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Original Article

Rotifers of Bahia State, Brazil: News records and limitations to studies

Rotíferos do Estado da Bahia, Brasil: Novos registros e limitações dos estudos

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Abstract

A first checklist of Rotifera species in freshwater environments in Bahia State, in northeastern Brazil, is provided. The list includes sampling data from 26 aquatic environments (lotic and lentic) undertaken from 2010 to 2016. One hundred and fifty-five species were recorded, with 68 new records for the state. The family Brachionidae and Lecanidae were the most representative (54.8%). The greatest richness was recorded in the Colônia River (57 species). Those results reflect the low numbers of studies previously undertaken in the region, indicating more research needs to be focused on Rotifera biodiversity in Bahia, the fifth largest state in Brazil (567,295 km^2) with large numbers of freshwater bodies.

Keywords: first records, inventory, freshwater, northeast Brazil, zooplankton.

Resumo

É fornecida uma primeira lista de verificação das espécies de Rotifera em ambientes de água doce no Estado da Bahia, nordeste do Brasil. A lista de espécies inclui dados de amostragem de 26 ambientes aquáticos (lóticos e lênticos) de 2010 a 2016. Cento e cinquenta e cinco espécies foram registradas, com 68 novos registros para o estado. As famílias Brachionidae e Lecanidae foram as mais representativas (54,8%). A maior riqueza foi registrada no rio Colônia (57 espécies). Esses resultados provavelmente refletem o número de estudos na região, sugerindo mais pesquisas sobre a biodiversidade de Rotifera na Bahia, o quinto maior estado do Brasil (567.295 km^2) com grande número de corpos aquáticos de água doce.

Palavras- chaves: primeiros registros, inventário, água doce, nordeste do Brasil, zooplâncton

1. Introduction

Rotifera are microscopic euthelic metazoans (50-2000 μm), with approximately 2030 described species represented by two classes: Pararotatoria and Eurotatoria (Segers, 2002). The former includes only the order Seisonacea, while Eurotatoria comprises the subclasses Monogononta and Bdelloidea. Seisonacea is the least representative group, consisting of four epizootic marine species of branchiae crustaceans, *Seison africanus*, *S. nebaliae*, *Paraseison annulatus,* and *P. kisfaludyi* (Ricci et al., 1993; Sørensen et al., 2005; Leasi et al., 2012). Bdelloidea and Monogononta are the best known and most diversified, with approximately 2000 species between them (Monogononta ~1600, and Bdelloidea ~360) (Segers, 2007; Serra et al., 2019).

Rotifers are cosmopolitan organisms, although largely restricted to continental waters, and constitute important components of the zooplankton in lakes, rivers, and reservoirs (Serafim et al., 2003; Tundisi and Matsumura-Tunsdisi, 2008); they are considered opportunistic, having well-developed adaptive abilities that allow them to quickly colonize a wide variety of habitats under favorable conditions (Sharma and Sharma, 2005; Bonecker et al., 2009). Rotifers make up part of the fundamental food chains of continental waters, occupying the ecological niche of small filterers. They are considered indicators of specific ecological conditions and can be used in evaluating the trophic states of bodies of water (Bërzinš and Pejler, 1989; Duggan et al., 2001). Some species develop well in highly eutrophic sites, while others are more sensitive to organic and chemical residues (Edmondson and Litt, 1982). *Keratella cochlearis*, *Polyarthra vulgaris*, *Brachionus urceolaris,* and *Pompholyx sulcata*, for example, are known to indicate eutrophic conditions due to their saprobic valences (Dorak, 2019).

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A complete inventory of species and reliable quantitative data are required to accurately describe the structures and functioning of zooplankton communities (Karjalainen et al., 1996) – important groups in terms of our knowledge of global biodiversity, and relevant to all macroecological analyses (Tittensor et al., 2010). A total of 625 Rotifera species are known to Brazil (representing 84 genera), including 103 species of Lecanidae and 72 of Brachionidae (the most representative families) (Garraffoni and Lourenço, 2012).

Exclusively taxonomic inventories (checklists) of the Rotifera in Brazil have been published by Oliveira-Neto and Moreno (1999), Melo et al. (2007), Roche and Silva (2017), Souza-Soares et al. (2011), and Garraffoni and Lourenço (2012). All of those publications, except Melo Jr. et al. (2007), sampled both Bdelloidea and Monogononta species, with Bdelloidea demonstrating lower diversity. Several ecological surveys have also been published (e.g., Aguiar et al., 2017; Montavano et al., 2015; Bonfim et al., 2015; Dias et al., 2014; Jorge Filho et al., 2014; Rossa et al., 2007; Bonecker et al., 2005; Leitão et al., 1992).

It is estimated that about 14% of the Rotifera species recorded globally can be found in Brazil (Lewinsohn and Prado, 2002), although the true biodiversity of that group in continental aquatic ecosystems in that country is still only poorly understood and difficult to estimate (Agostinho et al., 2005). While a number of studies focusing on the Rotifera community in the continental waters of Bahia State have been published (Neumann-Leitão and Nogueira-Paranhos, 1987, Crispim and Watanabe, 2000; Souza et al., 2004; Oliveira et al., 2015; Araújo and Nogueira, 2016, Santos et al., 2019), most were reports, monographs, dissertations, and theses. Bahia is the largest state in northeastern Brazil (covering approximately 564,732 km^2) (IBGE, 2017) and detailed Rotifera inventories will surely identify significant species richness there.

We undertook a taxonomic inventory of the planktonic Rotifera inhabiting continental aquatic environments in Bahia State (the first such survey for the region), citing new occurrences and discussing the limitations of studies of those microorganisms.

2. Material and Methods

The list of species presented here was based on a literature search for published studies concerning the Rotifera of Bahia State (Neumann-Leitão and Nogueira-Paranhos, 1987; Crispim and Watanabe, 2000; Souza et al., 2004; Oliveira et al., 2015; Araújo and Nogueira, 2016; Santos et al., 2019). Sampling was also undertaken at 23 sites in lentic and lotic environments, during the period between 2010 and 2016, including the southern portion of the state (near the cities of Vitória da Conquista and Mucugê) (Table 1) (Figure 1). Three sites were sampled in the Lagoa das Bateias lake, three sites in the reservoir at the Fazenda Beija-flor farm, four sites in the Cumbuca River, four sites in the Piabinha River, and nine sites in the Cachoeira River basin.

Published articles concerning field collections of Rotifera generally employed sample volumes of 25 to 100 L of water and horizontal drags for 10 minutes, except Santos et al. (2019), who collected 100 L of water using a graduated bucket. The samples were collected using plankton nets with 50 μm, 65 μm, and 68 μm meshes, and the captured specimens were fixed with 4% formaldehyde; in some cases they were neutralized with sodium tetraborate, and some with a saturated sugar solution or precipitated calcium carbonate.

The surveys we conducted between 2010 and 2016 used plankton net nets (20 μm mesh) and the specimens were fixed in 4% formaldehyde buffered with Hexamethylenetetramine. The samples were obtained using horizontal subsurface drags with a 30X70 cm conical plankton net for five minutes per collecting site, covering a drag distance of approximately 10 m^2 (except in the CRB, where 400 L of water (using a graduated bucket) per point was filtered.

The samples were processed in Sedgewick-Rafter type chambers and viewed using an optical microscope; the individual Rotifers found were separated on slides with glycerin for better visualization and manipulation. When necessary, a 75% hypochlorite solution was used for trophos extraction, and rose bengal staining was used to better visualize the specimens. An Olympus CX31 microscope with a coupled digital camera was used to photograph the specimens.

Some forms of Rotifera, principally the Bdelloidea group, and representatives of the families of Dicranophoridae and Notommatidae, must be alive for accurate taxonomic identification, as the fixation solution causes contraction into their lorica. The samples analyzed from 2010 to 2016 were fixed in formaldehyde, however, and thus only useful for studying the Monogononta group.

Segers (2007) was consulted to elucidate questionable nomenclature for the species; those not classified are indicated in the list of species occurrences. Only the lowest possible taxonomic level was considered in the compilation of data presented in the published literature (e.g., *Polyarthra* sp. de Souza et al. (2004) was not included in the list).

The frequency of occurrence (FO%) of the species was determined considering the number of samples in which they occurred in relation to the total number of samples, with the species being classified as *constant* (present in more than 80% of samples), *frequent* (present in between 50 to 80% of the samples), *common* (from 20 to 50%), or *rare* (< 20%) (Dajoz, 1983).

The Jackknife2 richness estimator was calculated based on the presence and absence data of species using EstimateS 9.1 software. We generated an accumulation curve to verify that the analyzed samples were sufficient to estimate Rotifera richness using asymptotic behavior analysis (Santos et al., 2019). The average percentage of richness extrapolation was calculated based on Heck Junior et al. (1975).

The specimens collected between 2010 and 2016 were deposited in the limnological collection of the Federal University of Bahia - Anísio Teixeira Campus and in the Laboratory of Plankton Ecology at the State University of Santa Cruz (UESC).

Table 1. Sampling localities of Rotifera in the State of Bahia, with number of locations, code, region, environment, geographic coordinates and references. CDDTA: Center for the Development and Dissemination of Aquaculture Technology

Samplig sites	Code	Locality	Municipality	Environment	Coordinates (S-W)	References
1	TT	Tilapia cultivation tank - CDDTA	Paulo Afonso (PA)	Lentic	9°24'36.21"- 38°13'17.16'	Oliveira et al (2015)
2	RN	Natural Reservoir	Povoado Olhos D'água do Souza, Glória (GL)	Lentic	9°21'29.86"- 38°15'38.23"	Araújo and Nogueira (2016)
3	BS	Barrage Sobradinho	Casa Nova (CS)	Lentic	9°25'34.78"- 41°09'24.80"	Crispim and Watanabe (2000)
4	SFb	São Francisco River	Barra (BR)	Lotic	11°05'56.46"- 43°08'23.62"	Neumann-Leitão and Nogueira-Paranhos (1987)
5	SFx	São Francisco River	Xique-Xique (XX)	Lotic	11°00'02.85"- 43°02'42.46"	Neumann-Leitão and Nogueira-Paranhos (1987)
6	SFs	São Francisco River	Sobradinho (SD)	Lotic	9°26'31.36"- 40°47'57.05"	Neumann-Leitão and Nogueira-Paranhos (1987)
7	SFr	São Francisco River	Rodelas (RD)	Lotic	8°59'14.64"- 38°39'32.78"	Neumann-Leitão and Nogueira- Paranhos (1987)
8	RPC	Reservoir of Pedra do Cavalo	Feira de Santana	Lentic	12°35' - 38°59'	Santos et al (2019)
9	LB	Lagoon of Bateias	Vitória da Conquista (VC)	Lentic	14°51'15.45"- 40°52'12.06"	Data of 2010 - 2011
10	PNSV	*National Park of Sempre Vivas*	Mucugê (MC)	Lotic	12°59'35.9"- 41°20'25.8"	Data of 2011 - 2012
	RC	Cumbuca River				Data of 2011 - 2013
	RP	Piabinha River				Data of 2011 - 2014
11	RFBF	Reservoir of Fazenda Beija-flor	Vitória da Conquista	Lentic	14°58'12.74" - 40°49'12.61"	Data of 2012 - 2013
	CRB	*Cachoeira River Basin*	South Bahia	Lotic		data of 2014 - 2015
12	RS	Salgado River			14°53'56.47" - 39°42'21.53"	data of 2014 - 2016
13	RCo	Colônia River			15°06'18.19"- 39°56'12.04"	data of 2014 - 2017
14	RCa	Cachoeira River			14°54'44.16'- 39°23'15.74"	data of 2014 - 2018

3. Results

A total of 155 Rotifera species were recorded, distributed among 36 genera and 21 families (Table 2) (Figure 2 and 3). The richest families were Lecanidae (44 species) and Brachionidae (41 species), together representing 56.6% of Rotifera richness, followed by Trichocercidae (18 species). The others families totaled 70 species (Figure 4); 62 species were characterized as new occurrences for Bahia (Table 2).

The frequency of occurrence indicated *Trichocerca pusilla* as the only constant species (80%); *Keratella americana* (66.67%), *Lecane bulla bulla* (53.33%), *Lecane leontina* and *Polyarthra dolichoptera* (60.00% each) were the frequent species; 44 species were common; most species were considered rare (106 species) (Table 2).

Analyses of the numbers of species in the sampled areas showed that the Reservoir of Pedra do Cavalo (70 species) was the most species rich, followed by Colônia river (57 species), the rivers Cachoeira, Salgado, and Lagoa das Bateias (47 species, each), and the reservoir at Fazenda Beija-flor (22 species); the least representative areas were: the tilapia cultivation tank, the São Francisco River (municipalities of Sobradinho and Rodelas), and the Salgado River (each 10 species), followed by the Sobradinho reservoir (nine species) (Figure 5).

The rarefaction curve evidence that the Rotifera samples taken in Bahia were not sufficient to define an asymptotic trend (Figure 6). The average percentage of wealth extrapolation calculations indicated the rotifer data was able to assess approximately 67% of the species.

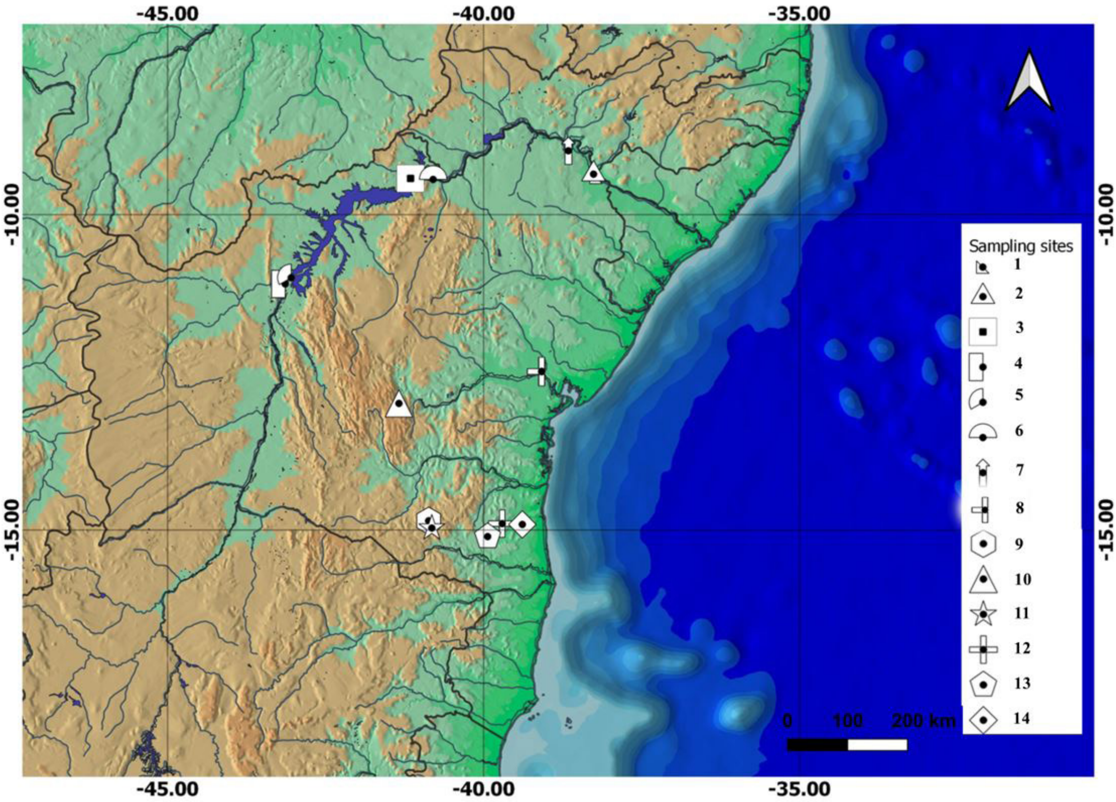

Figure 1. Map of Bahia State, Brazil, highlighting in the 13 sampling sites. Sampling sites described in Table 1.

4. Discussion

The only checklist available of the Rotifera of northeastern Brazil was prepared by Melo and Almeida (2007) for Pernambuco State, and listed 64 planktonic species for 19 freshwater environments. That total is lower than described here for Bahia. Souza-Soares et al. (2011) studied 250 aquatic environments in São Paulo State and recorded 277 species, highlighting the potential for significant increases in species richness if additional efforts were undertaken in Bahia.

Brachionidae and Lecanidae, the most representative families in our study, are highly diversified in the tropics (Segers, 1995), and considered the main representatives of Rotifera in tropical freshwater environments in South America (Rocha et al., 1995; Aoyagui and Bonecker, 2004; Melo and Almeida, 2007). Among the genera registered in Bahia State, *Brachionus* (considered endemic to Australia and South America) (Dumont, 1983) and *Lecane* stand out; the species included in those genera have been identified as bioindicators of eutrophic environments (Sládecek, 1983; Pontin and Langley, 1993). *Lecane* is a predominantly subtropical or warm-water genus, with numerous regional and local endemics, but also comprises numerous Holarctic, Palaeotropical, Australasian, New World, and Old World species (Segers 2008). They are predominantly non-planktonic (Borges and Pedrozo, 2009) and associated with aquatic macrophytes (Duggan et al., 2001; Kuczyn'ska-Kippen, 2009), although they are frequently recorded as plankton.

Although the Rotifera richness in Bahia can appear high when compared to other studies with more intense sampling efforts (Souza-Soares et al., 2011), the accumulation curve for Rotifera species has not yet reached its asymptote, indicating that much more sampling needs to be done. Heck Junior et al. (1975) noted, however, that inventories where 50 to 75% of the species represent common taxa can be considered satisfactory. Due to differences in sampling efforts, it was not possible to infer Rotifera diversity patterns in the available published studies. Reservoir systems, natural lakes, and rivers are all distinct environments, with reservoirs generally being more complex than natural lakes due to their interactions with entire river basins, and the inflow from many tributaries (Straskraba and Tundisi, 1999). Aquatic communities will therefore vary among different bodies of water, with their compositions and dynamics being influenced by surrounding environmental conditions and dependent on a variety of factors – whether local or regional. Biological, physical, and chemical factors, as well as interactions between them, all play important roles in the selection of predominant species (Casanova et al., 2009).

In the present study, the Cachoeira River Basin and Lagoa das Bateias were observed to have the highest nutrient concentrations, mainly due to the inflow of organic sewage, quite different from the Cumbuca and Piabinha rivers in the

Table 2. List of occurrence and Frequency of occurrence (FO%) of Rotifera species in freshwater, state of Bahia, Brazil. Families are featured in bold. †¤ Taxa not identified following Segers (2007). ** New occurrences for the State. From PA to RD indicates the survey of species of published data. From VC to CRB indicates the survey of species in this study of 2010 to 2016. Meaning of the codes follows table 1.

	Published studies								**Sampling in this study**							
	PA	**GL**	**CS**	**BR**	**XX**	**SD**	**RD**	**FS**	**VC**		**MC**		**CRB**			**FO (%)**
	TCT	**RS**	**BS**	**SFb**	**SFx**	**SFs**	**SFr**	**RPC**	**LB**	**RFBJ**	**RT**	**RP**	**RS**	**RCo**	**RCa**	
DIGONONTA (=BDELLOIDEA)																
Philodinidae Ehrenberg, 1838																
Rotaria rotatoria (Pallas, 1766)							x									6.67
MONOGONONTA																
Asplanchinidae Eckstein, 1883																
Asplanchna priodonta Gosse, 1850							x									6.67
Asplanchnopus multiceps (Schrank, 1793)**									x		x	x				20.00
Brachionidae Ehrenberg, 1838																
Anuraeopsis navicula Rousselet, 1911	x															6.67
Anuraeopsis fissa Gosse, 1851**									x				x	x	x	26.67
Brachionus angularis Gosse, 1851		x		x				x								20.00
Brachionus angularis angularis Gosse, 1851**													x	x	x	20.00
Brachionus bidentatus Anderson, 1889		x														6.67
Brachionus brevispinus Ehrenberg, 1832				x	x											13.33
Brachionus calyciflorus Pallas, 1766		x						x	x				x	x	x	40.00
Brachionus calyciflorus calyciflorus Pallas, 1766				x	x											13.33
Brachionus caudatus Barrois & Daday, 1894				x	x			x	x				x	x	x	46.67
Brachionus dolabratus Waning, 1914			x	x												13.33
Brachionidae Ehrenberg, 1838																
†¤ *Brachionus caudatus f. austrogenitus* Ahlstrom, 1940**									x							6.67
†¤ *Brachionus caudatus f. majusculus* Ahlstrom 1940**															x	6.67
†¤ *Brachionus caudatus f. vulgatus* Ahlstrom 1940**													x	x	x	20.00
Brachionus falcatus Zacharias, 1898**								x	x	x			x	x	x	40.00
Brachionus havanaensis Rousselet, 1991**								x					x	x	x	26.67
Brachionus mirus Daday, 1905								x								6.67
†¤ *Brachionus pala anuraeiformis* Brehm, 1909				x	x				x							20.00
†¤ *Brachionus patulus* Müller, 1786					x											6.67
†¤ *Brachionus patullus patullus* Müller, 1786**									x	x			x	x	x	33.33
†¤ *Brachionus patulus var. macrocanthus*Jakubski, 1912**									x							6.67
Brachionus plicatilis Muller, 1786**		x														6.67

Table 2. Continued...

	Published studies								Sampling in this study							FO (%)
	PA	GL	CS	BR	XX	SD	RD	FS	VC		MC		CRB			
	TCT	RS	BS	SFb	SFx	SFs	SFr	RPC	LB	RFBJ	RT	RP	RS	RCo	RCa	
Brachionus plicatilis plicatilis Müller, 1786**									x				x	x	x	26.67
†¤ *Brachionus polyacanthoide* Berzinš, 1943**									x							6.67
Brachionus pterodinoides Rousselet, 1913**									x							6.67
Brachionus quadridentatus Hermann, 1783		x						x	x				x	x	x	40.00
†¤ *Brachionus quadridentatus* f. *cluniorbicularis* Skorikov, 1894**									x							6.67
Brachionus quadridentatus quadridentatus Hermann, 1783**									x	x		x				20.00
Brachionus q. q. cluniorbicularis Skorikov, 1894**									x							6.67
Brachionus rubens Ehrenberg, 1838		x														6.67
Brachionus urceolaris Müller, 1773**								x	x				x		x	26.67
†¤ *Brachionus urceolaris nilsoni* (Ahlstrom, 1940)**															x	6.67
Brachionus variabilis Hempel, 1896**									x							6.67
Keratella americana Carlin, 1943				x	x	x	x	x	x	x			x	x	x	66.67
Brachionidae Ehrenberg, 1838																
Keratella cochlearis (Gosse, 1851)				x	x	x	x	x			x			x		46.67
†¤ *Keratella cochlearis f. hispida* (Lauterborn, 1898)			x													6.67
†¤ *Keratella cochlearis f. tecta* (Gosse, 1851)			x													6.67
†¤ *Keratella lenzi* Hauer, 1953								x								6.67
Keratella tropica (Apstein, 1907)				x	x			x	x				x	x	x	46.67
†¤ *Keratella tropica reducta* Fadeev,1927				x	x											13.33
Platyias quadricornis (Ehrenberg, 1832)**								x	x	x			x	x	x	40.00
Plationus patulus (Muller, 1786)								x								6.67
Conochilidae Harring, 1913																
Conochilus coenobasis (Skorikov, 1914)								x								6.67
Conochilus dossuarius Hudson, 1885						x		x								13.33
Conochilus unicornis Rousselet, 1892	x															6.67
Conochilus cf. unicornis Rousselet, 1892								x								6.67
Dicranophoridae Harring, 1913																
†¤ *Dicranophorus epicharis* Harring & Myers, 1928								x								6.67
Epiphanidae Harring, 1913																

Table 2. Continued...

	Published studies								Sampling in this study							FO (%)
	PA	GL	CS	BR	XX	SD	RD	FS	VC		MC		CRB			
	TCT	RS	BS	SFb	SFx	SFs	SFr	RPC	LB	RFBJ	RT	RP	RS	RCo	RCa	
Epiphanes clavatula (Ehrenberg, 1832)								x								6.67
Epiphanes macroura (Barrois & Daday, 1894)**									x							6.67
Proalides tentaculatus de Beauchamp, 1907		x														6.67
Euchlanidae Ehrenberg, 1838																
Dipleuchlanis propatula (Gosse, 1886)**								x					x	x	x	26.67
Euclanis arenosa Myers, 1936**													x	x	x	20.00
Euclanis dilatata Ehrenberg, 1832							x	x					x	x	x	33.33
Euchlanis meneta Myers, 1930								x								6.67
Euchlanis lyra Hudson, 1886								x								6.67
Filiniidae Harring & Myers, 1926																
Filinia longiseta (Ehrenberg, 1834)		x	x					x	x				x	x	x	46.67
†¤ *Filinia longiseta var. passa* Ehrenberg, 1834**														x	x	13.33
Filinia minuta (Smirnov, 1928)**											x	x				13.33
Filinia opoliensis (Zacharias, 1898)**									x	x			x	x	x	33.33
Filinia terminalis (Plate, 1886)**									x	x			x	x	x	33.33
Flosculariidae Ehrenberg, 1838																
Sinantherina spinosa (Thorpe, 1893)							x									6.67
Gastropodidae																
Gastropus hyptopus (Ehrenberg, 1938)								x								6.67
Hexarthridae Bartos, 1959																
Hexarthra intermedia brasiliensis Hauer, 1953**									x	x			x	x	x	33.33
Hexarthra mira (Hudson, 1871)	x		x						x	x			x			33.33
Hexarthra fennica (Levander, 1892)**													x	x	x	20.00
Lecanidae Remane, 1933																
†¤ *Lecane aquila* Harring & Myers, 1926**									x	x	x	x	x	x	x	46.67
Lecane aculeata (Jakubski, 1912)**									x							6.67
Lecane arcuata (Bryce, 1981)**													x			6.67
Lecane braumi Koste, 1988**										x				x		13.33
Lecane bulla (Gosse, 1851)						x	x	x								20.00
Lecane bulla bulla (Gosse, 1851)**	x								x	x	x	x	x	x	x	53.33
Lecane closterocerca (Schmarda, 1859)**											x	x	x	x	x	33.33
Lecane cornuta (Müller, 1786)**								x					x		x	20.00
Lecane curvicornis (Murray, 1913)						x	x	x	x				x	x	x	46.67
Lecane clara (Bryce, 1892)	x															6.67

Table 2. Continued...

	Published studies								Sampling in this study							FO (%)
	PA	GL	CS	BR	XX	SD	RD	FS	VC		MC		CRB			
	TCT	RS	BS	SFb	SFx	SFs	SFr	RPC	LB	RFBJ	RT	RP	RS	RCo	RCa	
Lecane elegans Harring, 1914**											x	x				13.33
Lecane elsa Hauer, 1931								x								6.67
Lecanidae Remane, 1933																
Lecane haliclysta Harring & Myers, 1926								x								6.67
Lecane furcata (Murray, 1913)							x		x	x			x	x	x	40.00
Lecane hamata (Stokes, 1896)**									x				x	x		20.00
Lecane hastata(Murray, 1913)**								x							x	13.33
Lecane hornemanni (Ehrenberg, 1834)**													x	x		13.33
Lecane imbricata Carlin, 1939**														x	x	13.33
Lecane kutikowa Koste, 1972**												x				6.67
Lecane latissima Yamamoto, 1955**										x						6.67
Lecane leontina (Turner, 1892)						x		x	x	x	x	x	x	x	x	60.00
Lecane ludwigii (Eckstein, 1883)**								x	x	x					x	26.67
Lecane luna (Müller, 1776)	x						x	x	x				x	x	x	46.67
Lecane lunaris (Ehrenberg, 1832)	x							x			x	x	x	x	x	46.67
Lecane lunaris crenata (Harring, 1913)**											x					6.67
†¤ *Lecane lunaris f. constricta* (Murray 1913)**														x		6.67
Lecane minuta Segers, 1994**													x			6.67
Lecane monostyla (Daday, 1897)**								x	x	x				x		26.67
Lecane nana (Murray, 1913)**													x			6.67
Lecane nelsoni Segers, 1994**									x							6.67
Lecane niothis Harring & Myers, 1926**													x			6.67
Lecane papuana (Murray, 1913)**								x	x		x	x	x	x	x	46.67
Lecane punctata (Murray,1913)**													x	x	x	20.00
Lecane pyriformis (Daday, 1905)	x												x	x		13.33
Lecane quadridentata (Ehrenberg, 1830)**								x					x	x		20.00
Lecane rhytida Harring e Myers, 1926								x								6.67
Lecane spinulifera (Edmondson, 1935)								x								6.67
Lecane crepida Harring, 1914**														x		6.67
Lecanidae Remane, 1933																
Lecane stenroosi (Meissner, 1908)								x								6.67
Lecane stichaea Hairing, 1913								x								6.67
Lecane subulata (Harring & Myers, 1926)**									x							6.67
Lecane tabida Harring & Myers, 1926**									x							6.67
Lecane thalera (Harring & Myers, 1926)**														x		6.67

Table 2. Continued...

	Published studies								Sampling in this study							FO (%)
	PA	GL	CS	BR	XX	SD	RD	FS	VC		MC		CRB			
	TCT	RS	BS	SFb	SFx	SFs	SFr	RPC	LB	RFBJ	RT	RP	RS	RCo	RCa	
Lecane ungulata (Gosse 1887)	x															6.67
Lepadellidae Harring, 1913																
Colurella adriatica Ehrenberg, 1831**											x					6.67
Colurella salina Althaus, 1957**									x	x						13.33
Colurella obtusa obtusa (Gosse, 1856)**													x	x	x	20.00
Lepadella patella patella (Müller, 1786)**									x	x	x	x	x	x	x	46.67
Lepadella benjamini Harring, 1916								x								6.67
Lepadella ovalis (Muller,1786)								x								6.67
†¤ *Squatinella mutica* (Ehrenberg, 1832)**														x	x	13.33
Mytilinidae Harring, 1913																
Mytilina mucronata (Muller, 1773)								x								6.67
Mytilina ventralis (Ehrenberg, 1830)						x		x								13.33
Notommatidae Hudson & Gosse, 1886																
Cephalodella gibba (Ehrenberg, 1830)**								x						x		13.33
Cephalodella tenuiseta (Burn, 1890)								x								6.67
Monommata actices Myers, 1930**														x		6.67
Notommata cerberus (Gosse, 1886)								x								6.67
Notommata copeus Ehrenberg, 1834								x								6.67
Scaridiidae Manfredi, 1927																
Scaridium longicaudum (Muller, 1786)								x								6.67
Synchaetidae Hudson & Gosse, 1886																
Ploesoma truncatum (Levander, 1894)		x	x	x	x	x										33.33
Polyarthra dolichoptera Idelson, 1925			x					x	x	x	x	x	x	x	x	60.00
Polyarthra vulgaris Carlin, 1943								x								6.67
Synchaeta stylata Wierzejski, 1893								x								6.67
Testudinellidae Harring, 1913																
Pompholyx cf. *sulcata* Hudson, 1885			x													6.67
†¤ *Testudinella dendradena* de Beauchamp, 1955**									x	x			x	x	x	33.33
Testudinella patina (Hermann, 1783)								x								6.67
Trichocercidae Harring, 1913																
Trichocerca bicristata (Gosse, 1887)**								x						x		13.33
Trichocerca bidens (Lucks, 1912)								x								6.67

Table 2. Continued...

	Published studies								Sampling in this study							FO (%)
	PA	GL	CS	BR	XX	SD	RD	FS	VC		MC		CRB			
	TCT	RS	BS	SFb	SFx	SFs	SFr	RPC	LB	RFBJ	RT	RP	RS	RCo	RCa	
Trichocerca capucina (Wierzejski e Zacharias, 1893)								x								6.67
Trichocerca cf. *lata* (Jennings, 1894)			x													6.67
Trichocerca cylindrica (Imhof, 1891)						x										6.67
Trichocerca elongata (Gosse, 1886)**														x		6.67
†¤*Trichocerca elongata braziliensis* (Murray, 1913)								x								6.67
Trichocerca heterodactila (Tschugunoff, 1921)								x								6.67
Trichocerca insignis (Herrick, 1885)								x								6.67
Trichocerca intermedia (Stenroos, 1898)								x								6.67
†¤ *Trichocerca fusiforme* Gosse,1886**														x		6.67
Trichocerca marina (Daday, 1890)**											x	x				13.33
Trichocercidae Harring, 1913																
Trichocerca pusilla (Jennings, 1903)	x	x			x	x		x	x	x	x	x	x	x	x	80.00
Trichocerca ruttneri Donner, 1953**									x							6.67
Trichocerca similis grandis Hauer, 1965**														x	x	13.33
Trichocerca similis similis (Wierzejski, 1893)**														x	x	13.33
Trichocerca tenuidens (Hauer, 1931)**														x		6.67
Trichocerca vernalis (Hauer, 1936)**											x	x				13.33
Trichotriidae Harring, 1913																
Macrochaetus collinsii (Gosse, 1867)					x											6.67
Macrochaetus sericus (Thorpe, 1893)								x								6.67
Trichotria tetractis (Ehrenberg, 1830)								x								6.67
Trochosphaeridae Harring, 1913																
Horaella thomassoni Koste, 1973								x								6.67

Sempre Vivas Municipal Park. High densities of *Brachionus angularis angularis* have been found to be associated with high nutrient concentrations (Branco and Senna, 1996; Slàdeček, 1983), and that species was encountered in three rivers in the Cachoeira river basin (Table 2).

Oligotrophic lakes support large numbers of phytoplankton and zooplankton species, but usually have only small numbers of individuals; eutrophic lakes, on the other hand, support smaller numbers of plankton species but larger populations of each (Maitland, 1990). Therefore, to fully understand Rotifera diversity patterns in Bahia State, taxonomic and ecological studies will need to be combined.

The shortage of studies in Bahia, together with the lack of Rotifera specialist in northeastern Brazil have resulted in artificially lower established richness of that group as

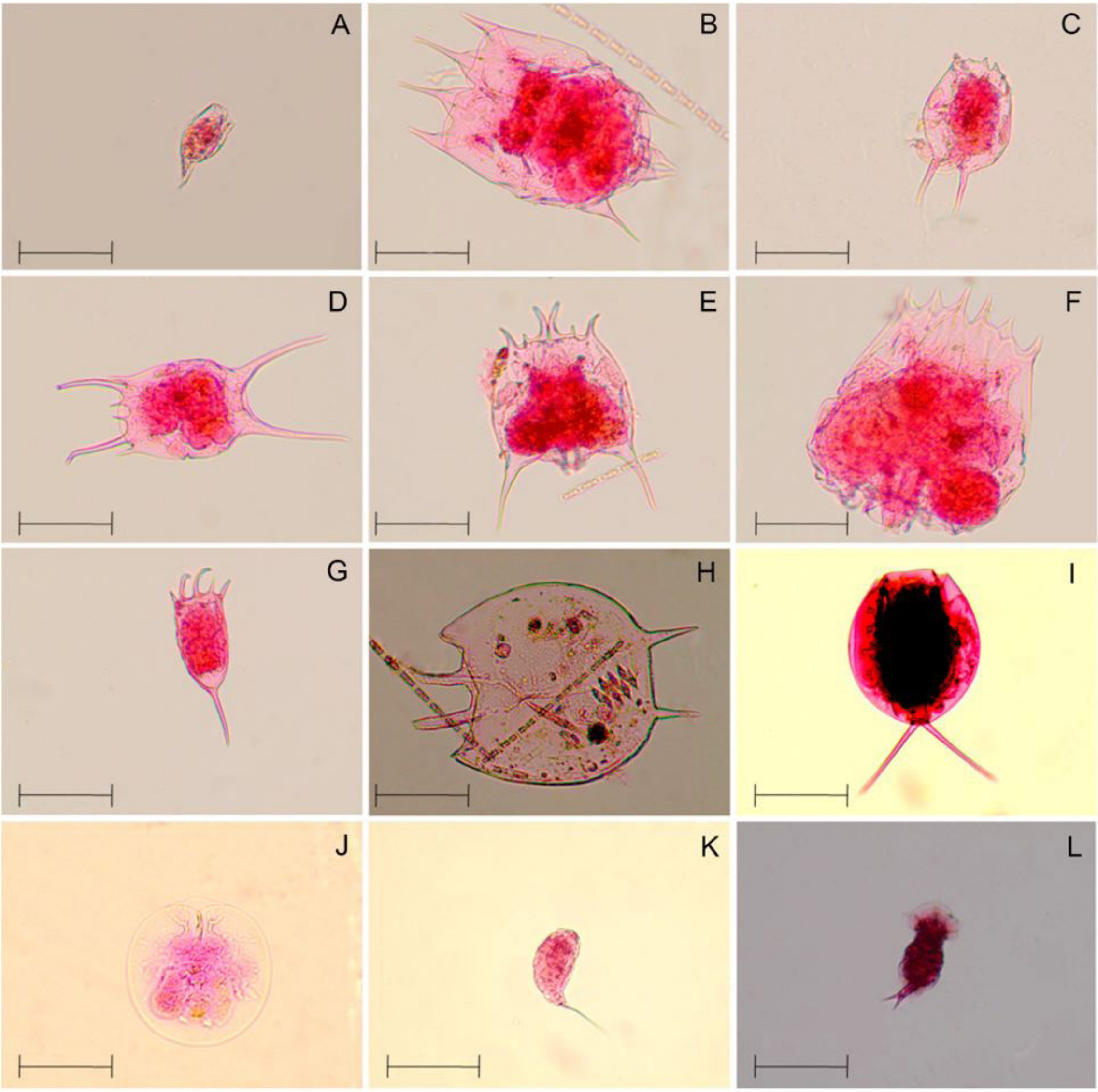

Figure 2. Rotifers from Bahia State, Brazil, sampled from 2010 to 2016. A. *Anuraeopsis fissa* Gosse, 1851. B. *Brachionus calyciflorus* Pallas, 1766. C. *Brachionus caudatus f. austrogenitus* Ahlstrom, 1940. D. *Brachionus falcatus* Zacharias, 1898. E. *Brachionus quadridentatus quadridentatus* Hermann, 1783. F. *Brachionus urceolaris urceolaris* Müller, 1773. G. *Keratella cochlearis* (Gosse, 1851). H. *Platyias quadricornis* (Ehrenberg, 1832). I. *Dipleuchlanis propatula* (Gosse, 1886). J. *Testudinella dendradena* de Beauchamp, 1955. K. *Trichocerca pusilla* (Jennings, 1903). L. *Squatinella mutica* (Ehrenberg, 1832). Species stained with bengal rose. Scale bars= 100 μm.

compared to the states Mato Grosso do Sul (Roche and Silva, 2017) and São Paulo (Souza-Soares et al., 2011). Nonetheless, 155 species were recorded here, including 68 new occurrences, and most freshwater environments in Bahia have not yet even been sampled. Many news sites will need to be surveyed and many aspects of the ecology and physiology of that group investigated (which will also contribute to our knowledge of New World biodiversity).

4.1. Limitations for taxonomic studies of Rotifera

The taxonomy of the Rotifera can be extremely complex due to wide morphological variations observed within the group, cyclomorphosis, their capacity for phenotypic plasticity (Segers and De Smet, 2008), and factors such as temperature and predation that can modify their morphological characteristics and make identifications much more difficult (Gilbert, 2011). As such, the complex morphological details of small metazoans and, in some cases, their polymorphic cycles, tend to inflate the numbers of species (Finlay et al., 1996).

Among the representatives of Rotifera (Monogononta, Bdelloidea, and Seisonacea), taxonomic difficulties are most evident among the Bdelloidea, one of the most sustained clades of ancient asexuals (Butlin, 2002). They reproduce only by parthenogenesis, as

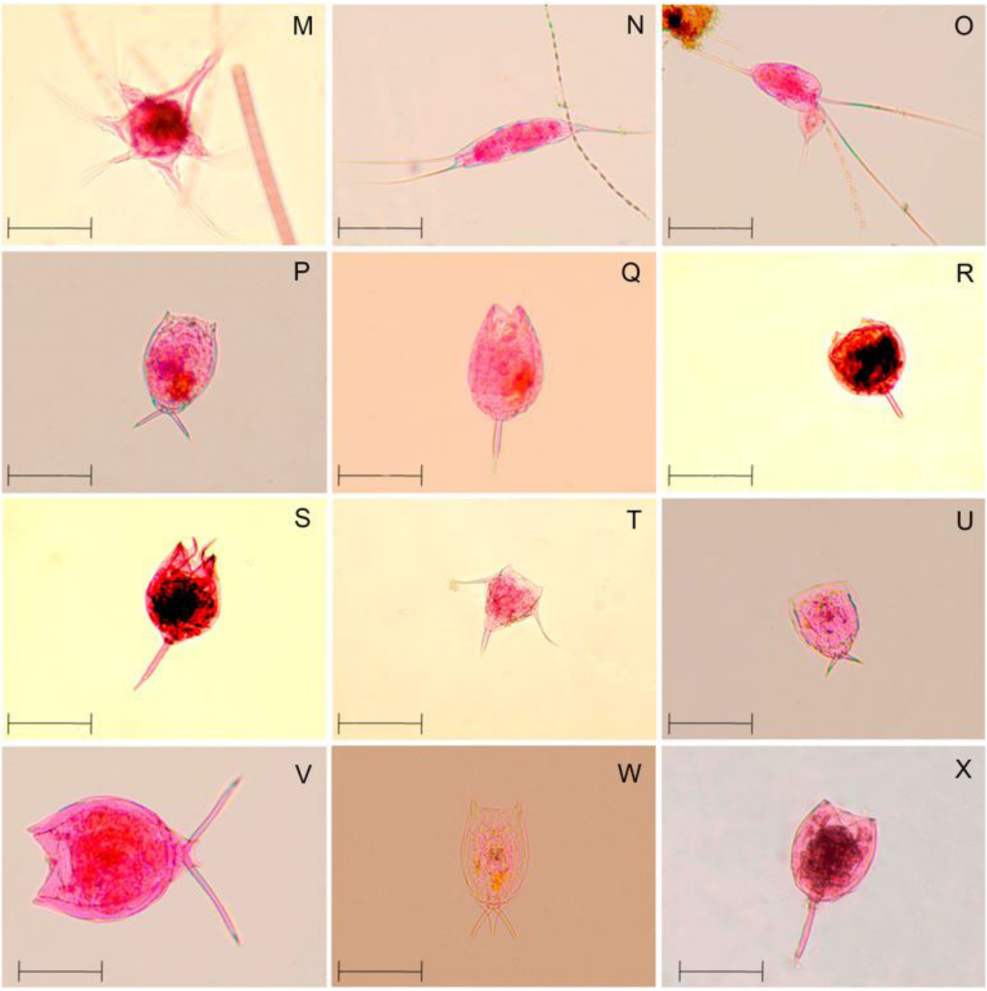

Figure 3. Rotifers from Bahia State, Brazil, sampled from 2010 to 2016. M. *Hexarthra intermedia brasiliensis* Hauer, 1953. N. *Filinia opoliensis* (Zacharias, 1898). O. *Filinia terminalis* (Plate, 1886). P. *Lecane aquila* Harring & Myers, 1926. Q. *Lecane bulla bulla* (Gosse, 1851). R. *Lecane cornuta* (Müller, 1786). S. *Lecane quadridentata* (Ehrenberg, 1830). T. *Lecane monostyla* (Daday, 1897). U. *Lecane hornemanni* (Ehrenberg, 1834). V. *Lecane leontina* (Turner, 1892). W. *Lecane ludwigii* (Eckstein, 1883). X. *Lecane lunaris crenata* (Harring, 1913). Species stained with bengal rose. Scale bars= 100 μm.

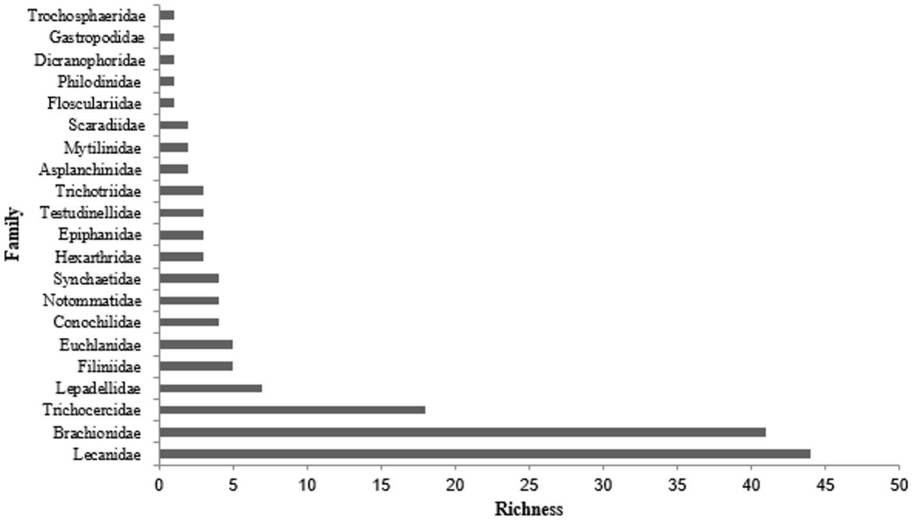

Figure 4. Numbers of Rotifera species per family in Bahia State, Brazil.

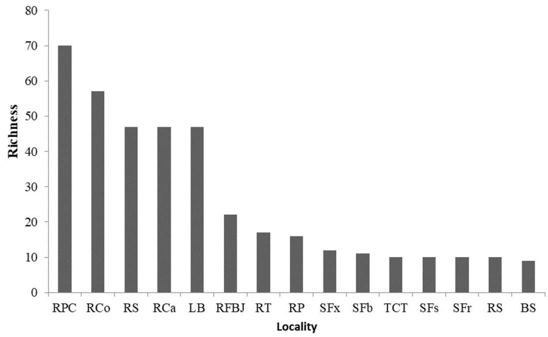

Figure 5. Numbers of Rotifera species per locality in Bahia State, Brazil. The codes follow Table 1.

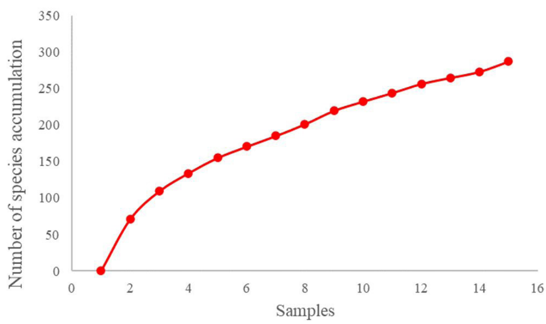

Figure 6. Accumulation curve of Rotifera species from Bahia State, Brazil, based on richness, sampled locations, and the Jackknife2 richness estimator.

no males or signs of meiosis have ever been observed (Welch et al., 2004), and demonstrate high morphological variability. Furthermore, they retract during the process of chemical fixation, so that live organisms are necessary for the identification of the group. The use of anesthetics such as marcaine (0.5%) (Fontaneto et al., 2008) and carbonated water (De Carli et al., 2017) are recommended, although those methods are not always efficient. Orstan (2015) recently proposed a new method for fixing bdelloids: the hot glutaraldehyde method, which preserves those organisms in superior conditions, suitable for taxonomic identification and internal anatomical studies.

The accuracies and reliabilities of data sets in which rotifer taxonomies are not fully resolved and that contain cryptic species are inevitably low (Malekzadeh-Viayeh et al., 2014). Among Rotifers, the species complex *Brachionus plicatilis* Müller, 1786 (Monogononta, Brachionidae) is a classic example of high diversity that remained hidden and unclear using only the tools of morphological taxonomy. Research involving a range of genetic techniques, however, has improved our knowledge of the diversity of those species complexes (Gomez et al., 2002).

Among Rotifera, mainly the loricate organisms, taxonomic identifications depend on analyzes of the ultrastructure of the mastax (a modified pharynx composed of muscle sets and trophos) (Obertegger et al., 2006). The use of scanning electron microscopy (SEM) allows a more detailed visualization of the ultrastructure of the trophos that cannot be obtained using light microscopy. A thorough examination of trophos using light and scanning electron microscopy should be part of all Rotifera taxonomic studies (De Smet, 1998), and their morphological taxonomy should be aligned with ecological and molecular taxonomic studies to increase the precision of the diagnoses (Roche and Silva, 2017).

The use of valid nomenclature, excluding synonyms, is also a recurrent problem, and recent research has addressed synonyms referred to as valid species or variant names of the subspecies (Souza-Soares et al., 2011). Synonyms are used in many Rotifera species based on morphological characters, such as in the genus *Brachionus* where *Brachionus angularis orientalis* (Sudzuki 1989) = *B. angularis* (Gosse 1851) (Segers, 2007).

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References

AGOSTINHO, A.A., THOMAZ, S.M. and GOMES, L.C., 2005. Conservação da biodiversidade em águas continentais do Brasil. *Megadiversidade*, vol. 1, no. 1, pp. 70-78.

AGUIAR, G., DINIZ, L.P., ALMEIDA, V.L., LEITÃO, S.N. and MELO JUNIOR, M.D., 2017. Rotifer community structure in fish-farming systems associated with a Neotropical semiarid reservoir in Northeastern Brazil. *Aquaculture Research*, vol. 48, no. 9, pp. 4910-4922. http://dx.doi.org/10.1111/are.13310.

AOYAGUI, A.S.M. and BONECKER, C.C., 2004. The art status of rotifer studies in natural environments of South America: floodplains. *Acta Scientiarum. Biological Sciences*, vol. 26, pp. 385-406.

ARAUJO, A.P. and NOGUEIRA, E.M.S., 2016. Zooplâncton como bioindicador das águas do reservatório Natural do povoado olhos D'águado Souza, Glória, Bahia, Brasil. *Revista Ouricuri*, vol. 6, pp. 1-16.

BËRZINŠ, B. and PEJLER, B., 1989. Rotifers occurence and trophic degree. *Hydrobiologia*, vol. 182, no. 2, pp. 171-180. http://dx.doi.org/10.1007/BF00006043.

BRANCO, C.W.C. and SENNA, P.A.C., 1996. Relations among heterotrophic bacteria, chlorophyll-a, total phytoplankton, total zooplankton and physical and chemical features in the Paranoá reservoir, Brasília, Brazil. *Hydrobiologia*, vol. 337, no. 1-3, pp. 171-181. http://dx.doi.org/10.1007/BF00028518.

BONECKER, C.C., AOYAGUI, A.S.M. and SANTOS, R.M., 2009. The impact of impoundment on the rotifer communities in two tropical floodplain environments: interannual pulse variations. *Brazilian Journal of Biology = Revista Brasileira de*

Biologia, vol. 69, no. 2, (suppl.), pp. 529-537. http://dx.doi.org/10.1590/S1519-69842009000300008. PMid:19738960.

BONECKER, C.C., COSTA, C.L., VELHO, L.F.M. and TOHA, F.A.L., 2005. Diversity and abundance of the planktonic rotifers in different environments of the upper Paraná River Floodplain (Paraná State - Mato Grosso do Sul State, Brazil). *Hydrobiologia*, vol. 546, no. 1, pp. 405-414. http://dx.doi.org/10.1007/s10750-005-4283-2.

BONFIM, F.F., SCHWIND, L.T.F., BONECKER, C.C. and LANSAC-TOHA, F.A., 2015. Variação espacial de rotíferos planctônicos: diversidade e riqueza de espécie. *Arquivos do Mudi*, vol. 19, no. 1, pp. 45-56. http://dx.doi.org/10.4025/arqmudi.v19i1.28230.

BORGES, M.G. and PEDROZO, C.S., 2009. Zooplankton (Cladocera, Copepoda and Rotifera) richness, diversity and abundance variations in the Jacuí Delta, RS, Brazil, in response to the fluviometric level. *Acta Limnologica Brasiliensia*, vol. 21, pp. 101-110. http://dx.doi.org/10.1590/S1676-06034040.

BUTLIN, R., 2002. The costs and benefits of sex: new insights from old assexual lineages. *Nature Reviews. Genetics*, vol. 3, no. 4, pp. 311-317. http://dx.doi.org/10.1038/nrg749. PMid:11967555.

CASANOVA, S.M.C., PANARELLI, E.A. and HENRY, R., 2009. Rotifer abundance, biomass, and secondary production after there covery of hydrologic connectivity between a river and two marginal lakes (São Paulo, Brasil). *Limnologica*, vol. 39, no. 4, pp. 292-301. http://dx.doi.org/10.1016/j.limno.2009.06.008.

CRISPIM, M.C. and WATANABE, T., 2000. Caracterização limnológica das bacias doadoras e receptoras de águas do Rio São Francisco: 1- Zooplâncton. *Acta Limnologica Brasiliensia*, vol. 12, pp. 93-103.

DAJOZ, R., 1983. Ecologia geral. *Vozes de Petrópolis*, vol. •••, pp. 472.

DE-CARLI, B.P., DE ALBULQUERQUE, F.P., BAYANOV, N.G., MOSCHINI-CARLOS, V. and POMPEO, M.L.M., 2017. Dispersão e primeiro registro da espécie invasora *Kellicottia bostoniensis* (Rotifera: Brachionidae) em dois reservatórios brasileiros. *Oecologia Australis*, vol. 21, no. 4, pp. 455-460. http://dx.doi.org/10.4257/oeco.2017.2104.10.

DE SMET, W.H., 1998. Preparation of rotifer trophi for light and scanning electron microscopy. *Hydrobiologia*, vol. 387, no. 387, pp. 117-121. http://dx.doi.org/10.1023/A:1017053518665.

DIAS, J.D., BONECKER, C.C. and MIRACLE, M.R., 2014. The rotifer community and its functional role in lakes of a neotropical floodplain. *International Review of Hydrobiology*, vol. 99, no. 1-2, pp. 72-83. http://dx.doi.org/10.1002/iroh.201301706.

DORAK, Z., 2019. A preliminary study on using rotifera fauna to determine the trophic level of the büyükçekmece reservoir (Istanbul, Turkey). *Aquatic Sciences and Engineering*, vol. 34, no. 4, pp. 103-111. http://dx.doi.org/10.26650/ASE2019586048.

DUGGAN, I.C., GREEN, J.D. and SHIEL, R.J., 2001. Distribution of rotifers in North island, New Zealand, and their potential use as indicator of lake trophic state. *Hydrobiologia*, vol. 446, pp. 155-164. http://dx.doi.org/10.1023/A:1017503407240.

DUMONT, H.J., 1983. Biogeography of rotifers. *Hydrobiologia*, vol. 104, no. 1, pp. 19-30. http://dx.doi.org/10.1007/BF00045948.

EDMONDSON, W.T. and LITT, A.H., 1982. *Daphnia* in Lake Washington. *Limnology and Oceanography*, vol. 27, no. 2, pp. 272-293. http://dx.doi.org/10.4319/lo.1982.27.2.0272.

FINLAY, B.J., CORLISS, J.O., ESTEBAN, G. and FENCHEL, T., 1996. Biodiversity at the microbial level: the number of free-living ciliates in the biosphere. *The Quarterly Review of Biology*, vol. 71, no. 2, pp. 221-237. http://dx.doi.org/10.1086/419370.

FONTANETO, D., DE SMET, W.H. and MELONE, G., 2008. Identification key to the genera of marine rotifers worldwide. *Meiofauna Marina*, vol. 16, pp. 75-99.

GARRAFFONI, A.R.S. and LOURENÇO, A.P., 2012. Synthesis of Brazilian Rotifera: An updated list of species. *Check List*, vol. 8, no. 3, pp. 375-407. http://dx.doi.org/10.15560/8.3.375.

GILBERT, J.J., 2011. Induction of different defences by two enemies in the rotifer Keratella tropica: response priority and sensitivity to enemydensity. *Freshwater Biology*, vol. 56, no. 5, pp. 926-938. http://dx.doi.org/10.1111/j.1365-2427.2010.02538.x.

GOMEZ, A., SERRA, M., CARVALHO, G.R. and LUNT, D.H., 2002. Speciation in ancient cryptic species complexes: evidencefrom the molecular phylogeny of Brachionus plicatilis (Rotifera). *Evolution; International Journal of Organic Evolution*, vol. 56, no. 7, pp. 1431-1444. http://dx.doi.org/10.1111/j.0014-3820.2002.tb01455.x. PMid:12206243.

HECK JUNIOR, K.L., VAN-BELLE, G.E. and SIMBERLOFF, D., 1975. Explicit calculation of the rarefaction diversity measurement and the determination of sufficient sample size. *Ecology*, vol. 56, no. 6, pp. 1459-1461. http://dx.doi.org/10.2307/1934716.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE, 2017 [viewed 10 January 2020]. *Território e Ambiente* [online]. Available from: https://cidades.ibge.gov.br/brasil/ba/panorama

JORGE FILHO, S., NEUMANN-LEITÃO, S., SILVA, T.R. and MELO JÚNIOR, M.D., 2014. Planktonic rotifers from a tropical estuary under high marine influence (Passos river, PE, Brazil). *Tropical Oceanography (Online)*, vol. 42, pp. 68-79.

LEITÃO, S.N., PARANAGUÁ, N.M. and VALENTIN, J.L., 1992. The Planktonic Rotifers Of The Estuarine Lagunar Complex Of Suape (Pernambuco, Brazil). *Hydrobiologia*, vol. 232, pp. 133-143. http://dx.doi.org/10.1007/BF00017472.

LEWINSOHN, T.M. and PRADO, P.I. 2002. Biodiversity of Brazil: a synthesis of the current state of knowledge. In: T.M. LEWINSOHN and P.I. PRADO, *Biodiversidade brasileira: síntese do estado do conhecimento atual.* São Paulo: Contexto, pp. 139-144.

KARJALAINEN, J., RAHKOLA, M., VILJANEN, M., ANDRONIKOVA, I.N. and AVINSKII, V.A., 1996. Comparison of methods used in zooplankton sampling and couting in the joint Russian- Finnish evaluation of the trophic state of Lake Ladoga. *Hydobiologia*, vol. 322, no. 1-3, pp. 249-253. http://dx.doi.org/10.1007/BF00031836.

KUCZYŃSKA-KIPPEN, N., 2009. The spatial segregation of zooplankton communities with reference to land use and macrophytes in shallow Lake Wielkowiejskie (Poland). *International Review of Hydrobiology*, vol. 94, no. 3, pp. 267-281. http://dx.doi.org/10.1002/iroh.200811089.

LEASI, F., ROUSE, G.W. and SØRENSEN, M.V., 2012. A new species of *Paraseison* (Rotifera: Seisonacea) from the coast of California, USA. *Journal of the Marine Biological Association of the United Kingdom*, vol. 92, no. 5, pp. 959-965. http://dx.doi.org/10.1017/S0025315411000129.

MAITLAND, P.S. 1990. *Biology of fresh water*. 1st ed. Netherlands: Springer. 287 p., Tertiary Level Biology.

MALEKZADEH-VIAYEH, R., PAK-TARMANI, R., ROSTAMKHANI, N. and FONTANETO, D., and the MALEKZADEH-VIAYEH, 2014. Diversity of the rotifer Brachionus plicatilis species complex (Rotifera: Monogononta) in Iran through integrative taxonomy. *Zoological Journal of the Linnean Society*, vol. 170, no. 2, pp. 233-244. http://dx.doi.org/10.1111/zoj.12106.

MELO, J.R.M. and ALMEIDA, V.L.S., 2007. O estado da arte da biodiversidade de rotíferos planctônicos de ecossistemas límnicos de Pernambuco. *Biota Neotropica*, vol. 7, pp. 109-107. http://dx.doi.org/10.1590/S1676-06032007000300013.

MANTOVANO, T., ARRIEIRA, R.L., SCHWIND, L.T.F., BONECKER, C.C. and TÔHA, F.A.L., 2015. Rotifer community structure along a stretch under the influence of dams in the Upper paraná River floodplain. *Acta Scientiarum. Biological Sciences*, vol. 37, no. 3, pp. 281-289. http://dx.doi.org/10.4025/actascibiolsci.v37i3.27759.

NEUMANN-LEITÃO, S. and NOGUEIRA-PARANHOS, J.D., 1987. Zooplâncton do Rio São Francisco- Região Nordeste do Brasil. *Tropropical Oceanography*, vol. 20, p. 173-196.

OBERTEGGER, U., BRAIONI, M.G., RRIGHETT, G. and FLAIM, G., 2006. Trophi morphology and its usefulness for identification of formalin preserved species of *Synchaeta* Ehrenberg, 1832 (Rotifera: Monogononta: Synchaetidae). *Zoologischer Anzeiger*, vol. 245, pp. 109-120. https:// doi: 10.1016/j.jcz.2006.05.005.

OLIVEIRA, T.B., SILVA, T.A. and TERRA NOVA, L.S., 2015. Rotíferos como indicadores da qualidade de água em cultivo de tilápias (Oreochromis niloticus) com utilização de águas salobras. *Acta Fish,* vol. 3, pp. 65-76. https:// doi 10.2312/ ActaFish.2015.3.1.65-76.

OLIVEIRA-NETO, A.L. and MORENO, I.H., 1999. Rotíferos. In: C.A. JOLY and C. E. M. BICUDO, *Biodiversidade do Estado de São Paulo, Brasil: síntese do conhecimento ao final do século XX. Invertebrados de água doce*. São Paulo, FAPESP, 4 p.

ORSTAN, A., 2015. A method for the preservation of bdelloid rotifers for taxonomical and anatomical studies. *Quekett Journal of Microscopy*, vol. 42, pp. 355-359.

PONTIN, R.M. and LANGLEY, J.M., 1993. The Use of rotifer communities to provide a preliminary na classification of small water bodies in England. *Hydrobiologia*, vol. 255, pp. 411-419.

RICCI, C., MELONE, G. and SOTGIA, C., 1993. Old and new data on Seisonidea (Rotifera). *Hydrobiologia*, vol. 255, no. 1, pp. 495-511. http://dx.doi.org/10.1007/BF00025879.

ROCHA, O., SENDACZ, S. and MATSUMURA-TUNDISI, T. 1995. Composition, biomass and productivity of zooplankton in natural lakes and reservoirs of Brazil. In: J. B. TUNDISI, C. E. BICUDO and T. MATSUMURA-TUNDISI, *Limnology*. Rio de Janeiro. pp. 151-165.

ROCHE, K.F. and SILVA, W.M., 2017. Checklist dos Rotifera (Animalia) do Estado de Mato Grosso do Sul, Brasil. *Iheringia. Série Zoologia*, vol. 107, Suppl., pp. 1-10. http://dx.doi.org/10.1590/1678-4766e2017105.

ROSSA, D.C., BONECKER, C.C. and FULONE, L.J., 2007. Biomassa de rotíferos em ambientes dulcícolas: revisão de métodos e fatores influentes. *Interciencia*, vol. 32, pp. 220-226.

SANTOS, T.A.S, LANSAC-TÔHA, F.A., MANTOVANO, T., CONCEIÇÃO, E.O., SCHWIND, L.T.F., ARRIEIRA, R. L., LIMA, J.C., SERAFIM-JUNIOR, M., 2019. Structure and spatial distribution of the rotifer assemblages along a tropical reservoir. *Brazilian Journal of Biology*. vol. 81, no. 2, pp. 361-369.

SLÀDEČEK, V., 1983. Rotifers as indicator of water quality. *Hydrobiologia*, vol. 100, pp. 169-201. https://doi:10.1007/ BF00027429.

SERRA, M., GARCÍA-ROGER, E.M., ORTELLS, R. and CARMONA, M.J., 2019. Cyclically parthenogenetic rotifers and the theories of population and evolutionary ecology. *Limnetica*, vol. 38, pp. 67-93. http://dx.doi.org/10.23818/limn.38.13.

SERAFIM, M.J.R., BONECKER, C.C., ROSSA, D.C., LANSAC-TÔHA, F.A. and COSTA, C.L., 2003. Rotifers of the upper Paraná river floodplain: additions to the checklist. *Brazilian Journal of Biology = Revista Brasileira de Biologia*, vol. 63, no. 2, pp. 207-212. http://dx.doi.org/10.1590/S1519-69842003000200005. PMid:14509842.

SEGERS, H., 1995. *Rotifera. Guides to the Identification of the microinvertebrates of the continental waters of the world. The Lecanidae (Monogononta).* The Hague: SPB Academic. 226 p., vol. 2.

SEGERS, H., 2002. The nomenclature of the Rotifera: annoted checklist of valid family- and genusgroup names. *Journal of Natural History*, vol. 36, no. 6, pp. 631-640. http://dx.doi.org/10.1080/00222930231733970.

SEGERS, H., 2007. Annotated checklist of the rotifers (Phylum Rotifera), with notes on nomenclature, taxonomy and distribution. *Zootaxa*, vol. 1564, no. 1, pp. 1-104. http://dx.doi.org/10.11646/zootaxa.1564.1.1.

SEGERS, H., 2008. Global diversity of rotifers (Rotifera) in freshwater. *Hydrobiologia*, vol. 595, pp. 49-59. https://doi 10.1007/s10750-007-9003-7.

SEGERS, H. and DE SMET, W.H., 2008. Diversity and endemism in Rotifera: a review, and *Keratella* Bory de St Vincent. *Biodiversity and Conservation*, vol. 17, pp. 303-316. https://doi: 10.1007/ s10531-007-9262-7.

SHARMA, B.K. and SHARMA, S., 2005. Biodiversity of freshwater rotifers (Rotifera, Eurotatoria) from North-Eastern India. *Zoosystematics and Evolution*, vol. 81, no. 1, pp. 81-88. http:// dx.doi.org/10.1002/mmnz.200310002.

SOUZA, E.S., SILVA, J.D., SOUZA, G.N., SOUZA, J.M., ALVES, K.P., CIRIACO, S.T., OLIVEIRA, J.P.S., W.P.R. Junior. and MITSUKA, P.M., 2004. Aspectos limnológicos de uma trecho do rio Verde Grande: região semi-árida do sudoeste da Bahia. Revista Comciência.

SLÁDECEK, V. 1983. Rotifers as indicators of water quality. *Hydrobiologia*, vol. 100, pp. 169-201. https://doi: 10.1007/ BF00027429.

SOUZA-SOARES, F., TUNDISI, J.G. and MATSUMURA-TUNDISI, T.M., 2011. Checklist de Rotifera de água doce do Estado de São Paulo, Brasil. *Biota Neotropica*, vol. 11, pp. 1-25.

SØRENSEN, M.V., SEGERS, H. and FUNCH, P. 2005. On a new Seison Grube, 1861 from coastal waters of Kenya, with a reappraisal of the classification of the Seisonida (Rotifera). *Zoolgical Studies*, vol. 44, no. 1, pp. 34-43.

STRASKRABA, M. and TUNDISI, J.G., 1999. Reservoir ecosystem functioning: Theory and application. In: J.G. TUNDISI and M. STRAŠKRABA, org. *Theoretical reservoir ecology and its applications*. São Carlos, SP: International Institute of Ecology. Brazilian Academy of Science. Backhuys Publishers, pp. 565-583.

TITTENSOR, D.P., MORA, C., JETZ, W., LOTZE, H.K., RICHARD, D., BERGHE, E.V. and WORN, B. 2010. Global patterns and predictors of marine biodiversity across taxa. *Nature*, vol. 466, pp. 1098-1101. https://doi: 10.1038/nature09329.

TUNDISI, J.G. and MATSUMURA-TUNSDISI, T., 2008. *Limnologia*, São Paulo: Oficina de Texto.

WELCH, D.B.M., CUMMINGS, M.P., HILLIS, D.M. and MESELSON, M, 2004. Divergent gene copies in the asexual class Bdelloidea (Rotifera) separated before the bdelloid radiation of within bdelloid families. *Proceedings of the National Academy of Sciences of the United States of America*, vol. 101, no. 6, pp. 1622-1625. http://dx.doi.org/10.1073/pnas.2136686100. PMid:14747660.