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ROTIFERS (ROTIFERA) OF JAMAICAN INLAND WATERS. A SYNOPSIS.

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Abstract. Before the research project 'Rotifers of Jamaica: Ecology, Diversity and Biogeogtaphy' was started, only 34 rotifers had been known from Jamaica. In our investigations we were able to give evidence of 205 (179 monogonont and 26 bdelloid) rotifer species of which 177 species had not previously been found on Jamaica. The Jamaican rotifer fauna with a total of 211 species is dominated by *Lecane* (25%), followed by *Cephalodella* and *Lepadella* (10% each). *Accepted 28 March 1995.*

Key words: Rotifera, phytotelmata, gastrotelmata, Jamaica, Caribbean.

INTRODUCTION

Rotifers are a characteristic element of freshwater fauna and especially of temporary habitats. Their ecological success is related to their reproductive strategy, including egg dormancy and parthenogenesis, and therefore the paucity of records of rotifers on Caribbean islands is due to few research activities rather than to the absence of rotifers.

Until 1991, only 15 rotifer species were known for Jamaican inland waters (Collado *et al.* 1984, De Ridder 1977). Initial investigations on the presence of rotifers in phytotelmata (Koste *et al.* 1991) gave evidence of 20 rotifer species, 19 of them being listed for Jamaica for the first time. These results led to the current research project to investigate the abundance and distribution of rotifers in limnetic systems of Jamaica. As a result of the project 205 rotifers could be distinguished to species level, 177 of them new for Jamaica. Altogether, 211 species are now known to occur on this 'Island in the Sun' (Koste *et al.* 1993 and *in press*).

These findings are a first step in closing a gap in our knowledge of the biogeography of rotifers in the Caribbean region. The aim of this paper is to summarize the results of the research project in order to compare the Jamaican rotifer fauna with those of other Caribbean islands in order to see whether they have a characteristic rotifer community compared to the mainland of South and Central America.

STUDY SITES

The main sampling areas were the northern rim of the Cockpit Country (Windsor/Pantrepant), John Crow and Blue Mountains, Alligator Hole River, Black River Morass and Negril Morass (Fig. 1; Koste *et al.* 1993 and *in press*).

The investigations included cryptic microhabitats such as phytotelmata and gastrotelmata:

Phytotelmata (Greek, meaning 'plant-pool', Varga 1928) are aquatic microhabitats formed by terrestrial plants that impound water. Especially in bromeliads, distributed mainly in the tropical and subtropical Americas, the leaf arrangement causes rainwater and throughfall to be funneled towards the leaf axils, where it forms a temporary or even permanent pool (Fig. 2). In the Wet Limestone Forest of the Jamaican Cockpit Country, bromeliads are a typical feature in the understory and form the sole permanent water bodies of this area (Janetzky & Vareschi 1993, Koste *et al.* 1991, 1993).

Gastrotelmata (Fig. 2; derivatio nominis: Gastro - Gastropoda, telma - pool) are aquatic microhabitats caused by rain and especially by throughfall collected in empty snail shells lying on the top of the soil. Normally, water storage is restricted to the rainy season. Their limnological features are determined by rain and throughfall (Fig. 3; e.g., pH, leaching of nutrients), debris in the shell, as well as by the shells themselves, because of their buffering capacity (Koste *et al.* 1993 and *in press*).

METHODS

Planktonic rotifers and those species living on aquatic vegetation, except for *Eichhornia crassipes,* were caught by means of a plankton net (mesh size 56 µm).

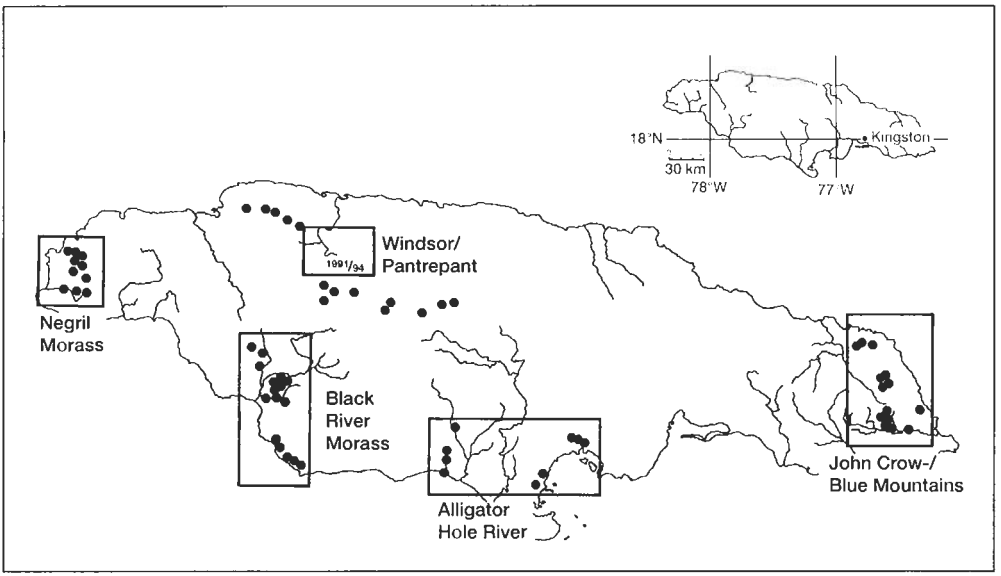

FIG. 1. Map of Jamaica. Frames show main sampling areas, dots sampling sites. In Windsor/Pantrepant investigations were performed in 1991, 1993 and 1994.

FIG. 2. Phytotelmata (top, from Janetzky & Vareschi 1993) and gastrotelmata (bottom, after Koste *et al.* 1993).

Rotifers associated with *Eichhornia* were caught by rinsing the root system with water after the whole plant had been transferred into a jar. Samples from microhabitats (phytotelmata, rock pools) were taken by means of a 60 ml syringe, those from gastrotelmata by rinsing the shells with water.

Samples were first treated with formalin or procaine hydrochloride and formalin (final concentration 5%). Since in some species identification was impeded by preservation, live specimens had to be studied in the laboratory.

The rotifers were sorted and identified under a microscope. The analysis of the trophi, if necessary, was made using sodium hypochlorite (NaOCl).

RESULTS

During two field studies (June – August 1993, March – April 1994) 156 samples were taken in which 199 different types of rotifers could be distinguished, including 175 monogonont and 24 bdelloid species. In additional six species *(Brachionus quadridentatus melheni, Cephallodella intuta, Keratella cochlearis* f. *micracantha, Monommata astia, Habrotrocha sylvestris,* and *Macrotrachela plicata)* identification was uncertain (Table 1). Further specimens of eight genera

(Cephalodella, Notommata, Ptygura, Trichocerca, Habrotrocha, Macrotrachela, Philodina, Rotaria) could not be identified due to preservation artefacts.

The taxonomy of the rotifers listed in Table 1 is based on Donner (1965), Koste (1978), Koste & Shiel (1986, 1987) and Segers *et al.* (1993). Segers *et al.* (1993) created the genus *Plationus* which is characterized by its trophi structure and its foot consisting of 3 pseudosegments. *Plationus* includes *P. patulus* and *P. patulus* var. *macracanthus* (Table 1, syn.: *Brachionus patulus* and *B. patulus* var. *macracanthus*). Regarding *Lecane*, Koste & Shiel (1990) distiguished the genera *Lecane, Monostyla* and *Hemimonostyla*, whereas Segers (1995) accepted only *Lecane* as valid genus. In Table 1 the classification provided by Koste (1978) is used.

DISCUSSION

Our investigations gave evidence of 205 species, including 179 monogonont und 26 bdelloid rotifers, and increased the number of Jamaican rotifers considerably, from 34 to 211 species. Three monogonont *(Collotheca heptabrachiata, Colurella anodonta, Ptygura* cf. *spongicola)* and three bdelloid species *(Habrotrocha collaris, H. rosa* and *Philodina acuticornis odiosa)* that had been detected before could not be found again (De Ridder 1977, Koste *et al.* 1991), as might be expected by sampling at different sites.

By comparing the results for different habitats under investigation first conclusions can be drawn concerning habitat preferences: out of 205 rotifer species *Filinia saltator* was restricted to the spring of Sulphur River, 46 species were only detected in running water, especially in brooks, and 32 rotifers only in standing waters, including cemented basins. In the latter, De Ridder (1977) found *Colurella anodonta*, a species not found during our study. 10 rotifers were exclusively distributed in aquatic microhabitats: 6 species in gastrotelmata *(Cephalodella tenuior, Habrotrocha lata, Macrotrachela multispinosa brevispinosa, M.* cf. *plicata, Rotaria tardigrada, Rotaria tridens)*, 3 in phytotelmata *(Collotheca trilobata, Lecane (Monostyla) janetzkyi, Macrotrachela quadricornifera)* and *Lecane (Lecane) elsa* in rock pools. Previous investigations by Koste *et al.* (1991) gave evidence that *Ptygura* cf. *spongicola, Collotheca heptabrachiata, Habrotrocha collaris, H. rosa* and *Philodina acuticornis*

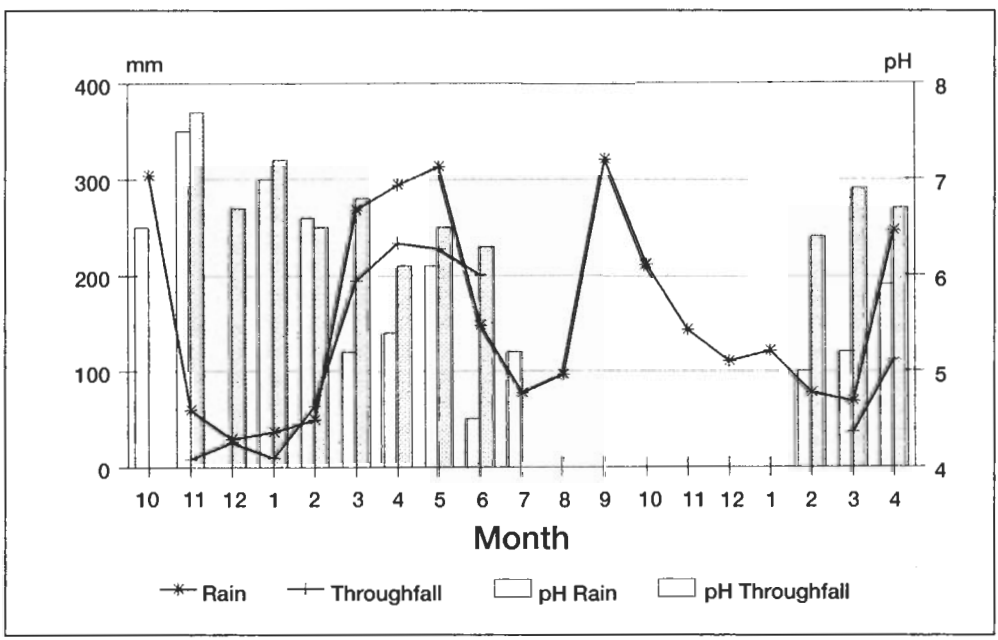

FIG. 3. Amount of rain and throughfall in Windsor, where Gastrotelmata were studied, and pH-values for both fractions (October 1992 – April 1994).

TABLE 1. List of rotifers found during this project in Jamaica. Further informations are given regarding their distribution in the Caribbean and in South and Central America. Abbreviations: D – De Ridder 1977, E – Edmondson 1934, F – Fernando in Collado *et al.* 1984, K – Koste *et al.* 1991, P – Pourriot 1975.

Rotifera	Jamaica (this study)															
	1 – Spring	2 – Running Water	3 – Pond, Pool, Lake	4 – Brackish	5 – Cemented Basin	6 – Rockpool	7 – Phytotelmata	8 – Gastrotelmata	9 – Temporary Water	Jamaica (previous studies)	Cuba	Haiti	Puerto Rico	Other Caribbean Islands	Central/South America
Monogononta															
Family Brachionidae															
Anuraeopsis fissa fissa			x		x									P	x
Anuraeopsis navicula		x			x						L				x
Brachionus angularis			x		x						FL			DP	x
Brachionus caudatus		x	x		x						L				x
Brachionus havanaensis			x								FL			D	x
Brachionus leydigi rotundus			x												
Brachionus mirabilis		x	x											P	x
Brachionus plicatilis				x								E		D	x
Brachionus quadridentatus			x								F	E		D	x
Brachionus quad. f. brevispinus			x												x
Brachionus quad. var. cluniorbicularis			x											P	x
Brachionus quad. cf. melheni		x	x												x
Brachionus urceolaris		x	x							F					x
Keratella cochlearis cf. micracantha		x													x
Plationus patulus patulus		x	x						x	F	F	EF		DP	x
Plationus patulus var. macracanthus		x	x											P	x
Platyias leloupi			x						x					P	x
Platyias quadricornis	x	x				x			x	F		E		P	x
Platyias quadricornis var. brevispinus		x													x
Family Euchlanidae															
Dipleuchlanis propatula			x								F	E		FP	x
Euchlanis dilatata	x	x				x						E		DF	x
Euchlanis lyra lyra	x	x				x								D	x
Euchlanis meneta		x													x
Family Mytilinidae															
Lophocharis salpina			x												x
Mytilina mucronata									x					D	x
Mytilina ventralis		x													x
Family Trichotridae															
Macrochaetus collinsi		x	x									E			x
Family Colurellidae															
Colurella adriatica		x	x	x										D	x
Colurella colurus		x		x										D	x
Colurella gastracantha		x	x		x	x				K					x
Colurella obtusa obtusa		x	x		x	x	x	x	x					D	x
Colurella salina				x					x						
Colurella uncinata	x	x	x											P	x
Colurella uncinata f. bicuspidata		x	x												x
Lepadella (Heterolepadella) apsicora		x													
Lepadella (H.) cyrtopus			x		x		x								
Lepadella (H.) heterodactyla					x										x
Lepadella (H.) heterostyla					x										x
Lepadella (Lepadella) acuminata		x								K				D	x
Lepadella (L.) apsida		x													x
Lepadella (L.) benjamini		x													x

	1	2	3	4	5	6	7	8	9	J	C	H	P	CI	A
Lepadella (L.) latusinus		x													x
Lepadella (L.) minuta	x	x													
Lepadella (L.) oblonga						x				K					x
Lepadella (L.) ovalis		x												DP	x
Lepadella (L.) patella	x	x	x		x	x	x		x	DK				DP	x
Lepadella (L.) patella f. similis		x												D	
Lepadella (L.) quadricarinata		x				x									x
Lepadella (L.) quinquecostata		x					x	x		K					x
Lepadella (L.) rhomboides		x	x			x			x						x
Lepadella (L.) triba		x													x
Lepadella (L.) triptera		x			x										x
Squatinella mutica		x			x										x
Family Lecanidae															
Lecane (Hemimonostyla) agilis			x			x	x								
Lecane (H.) inopinata inopinata		x			x										x
Lecane (H.) inopinata f. sympoda		x	x		x										x
Lecane (H.) kluchor var. syngenes						x	x								
Lecane (Lecane) aculeata	x	x	x	x	x					D				DP	x
Lecane (L.) aculeata arcula			x			x									x
Lecane (L.) crepida		x			x										x
Lecane (L.) curvicornis		x	x						x			E		P	x
Lecane (L.) elegans		x													x
Lecane (L.) elsa						x									x
Lecane (L.) flexilis		x										E		D	x
Lecane (L.) glypta		x													x
Lecane (L.) haliclysta		x													x
Lecane (L.) hornemanni		x	x		x		x			D		E			x
Lecane (L.) inermis	x	x	x			x				D				D	x
Lecane (L.) leontina	x	x	x		x					F	F	EF		P	x
Lecane (L.) ludwigi ludwigi		x	x		x										x
Lecane (L.) luna	x	x					x		x	D	F	E		DP	x
Lecane (L.) nana		x			x		x			D		E		DP	x
Lecane (L.) papuana	x	x								F				DP	x
Lecane (L.) signifera		x	x												x
Lecane (L.) subtilis		x	x												x
Lecane (L.) tenuiseta		x												D	x
Lecane (Monostyla) arcuata					x		x	x		D				D	x
Lecane (M.) bulla	x	x	x	x		x			x	F	F	E	D	DFP	x
Lecane (M.) bulla styrax	x	x												D	x
Lecane (M.) closterocerca	x	x	x	x	x	x								D	x
Lecane (M.) cornuta			x			x								D	x
Lecane (M.) crenata		x	x									E		D	x
Lecane (M.) decipiens	x	x	x				x	x		K					x
Lecane (M.) furcata		x	x		x				x			E		DP	x
Lecane (M.) hamata		x	x		x	x	x	x		K					x
Lecane (M.) janetzkyi							x			K					
Lecane (M.) lunaris		x	x									E		D	x
Lecane (M.) monostyla		x					x			K					x
Lecane (M.) obtusa		x												D	x
Lecane (M.) opias		x													x
Lecane (M.) pyriformis	x	x	x	x	x		x		x	K				DP	x
Lecane (M.) quadridentata		x	x				x			F				DP	x
Lecane (M.) rugosa		x	x												x
Lecane (M.) scutata			x		x		x					E		D	x
Lecane (M.) sinuata		x					x								
Lecane (M.) spinulifera		x										E			x
Lecane (M.) subulata									x						x
Lecane (M.) wulferti		x													x
Family Proalidae															
Proales decipiens	x	x	x			x	x								x
Proales fallaciosa		x													x
Proales similis		x													

	1	2	3	4	5	6	7	8	9	J	C	H	P	CI	A
Family Lindiidae															
Lindia torulosa			x												x
Family Notommatidae															
Cephalodella apocolea									x						x
Cephalodella elegans		x													
Cephalodella forficula		x	x			x			x						x
Cephalodella gibba		x	x		x	x								P	x
Cephalodella gracilis	x	x	x			x									x
Cephalodella holowdayi		x	x			x									x
Cephalodella cf. intuta			x												x
Cephalodella intuta jamaicaiensis		x				x		x							
Cephalodella irisae		x	x												
Cephalodella limosa		x													
Cephalodella megalocephala			x												
Cephalodella misgurnus			x												
Cephalodella mucronata		x	x												x
Cephalodella panarista		x													x
Cephalodella stenroosi	x	x							x						x
Cephalodella stercea	x	x	x		x	x									x
Cephalodella tenuior								x							
Cephalodella tinca			x												x
Cephalodella ventripes			x												x
Itura viridis			x												
Monommata cf. astia		x													
Notommata allantois		x													x
Notommata aurita		x	x												x
Notommata cerberus		x													x
Notommata glyphura		x													x
Notommata pachyura		x													x
Notommata tripus		x	x												x
Sphyrias lofuana		x													
Scaridium longicaudum		x	x												x
Taphrocampa selenura		x													x
Family Trichocercidae															
Trichocerca (Diurella) brachyura		x	x				x							D	x
Trichocerca (D.) insignis		x	x												x
Trichocerca (D.) tenuior		x	x		x	x	x		x					P	x
Trichocerca (D.) tigris	x		x											D	x
Trichocerca (D.) weberi	x				x									P	x
Trichocerca (Trichocerca) braziliensis		x	x		x										x
Trichocerca (T.) elongata		x													x
Trichocerca (T.) pusilla			x		x		x							P	x
Trichocerca (T.) rattus f. carinata		x	x									E			x
Family Synchaetidae															
Polyarthra remata		x									L			D	x
Polyarthra vulgaris		x	x								FL			DP	x
Family Asplanchnidae															
Asplanchna (Asplanchnella) sieboldi		x													x
Family Dicranophoridae															
Balatro calvus		x													x
Dicranophorus caudatus braziliensis		x	x												x
Dicranophorus epicharis		x	x											P	x
Dicranophorus forcipatus		x	x		x										x
Dicranophorus grandis	x	x	x												x
Dicranophorus hercules		x													x
Family Testudinellidae															
Testudinella incisa var. emarginula		x													x
Testudinella mucronata hauerisensis		x													x
Testudinella patina		x	x								F	E		DFP	x

	1	2	3	4	5	6	7	8	9	J	C	H	P	Cl	A
Family Flosculariidae															
Beauchampia crucigera		x													x
Floscularia decora		x													x
Floscularia ringens		x	x						x						x
Lacinularia flosculosa		x	x												x
Limnias ceratophylli		x	x				x			K					x
Limnias melicerta		x													x
Ptygura beauchampi			x												x
Ptygura elsteri			x												x
Ptygura furcata			x												
Ptygura furcillata			x												x
Ptygura longicornis		x	x												x
Ptygura longipes			x												
Ptygura melicerta			x												x
Ptygura melicerta var. mucicola	x	x													x
Ptygura tacita		x													x
Ptygura velata		x													x
Family Filiniidae															
Filinia passa			x												x
Filinia saltator	x													P	x
Family Collothecidae															
Collotheca ambigua		x	x												x
Collotheca campanulata campanulata			x												x
Collotheca campanulata brevispinus			x				x								
Collotheca ornata ornata			x							K					x
Collotheca ornata var. cornuta			x												x
Collotheca trilobata							x								
Family Atrochidae															
Cupelopagis vorax			x												x
Stephanoceros fimbriatus			x												x
Bdelloidea (Digononta)															
Family Habrotrochidae															
Habrotrocha ampulla		x													x
Habrotrocha angusticollis			x			x									x
Habrotrocha constricta		x								K					
Habrotrocha intermedia			x												
Habrotrocha lata								x							x
Habrotrocha cf. sylvestris		x						x							
Habrotrocha tridens tridens					x										
Otostephanus donneri			x												
Family Philodinidae															
Dissotrocha macrostyla macrostyla		x	x												x
Dissotrocha macrostyla tuberculata		x													x
Macrotrachela aculeata		x						x							
Macrotrachela ehrenbergi		x						x							
Macrotrachela multispinosa multispinosa		x	x				x	x							x
Macrotrachela multispinosa brevispinosa								x							
Macrotrachela papillosa						x			x						x
Macrotrachela cf. plicata								x							
Macrotrachela quadricornifera							x			K					x
Philodina acuticornis		x	x												
Philodina megalotrocha		x	x			x	x								x
Philodina roseola			x												
Rotaria macrura			x				x								
Rotaria neptunia			x												x
Rotaria rotatoria	x	x	x		x	x	x	x	x	K					x
Rotaria socialis						x	x								x
Rotaria tardigrada		x						x							x
Rotaria tridens								x							x

odiosa are also restricted to phytotelmata. *Brachionus plicatilis* was only found in brackish water.

A comparision of the Jamaican rotifer fauna with that of different Caribbean islands is somewhat questionable because so few rotifer species have been described for the other islands: for the Antillean region, 45 monogonont genera with 234 species (incl. subspecies, varieties, etc.) are known, most of them occurring in Jamaica (37 genera, 177 species). In contrast to Jamaica, only 30 species (15 genera) were reported for Cuba and 36 rotifers (17 genera) for Haiti. For the Dominican Republic only *Brachionus plicatilis* was mentioned, for Puerto Rico *Lecane (Monostyla) bulla* (Table 1, Table 2; Collado *et al.* 1984: results of their own and of previous investigations throughout the Caribbean; Edmondson 1934: Haiti; Pourriot 1975: Martinique and Guadeloupe, De Ridder 1977: several Caribbean islands; Koste *et al.* 1991, 1993 and *in* press: Jamaica, Laiz *et al.* 1994: Cuba).

For bdelloid rotifers, only records for Jamaica have been published so far: Koste *et al.* (1991, 1993 and *in press*) gave evidence of 27 species belonging to the genera *Dissotrocha* (2 species), *Habrotrocha* (8), *Macrotrachela* (6), *Otostephanus* (1), *Philodina* (4) and *Rotaria* (6).

Variations in genus and species numbers as well as a lack of data for bdelloid rotifers can be explained by the low number of research activities, as indicated by the number of present publications, and by the problems concerning the identification of fixed material (live specimens are needed to see head apertures).

TABLE 2. Rotifers of the Caribbean region by species numbers. Genera occurring in the Caribbean region with one or two species only are summarized as 'other'.

	Caribbean Region	Jamaica	Cuba	Haiti	Puerto Rico	Other Caribbean Islands
Anuraeopsis	3	2	1			2
Asplanchna	3	1	2	1		1
Brachionus	16	10	8	3		10
Cephalodella	19	18				2
Collotheca	8	7		1		
Colurella	9	8				6
Dicranophorus	6	5	1			1
Euchlanis	6	3		2		4
Filinia	4	2	1			3
Hexarthra	4		2			3
Keratella	4		3			2
Lecane	57	45	4	17	1	28
Lepadella	20	18		1		5
Mytilina	4	2		1		2
Notommata	6	6				
Platyias	3	3		1		2
Polyarthra	3	2	2			3
Proales	3	3				
Ptygura	11	10	1			
Testudinella	3	3	1	1		1
Trichocerca	12	9	1	1		7
Other	30	20	3	7		10
Genera (total):	45	37	15	17	1	25
Species (total):	234	177	30	36	1	92

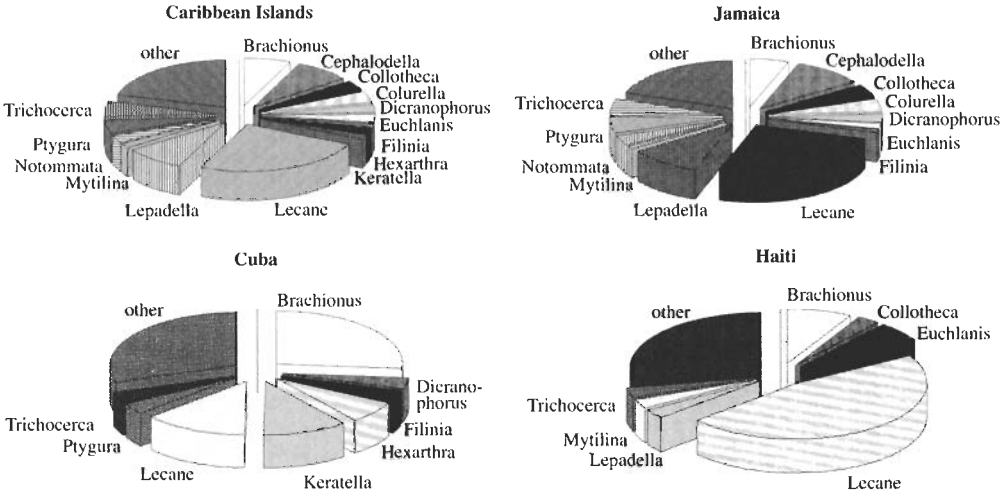

FIG. 4. Rotifer fauna by genera. Genera occurring in Caribbean region with three species or less are summarized as 'others'.

A comparison of the rotifer fauna of different islands shows that only few rotifers are widely abundant in the Caribbean: *Brachionus quadridentatus, Dipleuchlanis propatula, Lecane (Lecane) leontina, Lecane (L.) luna, Plationus patulus,* and *Testudinella patina* have been mentioned for the Greater Antilles except Puerto Rico and several smaller islands of the Antillean region, whereas *Lecane (Monostyla) bulla* was listed for Puerto Rico as well.

Among Jamaican rotifers *Lecane* is most abundant, 45 species accounting for 25% of the total rotifer fauna (Fig. 4), followed by *Cephalodella* and *Lepadella* (18 species each, 10% of the rotifer fauna), *Brachionus* and *Ptygura* (10 species each, 6%). The fact that the combination of genera in Jamaica resembles the composition for the Caribbean rotifer fauna is due to the fact that the calculation for the Caribbean region is mainly based on Jamaican data. Differences in genera combinations between various islands (e.g., Cuba: *Brachionus* 8 species, 27%) are probably caused by a lack of data as well as the particular habitats sampled. Most of the investigations performed in the Caribbean focussed on planktonic rotifers (e.g., Laiz *et al.* 1994, Pourriot 1965).

Pourriot (1982) stated that the rotifers of Central America and the Caribbean region do not differ from those of tropical South America. Comparison of data published so far for the South and Central America with the species list provided here corroborates this statement, since only 23 monogonont and 12 bdelloid species out of 205 rotifers listed in Table 1 are unknown for the continental fauna (Koste 1988; Koste & Böttger 1989, 1992; Koste & De Paggi 1982; Koste & Robertson 1990; Rico-Martinez & Silva-Briano 1993; Turner 1990; Turner & Da Silva 1992). We suggest that the rotifer fauna of the Caribbean region reflects the fauna of tropical and subtropical America. Colonization of the Caribbean region by rotifers was fostered by the age of the islands (approx. 30×10^6 years B.P.) and small distances between different islands as well as to the continent.

In this regard, the Caribbean situation differs from that of Pacific ocean islands: Segers & Dumont (1993) gave evidence of 35 species for the Galapagos and 19 for Easter Island. They stated that the 'most striking characteristic of the rotifer fauna of Easter Island is its poverty' (Segers & Dumont 1993), which might be caused by its age (3×10^6 years B.P.) the great distance to South America and the lack of sea-currents and winds reaching the island.

CONCLUSIONS

1. Focussing on monogonont rotifers the Jamaican fauna is, especially when compared with other Caribbean islands, well known.
2. Due to difficulties in identification, there is a lack of information about bdelloid rotifers, which were represented only in low species numbers in our samples.

3. The Jamaican (and Caribbean) rotifer fauna reflect that of South and Central America.
4. Further investigations with randomly chosen sampling sites all over the Caribbean and including various habitats are necessary for biogeographical research concerning the Antillean subregion of the Neotropics.

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