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The Rotifer fauna of Guatemala and Belize: survey and biogeographical affinities

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Abstract: Rotifer samples were obtained from 29 localities in northern Guatemala and central-southern Belize during March 2000 and June 2001. A total of 119 species were identified. Ten selected taxa are illustrated and commented: *Euchlanis semicarinata*, *Lepadella apsicora*, *L. cryphaea*, *Lecane curvicornis f. lofuana*, *L. whitfordi*, *Monommata maculata*, *Scaridium bostjani*, *Trichocerca elongata f. braziliensis*, and *T. hollaerti*. The species *Lepadella rhomboidula* is a first record for the American Continent. The species are 71 % cosmopolitan, 6 % tropicopolitan, and 4.2 % restricted to the subtropics. The Guatemala species number range was Petén-Itza lake (53 taxa), and Raxruja pool (three). La Democracia pool (49 taxa), and the Blue Hole sink-hole (six species) were the extremes in Belize. In total, 68 of the recorded taxa are new for Guatemala and 91 for Belize. Additionally, 47 species are registered by the first time in Central America. A comparison between these two countries and Mexico revealed that the south part of the latter conform a cluster with them, emphasizing the transitional character of this region between the Nearctics and the Neotropics. Furthermore, Guatemala and Belize have differences in species assemblages, as a response to the nature of their particular environments and topographical accidents. Rev. Biol. Trop. 55 (2): 569-584. Epub 2007 June, 29.

Key words: rotifera, taxonomy, diversity, distribution, Guatemala, Belize.

In Central America, studies on taxonomy and distribution of rotifers are relatively scarce and old (ie. Collado *et al.* 1984). Currently, knowledge on the rotifer fauna of Guatemala is poor compared with North and South America (Koste and De Paggi 1982, De Paggi and Koste 1995, Segers 1997, Sarma 1999, Sarma and Elías-Gutiérrez 1999a, b, García-Morales and Elías-Gutiérrez 2004). On the other hand, Belize's fauna is completely unknown; there are no previous reports on the rotifers from this country. Lately, a preliminary study on Cladoceran fauna published by Elías-Gutiérrez *et al.* (2006), emphasized about the diverse aquatic systems found in this region, and the effect on their fauna. In case of rotifers, recent publications are limited to the Mexican side, close to both countries. García-Morales and

Elías-Gutiérrez (2004) recorded 128 species from 36 localities in the south of Mexico. A previous study by Sarma and Elías-Gutiérrez (1999a) in 12 localities from Yucatan rendered 102 species. In both papers, a total of 37 new records for the region were figured, majority of them regarded as warm-stenotherm (García-Morales and Elías-Gutiérrez 2004).

North of Guatemala and Belize possess highly contrasting environments due to topographic accidents, quite different with the homogeneous adjacent south of Yucatan Peninsula. Nevertheless, all of them belong to the same biotic province, named Campechano-Petenense (UNAM 1990). As a result of the presence of mountain systems (for example Mayan mountains in Belize and Sierra Chinajá in north of Guatemala) and other topographic

accidents, both countries have diverse microhabitats reflected in the vegetation and aquatic systems. As a result, in the case of fish fauna for example, 13 endemic species dwell in north of Guatemala (Valdéz-Moreno *et al.* 2005). Many of the aquatic systems from these regions still remain as pristine and non polluted environments (Valdéz-Moreno *et al.* 2005, pers. obs.).

The aims of this study were to provide data on the species of the rotifer fauna found in zooplankton collections gathered in several freshwater bodies from Guatemala and Belize, to include a comment about the distribution of these animals in both countries, and to compare the species assemblage with adjacent Mexico.

MATERIALS AND METHODS

Rotifers were qualitatively collected using standard plankton net; 50 µm mesh size, attached to a handle in the littoral zone. Horizontal and vertical tows, with the same kind of net were performed, when a limnetic zone (more than 5 m deep) was clearly defined in the surveyed water body. As a minimum, 200 l of water were filtered for each sample. After collections, material was preserved in 4 % formalin. At least five samples represented bigger systems, as Petén Lake, and the small puddles were characterized by one. Littoral sampling included all possible habitats for rotifers: submersed vegetation, bottom dwellers, etc. Temperature, depth, and Secchi transparency were measured at every site to give a reference about the environment where the rotifers dwell. In total, 11 localities were sampled in Guatemala and 18 from Belize (Fig. 1). Each place was visited once. Data on physical parameters and geographical coordinates of the studied sites are presented in Table 1. In general, the surveyed systems are shallow (0.2-1.5 m depth), except for Petén-Itza Lake, the largest system. Transparency showed values ranging between 0.17-2 m, whereas temperature had values between 23-37 °C, ranges also found in other surveys from the region (Sarma and Elías-Gutiérrez 1999a, García-Morales and Elías-Gutiérrez 2004). Date of collection,

geographical coordinates, and environmental data of each sampling site are resumed in Table 1. Animals were sorted with a stereomicroscope and identified using a compound microscope. Identification of rotifers was made following Koste 1978, Nogrady *et al.* 1995, Segers 1995, De Smet and Pourriot 1997, Nogrady and Segers 2004. Also we consulted the Academy of Natural Sciences of Philadelphia database on rotifers (Jersabek *et al.* 2003). When needed, animals were dissolved in a sodium hypochlorite solution to allow examination of trophi. Information about varieties and forms is provided because rotifer taxonomy is still under discussion. For example, former varieties have been recently proposed to be good species (ie. Sarma and Nandini 2002 proposed to consider *macracanthus*, a former variety of *Brachionus patulus*, as a different species). Selected new records in Central America were illustrated by using a camera lucida. All material and original samples are deposited at the reference

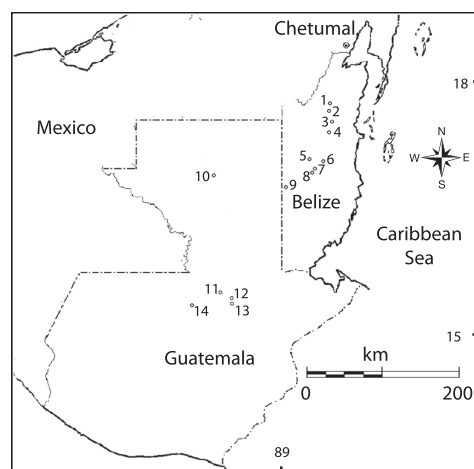


Fig. 1. Guatemala and Belize with localities collected (some of them were grouped due to their proximity). 1. Charco Seco; 2. Laguna and Estanque Crooked Tree; 3. Sand Hill; 4. La Democracia and Dos Charcos; 5. Charco Dos Puentes and Spanish Lockout I-III; 6. Blue Hole and Caves Branch; 7. Pine Ridge I-III; 8. Rio on Pools and Rio Puente Largo; 9. Caracol; 10. Petén-Itza Lake; 11. Charco El Pato and Sayaxché; 12. Charco Raxruja, Río Candelaria, Charco Rayulia and Río San Simón; 13. Charco Sebol and Río Sebol; 14. Río Chajmaic and Río Dolores.

TABLE 1
Physical variables and location of the water bodies sampled

Place	Geographical coordinates		Number of samples	Collecting date	Temperature (°C)	Maximum depth (m)	Secchi disk (m)
GUATEMALA	Latitude N	Longitude W					
A Laguna Petén-Itza	16°55'44"	89°53'38"	5	21/03/00	30	40	2
B Sayaxché	16°12'33.6"	90°10'47.3"	1	18/05/01	32	1	0.25
C Charco Raxruja	15°53'29"	90°05'51"	1	27/03/00	29	0.39	0.39
D Río Candelaria	15°53'04"	90°11'12"	2	27/03/00	28	0.5	0.5
E Charco Sebol	15°40'25"	89°56'39"	3	23/03/00	26	0.8	0.8
F Río Sebol	15°40'25"	89°56'39"	2	22/03/00	ND	1	1
G Charco Río Chajmaic	15°43'15"	89°56'24"	1	23/03/00	23	0.4	0.4
H Río Dolores	15°44'17"	90°22'34"	3	26/03/00	26	0.5	0.5
I Charco Rayulia	15°54'41"	90°06'06"	1	27/03/00	29	1.17	1.17
J Río San Simón	15°50'39"	90°17'01"	1	25/03/00	25	0.25	0.25
K Charco del Pato	16°07'36"	90°10'53"	1	27/03/00	29	0.79	0.47
BELIZE							
L Charco Seco	17°55'31.5"	88°31'10"	1	14/06/01	36	0.2	0.2
M Charco Dos Puentes	17°13'27.6"	88°52'29.2"	1	14/06/01	34	1.5	1.5
N Spanish Lokcout I	17°13'54.1"	88°55'49.2"	1	14/06/01	36	0.2	0.2
Ñ Spanish Lokcout II	17°13'59.4"	88°56'04.4"	1	14/06/01	35	0.55	0.41
O Spanish Lokcout III	17°14'17.1"	88°56'49.3"	1	14/06/01	37	0.2	0.2
P Pine Ridge I	17°02'55.6"	88°56'57.8"	1	15/06/01	25.5	0.56	0.56
Q Pine Ridge II	17°03'04.9"	88°57'17.5"	1	15/06/01	25	0.33	0.33
R Pine Ridge III	17°02'56.1"	88°57'03.1"	1	15/06/01	26	0.4	0.4
S Caracol	16°45'34.1"	89°07'13.7"	1	15/06/01	28	0.5	0.28
T Laguna Crooked Tree	17°46'30.4"	88°31'51.5"	2	16/06/01	30	0.7	0.7
U Estanque Crooked Tree	17°46'24.7"	88°30'54.8"	1	16/06/01	32	0.73	0.73
V Blue Hole	17°09'26.6"	88°41'00.6"	2	16/06/01	25	0.56	0.56
W Río on Pools	16°59'16.6"	88°58'40.3"	1	15/06/01	30	0.5	0.5
X Río Puente Largo	16°51'52.6"	89°02'21"	2	15/06/01	32	0.48	0.175
Y La Democracia	17°21'53.9"	88°32'20.7"	1	16/06/01	29	0.22	0.22
Z Sand Hill	17°35'41.5"	88°21'40"	1	16/06/01	35	0.25	0.25
AA Dos Charcos	17°21'53.9"	88°32'20.7"	1	16/06/01	30	0.36	0.36
AB Caves Branch	17°08'53.2"	88°42'33"	1	16/06/01	28	0.67	0.67

collection located in El Colegio de la Frontera Sur, Chetumal Unit.

To compare the fauna between Belize and Guatemala as well as Mexico, we performed a cluster analyses with the Sorensen Index (pres-

ence/absence) (Legendre and Legendre 2000) between all localities with known rotifer fauna. In the case of Mexico, we used already published data by Silva-Briano and Segers (1992), Rico-Martínez and Silva-Briano (1993), Kutikova

and Silva-Briano (1994), Sarma *et al.* (1996, 2000), Sarma and Elías-Gutiérrez (1997, 1998, 1999a, b, 2000), Silva-Briano and Adabache-Ortiz (1999), Rico-Martínez *et al.* (2003) and García-Morales and Elías-Gutiérrez (2004). Due to the fact that Mexico has a bigger size with a complex topography, the records of rotifer fauna were grouped as Central Plateau, Pacific slope, North, Southeast and Yucatan Peninsula regions.

RESULTS

A total of 119 species were recorded (Table 2); 68 are new records to Guatemala, and 91 taxa are recorded by the first time in Belize. The species found belong to two orders, 20 families, 35 genera and eight forms. The highest number of species was contained in *Lecane*, with 37 species (31 %), *Trichocerca* 14 (11.8 %), and *Lepadella* with 11 taxa (9.32 %). These results agree in part with other reports from tropical zones, where *Lecane* is the most common genus, followed by *Lepadella* (Segers *et al.* 1998, Sarma and Elías-Gutiérrez 1999a).

In the following section, a short description of selected taxa considered as new records for Central America is provided. Distributional data follow De Ridder and Segers 1992, unless otherwise stated.

Euchlanis semicarinata Segers, 1993 (Fig. 2): With a characteristic shallow dorsal keel. Dorsal and ventral plates present. Nearly circular in transversal view. Known from Nigeria, French Guyana, and Bolivia (Pourriot 1996, Segers *et al.* 1998).

Lepadella apsicora Myers, 1934 (Fig. 3a, b): Body ovoid, with a characteristic “V”-shaped sinus. Distal segment of foot longer than proximal. Toes asymmetric. Known from USA and Ecuador (Myers 1934, Koste and Shiel 1989, Jersabek *et al.* 2003).

Lepadella cryphaea Haring, 1916 (Fig. 4a, b): Related with *L. acuminata*. Lorica ovoid, posterior dorsal plate pointed. Characterized by the presence of folds and one dorsal-median keel. Known from Canada, USA, Brazil

and possibly Europe (Koste 1978, Segers and Sarma 1993, Jersabek *et al.* 2003).

Lepadella rhomboidula (Bryce, 1890) (Fig. 5): Known by some as *L. triptera f. rhomboidula* (see Koste 1978). In general view, body rhomboid. With a median keel on dorsal plate. Ventral margin of head “U”-like. Europe, India, Indonesia, and New Zealand. This is the first record of this species in the Americas, it was found only in one locality from Belize Mayan Mountains.

Lecane curvicornis f. lofuana (Murray, 1913) (Fig. 6a, b): Ventral plate broader than dorsal, two antero-lateral spines. Dorsal and ventral margins slightly convex. Posterior end of lorica trilobate. The species is relatively common, with cosmopolitan distribution (Segers 1995), but the *f. lofuana* has been reported more rarely, basically from Singapore and Brazil.

Lecane whitfordi (Ahlstrom, 1938) (Fig. 7a, b): Related with *L. obtusa*. Dorsal plate broader than ventral, head aperture margins straight or slightly convex. Antero-lateral corners with long triangular spines. Foot simple with a toe ending in two separated claws. Known only from two localities in North Carolina (USA), Lake Waccamaw, the type locality (Segers 1995), and Lake Mattamuskeet (Jersabek *et al.* 2003). Possibly a record of *L. obtusa* by Paggi (1989) could be *L. whitfordi*, according to Segers (1995). It was found only in one locality from Belize.

Monommata maculata Haring and Myers, 1924 (Fig. 8a, b): Body slender. Foot with two segments, toes unequal in length. Mastax with fulcrum conical, short; rami with complex dentition. Unci with three long teeth. Manubrium curved, with lamella. A common species with cosmopolitan distribution (Nogrady *et al.* 1995).

Scaridium botsjani Dames and Dumont, 1974 (Fig. 9): Trunk broad. Second segment of foot long. Toes relatively long. Fulcrum with a median-ventral crest. Basal plate well developed. Rami with long teeth. Manubria relatively narrow, with rounded alulae. Nepal is the type locality, but it is considered a warm stenoterm in all tropics (Segers 1995).

TABLE 2
List of species and localities

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Ñ	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	
Order Ploimida																														
1. Family Epiphaniidae																														
<i>Proalides tentaculatus</i> De Beauchamp, 1907 •	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2. Family Brachionidae																														
<i>Anuraeopsis fissa</i> (Gosse, 1851) +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Brachionus havanensis</i> Rousslet, 1911 *	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	
<i>B. patulus</i> (O. F. Müller, 1786) *	X	X	X	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	
<i>B. patulus f. macracanthus</i> (Daday, 1905) *	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	
<i>B. quadridentatus</i> (Hermann, 1783) *	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	
<i>Keratella americana</i> Carlin, 1943 *	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	
<i>K. cochlearis</i> (Gosse, 1851)	X	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>K. lenzi</i> (Hauer, 1953) *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	
<i>K. tropica</i> (Apstein, 1907) +	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Platyas quadricornis</i> (Ehrenberg, 1832) * +	-	-	-	X	X	-	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	
3. Family Euchlanidae																														
<i>Manfredium eudactyloia</i> (Gosse, 1886) +	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Dipleuchlanis propatula</i> (Gosse, 1886) * +	-	-	-	-	X	-	-	-	X	-	-	-	X	-	X	-	-	-	-	-	-	X	-	X	-	X	X	-	-	
<i>Euchlanis dilatata</i> Ehrenberg, 1832 * +	X	-	-	X	X	X	-	X	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	X	-	X	-	-	X	
<i>E. incisa</i> Carlin, 1939 * +	X	-	-	-	X	-	X	-	X	-	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-	X	
<i>E. oropha</i> Gosse, 1887 +	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>E. semicarinata</i> Segers, 1993 •	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Tripleuchlanis plicata</i> (Levander, 1894) * +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	
4. Family Mytilinidae																														
<i>Mytilina bisulcata</i> (Lucks, 1912) •	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	
<i>M. ventralis</i> (Ehrenberg, 1832) * +	X	-	-	-	X	-	X	X	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-	-	
5. Family Trichotriidae																														

TABLE 2 (Continued)
List of species and localities

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	N̄	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
<i>Trichotria tetractis</i> (Ehrenberg, 1830) *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
<i>Macrochaetus collinsi</i> (Gosse, 1867) * +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	X	X	X	X	X	X	X
<i>M. sericus</i> (Thorpe, 1893) •	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
6. Family Colurellidae																													
<i>Colurella adriatica</i> (Ehrenberg, 1831) •	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>C. obtusa</i> (Gosse, 1886) * +	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	X
<i>C. sulcata</i> (Stenroos, 1898) •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-
<i>C. uncinata f. bicuspidata</i> (Ehrenberg, 1832) * +	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X
<i>Lepadella acuminata</i> (Ehrenberg, 1834) •	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. apsicora</i> Myers, 1934 •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. cryphaea</i> Harring, 1916 •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. ehrenbergi</i> (Perty, 1850) •	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. ovalis</i> (O. F. Müller, 1786) * +	-	-	-	X	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
<i>L. patella</i> (O. F. Müller, 1786) * +	X	-	-	-	X	-	X	X	-	X	-	-	X	-	X	-	X	X	X	X	-	-	-	-	-	X	-	X	X
<i>L. quadricarinata</i> (Stenroos, 1898) •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. rhomboides</i> (Gosse, 1886) * +	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	-
<i>L. triba</i> Myers, 1934 •	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. triptera</i> (Ehrenberg, 1830) *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
<i>L. rhomboidula</i> (Bryce, 1890) •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
7. Family Lecanidae																													
<i>Lecane arcula</i> Harring, 1914 * +	X	-	-	-	-	-	-	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-
<i>L. bulla</i> (Gosse, 1851) * +	X	-	X	X	X	-	X	X	X	X	X	X	X	X	X	-	X	X	X	-	X	X	-	X	X	X	-	X	X
<i>L. clostercera</i> (Schmarda, 1859) * +	X	-	-	X	-	-	-	X	-	-	-	-	X	-	X	-	-	-	-	X	-	-	-	-	X	-	-	-	X
<i>L. cornuta</i> (O. F. Müller, 1786) * +	X	-	X	X	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	X	-	X	-
<i>L. crepida</i> Harring, 1914 * +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	-	-	-
<i>L. curvicornis f. nitida</i> (Murray, 1913) *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-

TABLE 2 (Continued)
List of species and localities

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
<i>L. curvicornis f. lofuana</i> (Murray, 1913) •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. decipiens</i> (Murray, 1913) +	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. doryssa</i> Harring, 1914 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. furcata</i> (Murray, 1913) *	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	X	X	-	X	-
<i>L. haliclystia</i> Harring & Myers, 1926 •	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. hamata</i> (Stokes, 1896) * +	X	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X
<i>L. hastata</i> (Murray, 1913) * + •	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-
<i>L. hornemanni</i> (Ehrenberg, 1834) * +	X	-	-	-	-	-	-	-	-	-	X	-	-	X	X	-	X	-	-	-	X	-	-	X	X	X	X	-	-
<i>L. inermis</i> (Bryce, 1892) *	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. leontina</i> (Turner, 1892) * +	X	-	X	-	X	-	X	-	-	-	-	X	X	X	X	X	-	X	X	-	-	-	-	X	-	X	X	-	-
<i>L. ludwigii</i> (Eckstein, 1883) * +	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-
<i>L. ludwigii f. ercodes</i> Harring, 1914 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. luna</i> (O. F. Müller, 1776) * +	X	-	-	X	-	X	X	-	-	-	X	-	X	-	X	-	-	-	-	-	X	-	-	-	X	X	-	X	X
<i>L. lunaris</i> (Ehrenberg, 1832) *	X	-	-	-	-	-	X	-	-	-	-	X	-	X	X	X	X	X	X	-	X	-	-	X	-	X	X	X	X
<i>L. margarethae</i> Segers, 1991 +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. monostyla</i> (Daday, 1897) *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	X	-	-
<i>L. nana</i> (Murray, 1913) * +	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. obtusa</i> (Murray, 1913) * +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	-	X	-	X	-
<i>L. papuana</i> (Murray, 1913) +	X	-	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. pertica</i> Harring & Myers, 1926 •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
<i>L. pyriformis</i> (Daday, 1905) * +	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. quadridentata</i> (Ehrenberg, 1832) * +	-	X	X	-	X	-	X	-	-	-	-	X	-	X	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
<i>L. rhenana</i> Hauer, 1929 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-
<i>L. rhytida</i> Harring & Myers, 1926 •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. rugosa</i> (Harring, 1914) •	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>L. signifera</i> (Jennings, 1896) * +	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
<i>L. spinulifera</i> Edmondson, 1935 ••	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-

TABLE 2 (Continued)
List of species and localities

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
<i>L. stenroosi</i> (Meissner, 1908) * +	-	-	-	-	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
<i>L. subtilis</i> Harring & Myers, 1926 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-
<i>L. uenoi</i> Yamamoto, 1951 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	-	-	-	-	-	-	-	X	-	-	-
<i>L. unguilata</i> (Gosse, 1887) * +	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. whitfordi</i> (Ahlistrom, 1938) *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
8. Family Lindiidae																													
<i>Lindia tortulosa</i> Dujardin, 1841 * +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
9. Family Notommatidae																													
<i>Eosphora anthadis</i> Harring & Myers, 1922+•	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cephalodella foveola</i> (Ehrenberg, 1832) * +	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
<i>C. gibba</i> (Ehrenberg, 1838) * +	X	-	-	-	-	-	X	-	-	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-
<i>Monommata maculata</i> Harring & Myers, 1924*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
<i>M. cf. phoxa</i> Myers, 1930*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>Notommata cerberus</i> (Gosse, 1886)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>N. copeus</i> Ehrenberg, 1834*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>N. saccigera</i> Ehrenberg, 1832*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>Scaridium botsjani</i> Dames & Dumont, 1974* +•	-	-	-	X	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>Tetrastiphon hydrocora</i> Ehrenberg, 1840*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
10. Family Trichocercidae																													
<i>Trichocerca bicristata</i> (Gosse, 1887)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
<i>T. bidens</i> (Lucks, 1912)*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	X	X	-	-
<i>T. capucina</i> (Wierzejski & Zacharias, 1893)+	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>T. collaris</i> (Rousset, 1896)*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
<i>T. elongata f. braziliensis</i> (Murray, 1913)* +•	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
<i>T. flagellata</i> Hauer, 1937*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
<i>T. hollaerti</i> De Smet, 1990*•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-

TABLE 2 (Continued)
List of species and localities

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	N̄	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
<i>T. iernis</i> (Gosse, 1887)+●	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>T. myersi</i> (Hauer, 1931)*●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
<i>T. pusilla</i> (Laterbourn, 1898)* +	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>T. similis</i> (Wierzejski, 1893)* +	X	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>T. stylata</i> (Gosse, 1851)*	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>T. tenuior</i> (Gosse, 1886)* +	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>T. weberi</i> (Jennings, 1903)+	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. Family Gastropodidae																													
<i>Ascomorpha ovalis</i> (Bergendal, 1892)+●	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Family Synchaetidae																													
<i>Polyarthra cf. dolichoptera</i> Idelson, 1925+●	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>P. cf. vulgaris</i> Carlin, 1943* +	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Synchaeta longipes</i> Gosse, 1887+	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Family Asplanchnidae																													
<i>Asplanchna grodi</i> (De Guerne, 1888)+●	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>A. sieboldi</i> (Leydig, 1854)* +	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-	-
<i>Asplanchnopus hyalinus</i> Harring, 1913*●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
14. Family Dicanophoridae																													
<i>Dicanophorus grandis</i> (Ehrenberg, 1832)*●	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	X
<i>D. prionacis</i> Harring & Myers, 1928+●	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order Gnesiotrocha																													
15. Family Testudinellidae																													
<i>Testudinella alstromi</i> Hauer, 1926* +●	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	X	-	-	-	-	-	X	-	X	-	-
<i>T. amphora</i> Hauer, 1938*●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
<i>T. patina</i> (Hermann, 1783)* +	X	-	X	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	X	-	-	X	-	X	-	-
16. Family Flosculariidae																													
<i>Limnia melicerta</i> Weisse, 1848+	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 2 (Continued)
List of species and localities

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
17. Family Conochilidae																														
<i>Conochilus dossuarius</i> (Hudson, 1875)+	X																													
18. Family Hexarthridae																														
<i>Hexarthra fennica</i> (Levander, 1892)*												X														X				
<i>H. intermedia</i> f. <i>braziliensis</i> (Hauer, 1953)* +●	X																										X			
19. Family Filiniidae																														
<i>Filinia novaezelandiae</i> Shiel & Sanoamuang, 1993* +●	X	X		X																		X		X						
20. Family Collotheceidae																														
<i>Collothea</i> cf. <i>pelagica</i> (Rousselet, 1893)+●	X																													

A-K belong to Guatemala and L-AB belong to Belize. For complete names of the localities see Table 1. New records: (*) for Belize; (+) for Guatemala; (●) for Central America region.

Trichocerca elongata braziliensis (Murray, 1913) (Fig. 10): Body cylindrical. Anterior margin smooth, double dorsal keel. Medial part of body broadest. With one long toe, and with small substylis in both sides. Trophi asymmetric; left manubria hook-shaped. Left uncus longer. Known from Malaysia, Singapore, and South America.

Trichocerca hollaerti De Smet, 1990 (Fig. 11): Dorsal keel covers all body. Head aperture margins with longitudinal folds. Right toe elongated, the left one "S"-like. It has been reported in Africa, and Brazil (Segers and Sarma 1993).

DISCUSSION

In total 47 taxa are new to the entire Central America region (Collado *et al.* 1984, De Ridder and Segers 1992). Most of these species are known in southern Mexico (Sarma 1999, García-Morales and Elías-Gutiérrez 2004).

Some species of *Euchlanis*, *Cephalodella*, *Scaridium* and *Sinantherina* could not be identified due to taxonomic problems or by their poor preservation. Some unidentified bdelloids were also present. These doubtful taxa were not included in the list.

As recorded herein, the fauna from Guatemala and Belize represents the first contemporaneous addition since Collado *et al.* (1984). Thus, the number of new records in the list is not surprising. Guatemala and Belize are small countries in size, but they possess complex and varied environments as highlands and lowlands with rainforest, floodplains, mangroves, savanna, *Pinus* forest, etc. (Archibold 1995). In particular, the region of Pine Ridge, located in the Mayan mountains, has a dramatic change from tropical vegetation to a *Pinus* forest in just few meters, possibly as a result of changes in the soil composition and altitude (Elías-Gutiérrez *et al.* 2006). Here we found the lower temperatures of water and several unique records, as *L. rhomboidula*.

For comparison, small countries such as Ecuador and Bolivia have reports of ca. 300 and 153 species recorded in their freshwater

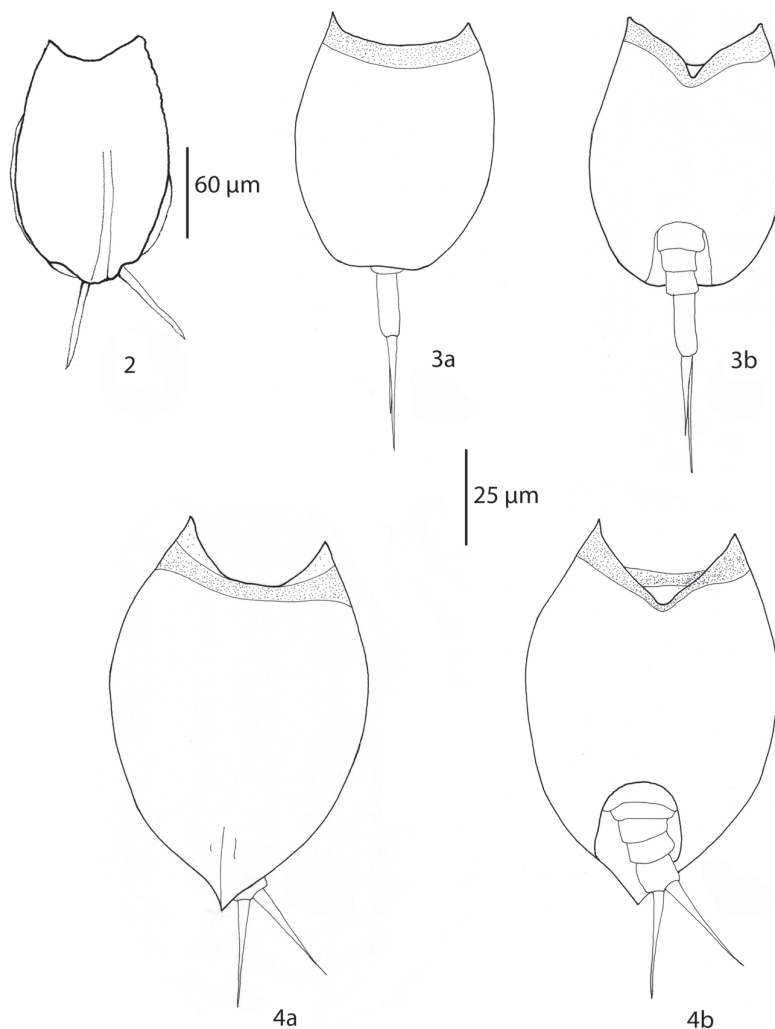


Fig. 2. *E. semicarinata* (dorsal). Fig. 3A. *L. apsicora* (dorsal), B. Ventral. Fig. 4A. *L. cryphaea* (dorsal), B. Ventral.

systems, respectively (Koste and Böttger 1992, Segers *et al.* 1998).

Out of the 119 taxa reported here, up to 70 % are cosmopolitan, about 6 % are tropicopolitans, 4.2 % are subtropical and 6.7 % have limited distribution to one locality. Two taxa (1.7 %) are neotropical: *Brachionus havanensis* and *Hexarthra intermedia* f. *braziliensis*. The present study demonstrated the occurrence

of some rotifers recorded earlier from Africa, Asia, Europe, New Zealand, USA, and South America (De Ridder and Segers 1992). For example this is the first time that *L. rhomboidula* is reported in the Americas.

Systems with highest and lowest diversity in Guatemala were Petén-Itza and Raxruja with 53 and 3 species, respectively. In Belize, the localities La Democracia and Blue Hole had

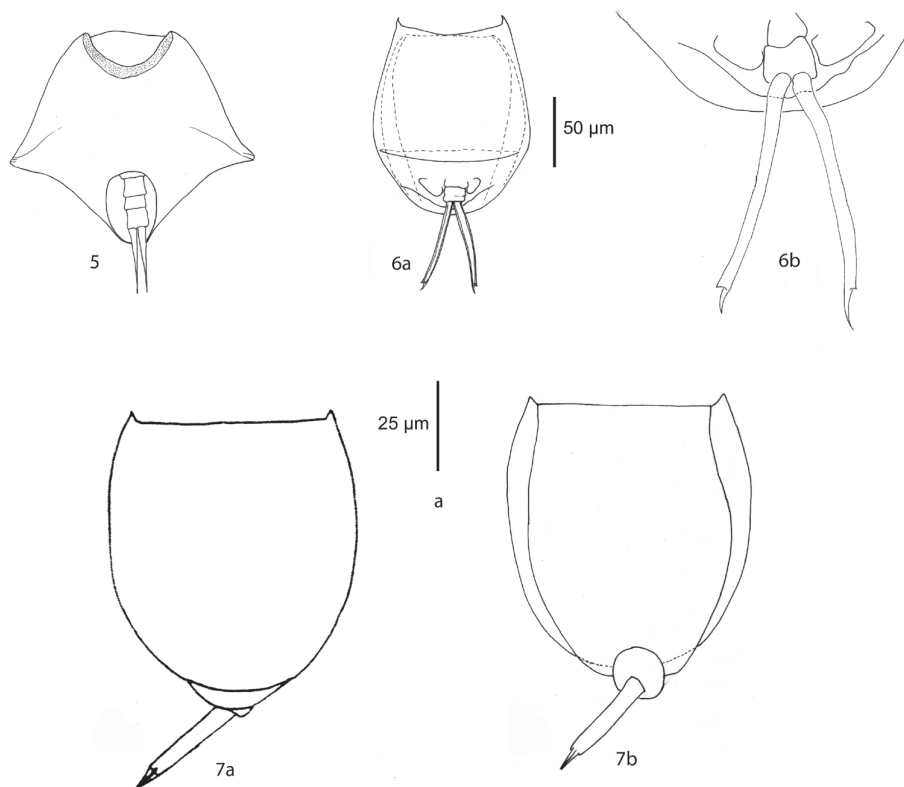


Fig. 5. *L. rhomboidula* (ventral). Fig. 6A. *L. curvicornis* f. *lofuana* (ventral), B. Close view of foot. Fig. 7A. *L. whitfordi* (dorsal), B. Ventral.

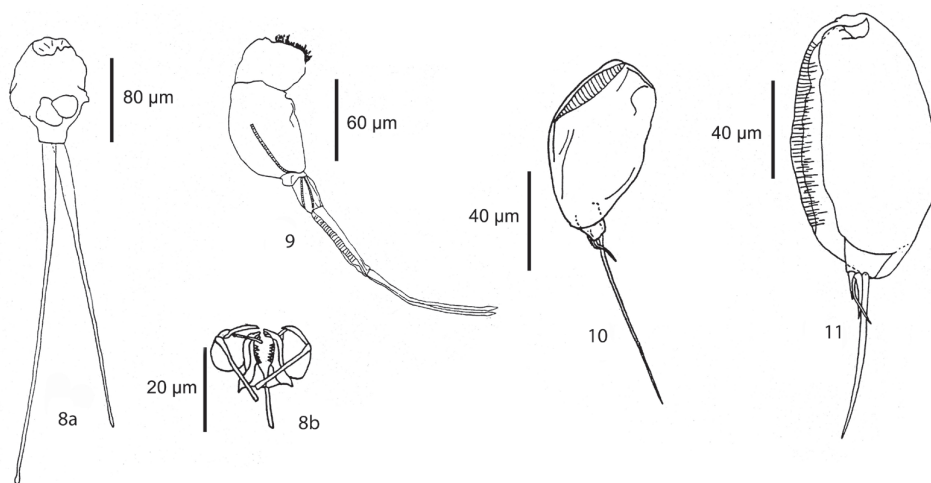


Fig. 8. A. *M. maculata* (habitus ventral), B. trophi (ventral). Fig. 9. *S. bostjani* (lateral). Fig. 10. *T. elongata* f. *braziliensis* (lateral). Fig. 11. *T. hollaerti* (ventral).

49 and 6 taxa, respectively. These numbers are low, when compared with other neotropical systems. For example Segers *et al.* (1998) found 104 species of rotifers in only three samples from Laguna Bufeos, Bolivia and Sarma and Elías-Gutiérrez (1998) found 78 species in a Mexican pond. The majority of the species recorded in both, Petén-Itza and La Democracia, were present in littoral samples collected from submerged vegetation, which harbors a high diversity (Uicab-Sabido 2001). It should be noticed that all samples from Petén-Itza Lake were taken in the west side, near the Flores Island and San Benito town, the most affected region by human pollution. The east shore, less affected, was not sampled in this survey.

Knowledge on the rotifer fauna of Central America is still limited when compared with that of North and South America. Presently, Panama is the country with the highest number of species recorded (180 taxa) in the region (De Ridder and Segers 1992). Since the early report by Harring 1914, who recorded 109 species, 71 taxa have been added (Koste and De Paggi 1982, Collado *et al.* 1984). With this study the number of species of Guatemala and Belize increased, but remains still behind that of Panama. The necessity of systematic research on rotifers is urgent in the rest of Central American countries. For example, in Nicaragua there are recorded 52 species only, Costa Rica 41, Honduras 24, and El Salvador 13 (De Ridder and Segers 1992).

Central America is an important biogeographic region; it constitutes a bridge (since Pliocene/Pleistocene age) between North and South America (Cox and Moore 1993). The region shows a mixture of species (De Ridder and Segers 1992); nevertheless, the overall influence of the nearctic fauna is weak (*Proalides tentaculatus*, *Keratella taurocephala*, *Lepadella triba* and *L. whitfordi*) (De Ridder and Segers 1992). A good number of taxa have clear affinities with that of South America and the lowlands of the east coast limit their distributional patterns. This fauna is formed mainly by lecanids, lepadelids and

tricercoids. The cluster analyses confirmed this statement. We found a major group (letter "A" in dendrogram, Fig. 12) formed by the Southeast Mexico, Yucatan Peninsula, Belize and Guatemala. As we stated, here we found the majority of rotifer species with South American affinity, emphasizing the transitional nature of this region between the Nearctics and Neotropics. North of Mexico has more affinity with the Nearctic fauna, with species as *Keratella paludosa* (Lucks), *Itura chamadis* Harring and Myers, *Ascomorphella volvocicola* (Plate) and *Synchaeta tremula* (O.F. Müller) (García-Morales 2001), and the Pacific coastal slope denote influence of species more tolerant to salinity. The "A" group also shows clear differences between both Mexican southern regions, for example, in Yucatan Peninsula there are more taxa related to alkaline waters (García-Morales and Elías-Gutiérrez 2004), than in the rest of the Southeast. Belize and

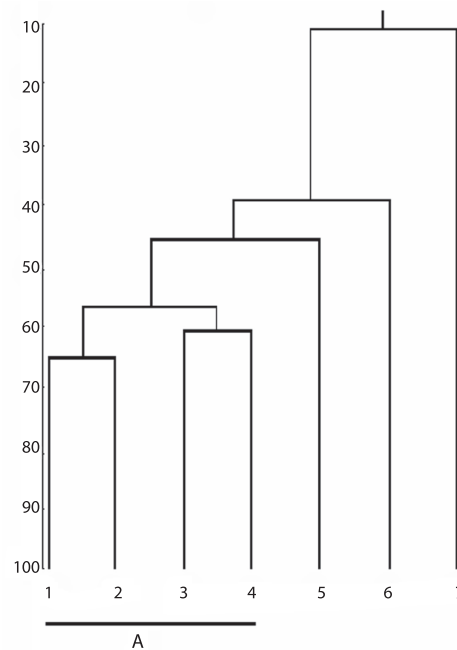


Fig. 12. Cluster analyses of the rotifers in Belize, Guatemala and adjacent Mexico. 1. Yucatan Peninsula; 2. Southeast Mexico; 3. Belize; 4. Guatemala; 5. Mexican Central Plateau; 6. North 7. Pacific slope.

Guatemala form other sub-group, but with some differences: as seen in Table 1, a high number of taxa represented in Belize (37 species) are not present in Guatemala, and vice versa 16 species are only found in the latter. Nevertheless, the whole community makes both countries to form a cluster, separated from the south of Mexico. Regardless of the few collecting localities in both countries (11 in Guatemala and 18 in Belize), the rotifers appear to show a peculiar assemblage related to particular environments across this transitional zone that should be confirmed with further studies.

Our results and the analysis of other records suggest that the tropical forest stretching from the Amazon River basin to Central America and Southeastern Mexico is the route by which the South American fauna penetrated northwards (Cox and Moore 1993). This seems to be true for rotifer fauna, as well as other groups of aquatic invertebrates as cladocerans (Eliás-Gutiérrez *et al.* 2001, 2006), and few calanoid copepods as *Prionodiptomus colombiensis* Thiébaud (Suárez-Morales *et al.* 2005).

Indeed, particular environments from Guatemala (as intermittent rivers, and sinkholes in Alta Verapaz) and Belize (the Mayan mountains, and many cave-related systems) deserve more intensive sampling in different seasons of the year to uncover more details about their peculiar microfauna.

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RESUMEN

El análisis de muestras procedentes del norte de Guatemala y centro-sur de Belice, recolectadas en marzo de 2000 y junio de 2001, dio como resultado la presencia de 119 especies. Se presenta una breve descripción de diez taxones seleccionados con base en sus distribuciones restringidas en ciertos ámbitos de América y el viejo continente: *Euchlanis semicarinata*, *Lepadella apsicora*, *L. cryphaea*, *Lecane curvicornis* f. *lofuana*, *L. whitfordi*, *Monommata maculata*, *Scardium bostjani*, *Trichocerca elongata* f. *braziliensis*, y *T. hollaerti*. Por primera vez se informa *Lepadella rhomboidula* en el continente americano. Las especies registradas incluyen 71 % con distribución cosmopolita y 6 % tropicopolitas; 4.2 % se encuentran restringidas a los subtrópicos. La máxima y mínima diversidad de especies en Guatemala correspondió al lago Petén-Itza (con 53 taxones) y al estanque Raxruja (con tres). El estanque La Democracia (con 49 taxones) y el Blue Hole (con seis) fueron máximo y mínimo en Belice. Del total encontrado, 47 especies se registran por primera vez en Centroamérica. Una comparación entre la fauna de rotíferos de estos dos países y México refleja una similitud; sin embargo, también se aprecian ciertas diferencias que permiten establecer un gradiente que va de la región neotropical hacia la neártica.

Palabras clave: rotífero, taxonomía, diversidad, distribución, Guatemala, Belice.

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