulare*, attained their highest densities in low pH conditions (Branco et al., 2000a). *Hexarthra longicornicula* was also dominant in Cabiúnas Lagoon, a freshwater environment with pH around 6.6 (Branco, 1998). Several species within this genus can be found in brackish conditions and alkaline waters (Koste, 1978) and are frequent in freshwater and oligohaline conditions in coastal lagoons (Comín & Valiela, 1993; Arcifa et al., 1994; Attayde & Bozelli, 1998).

Specific biological features of rotifers such as short lifespan, parthenogenetic reproduction, populations with a high intrinsic increase rate and the production of resting eggs may allow for a fast recovery under favorable environmental and/or food conditions. Nutrients and food availability have fast turnover in the tropics due to high temperatures, daily fluctuations in the chemical variables or sudden environmental changes associated with heavy rains. All these conditions may benefit organisms with rapid recovery or increase. Large fluctuations and rapid increases of population densities of some *Hexarthra* species have also been observed elsewhere, such as in a Brazilian coastal lagoon (Branco et al., 1998) and in an Austrian lake (Herzig, 1987). Many species of this genus are known as detritus feeders or have a preference for unicellular algae (Koste, 1978). If the same holds for *H. longicornicula*, this feeding behavior might explain its temporary abundance in the zooplankton of Comprida Lagoon since the low chlorophyll-*a* values have been associated to the presence of picoplankton, with cells $< 3\,\mu m$ and especially $< 1\,\mu m$ (Roland, 1998).

Furthermore, species of *Hexarthra, Polyarthra* and *Filinia* can often escape predators by making rapid jumps using a variety of appendages. The rotifer community of Comprida Lagoon is characterized by the presence of small species, forms loricated with spines or capable of rapid skipping movements. This suggests the existence of intense predation pressure, which favors the survival of less vulnerable species.

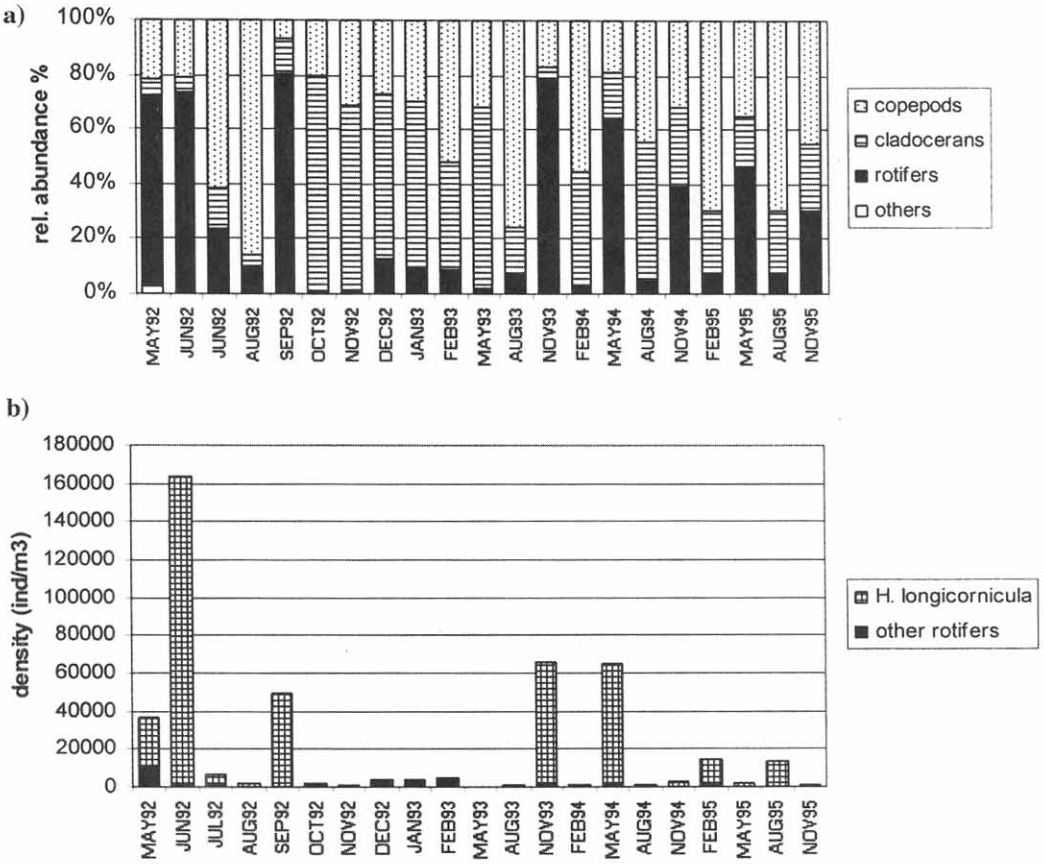


Figure 44. (a) Relative abundance (%) of rotifers, cladocerans, copepods and others in the zooplankton community of Comprida Lagoon during the study period; (b) densities (ind/m^3) of *H. longicornicula* and other rotifers in Comprida Lagoon during the sampling period.

Environmental influences on rotifer diversity and density

Most increases in the *Hexarthra longicornicula* population were during high pH values and corresponded to a decrease in the rotifer richness. This explains the opposite position of rotifer richness and rotifer density in the PCA plot, since most rotifer taxa found in Comprida Lagoon have preferences for low pH. Salinity is one of the main factors causing variations in species richness and, thus in the structure of zooplankton communities (Green, 1993). However, in our study the pH gradient was more important than salinity to explain data variability. Nonetheless, the salinity gradient represented the second axis of the PCA, and influenced mostly the abundance of copepods. Salinity increase may affect the competition within the zooplankton groups, favoring a few euryhaline rotifer species such as *Brachionus rotundiformis* and *Synchaeta bicornis*. These species have been determined as mesohaline indicators under similar conditions in the Carapebus (Attayde & Bozelli, 1998) and the Imboassica lagoons (Branco et al., 2000b).

The intermediate disturbance hypothesis (Connell, 1978) argues that the frequency and intensity of perturbations are decisive factors affecting species diversity. According to Walz (1997), rotifers are good candidates for studying the influence of environmental changes and testing the intermediate disturbance hypothesis. Tundisi and Matsumura-Tundisi (1994) applied this hypothesis to planktonic communities and concluded that the low rotifer richness in Lake Dom Helvecio (6) compared to the Barra Bonita Reservoir (20) was attributed to the permanent instability of the latter, which favors the possibilities of opportunists to exploit the changing resources. Marine intrusion in Comprida Lagoon can be suggested as a disturbance of intermediate intensity to the system causing short-term changes in the physical and chemical environment mainly through increases in pH. This promotes a decrease in the environment homogeneity allowing the occurrence of species with preference for higher pH, such as *Brachionus rotundiformis* and *Synchaeta bicornis* that presented high densities under these conditions.

Brazilian coastal lagoons are subject to increasing human impact, most commonly the direct sewage

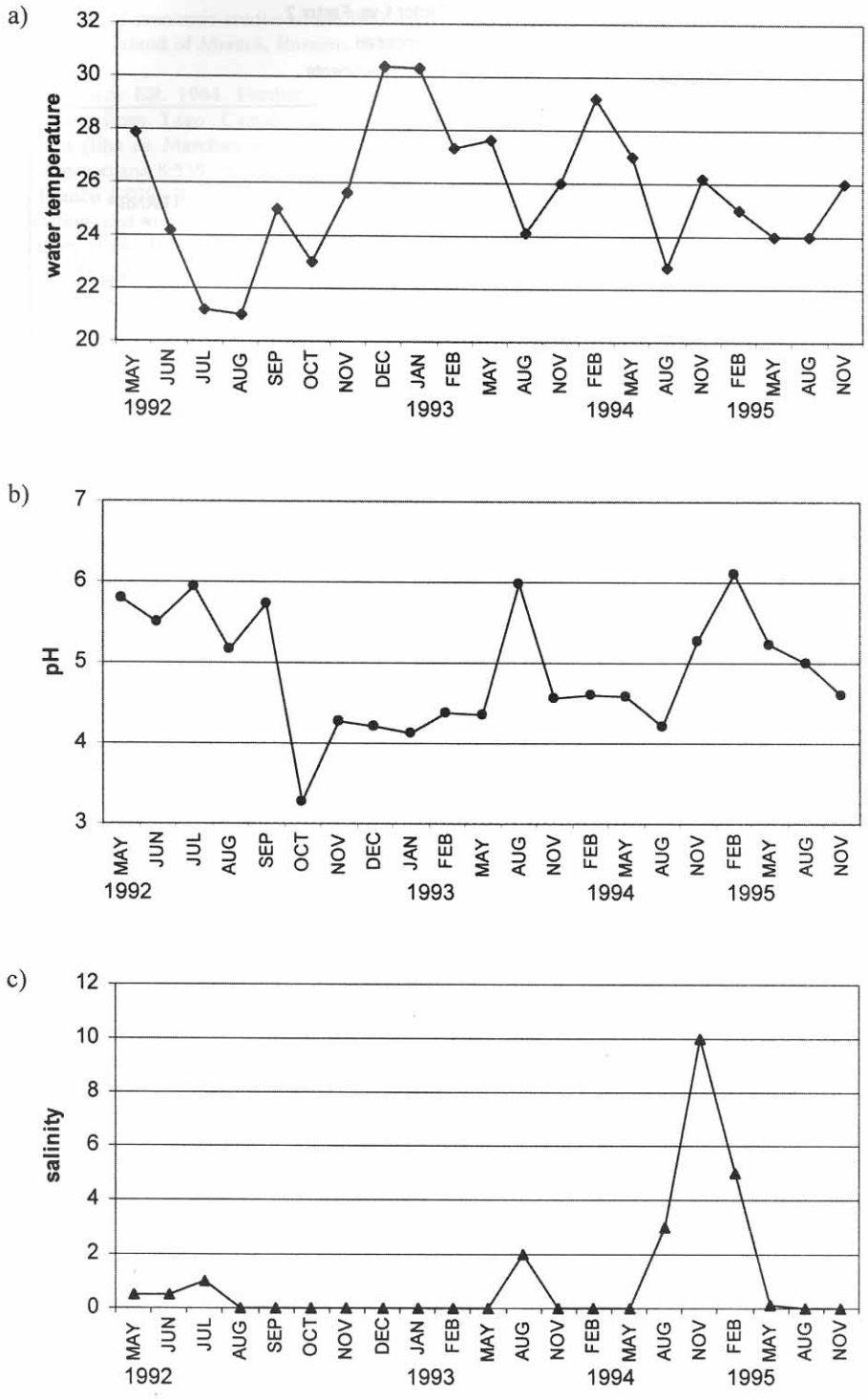


Figure 45. Seasonal variation of environmental parameters of Comprida Lagoon during the study period: (a) water temperature (°C); (b) pH; (c) salinity (u.s.).

input causing eutrophication, which often leads to an increase in phytoplankton biomass and pH. In addition, the artificial opening of the sand barriers aiming to decrease the water level during the rainy season, to export nutrients out or simply to manage fishery activities, causes sudden osmotic changes to the aquatic communities of the lagoons and results in decreasing species richness. Therefore, studies of taxonomy and ecology of zooplankton communities in pristine coastal ecosystems such as Comprida Lagoon should receive priority because they allow a better understanding of the influence of environmental variables on biodiversity.

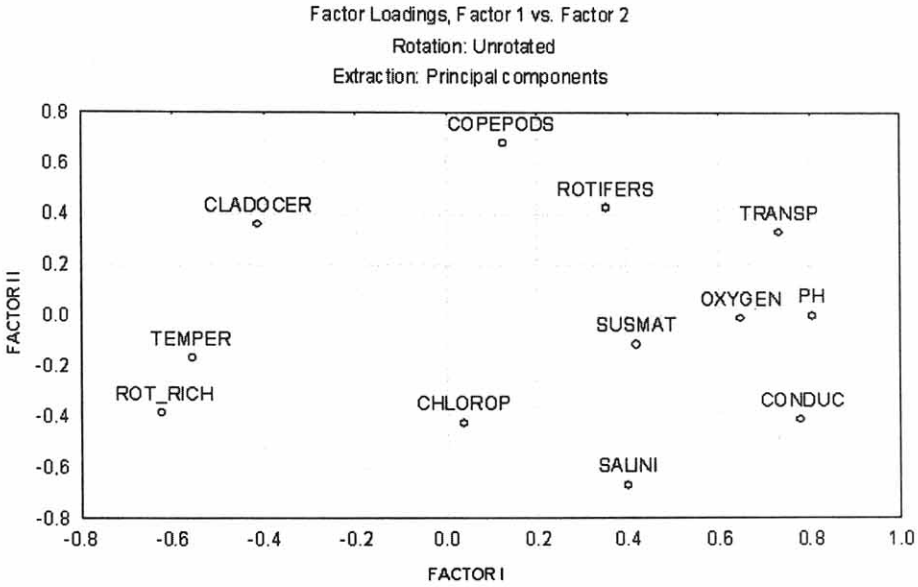


Figure 46. Principal component analysis on environmental variables, chlorophyll-*a*, rotifer richness, and abundance of zooplankton groups. Labels: CHLOROP = chlorophyll-*a*, CLADOCER = cladoceran density, CONDUC = conductivity, COPEPODS = copepod density, OXYGEN = dissolved oxygen, PH = pH, ROTIFER = rotifer density, ROT_RICH = rotifer richness, SALINI = salinity, SUSMAT = suspended matter, TEMPER = water temperature, TRANSP = water transparency.

Acknowledgments

We wish to thank all of our colleagues from the Limnology Laboratory of the Department of Ecology of UFRJ for their field assistance. We are also grateful to B. Robertson and W. Koste for their critical review of the manuscript.

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