

## Salinity and the distribution of rotifers in the Lagos Harbour – Badagry Creek system, Nigeria

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**Key words:** Salinity, rotifer occurrence, freshwater, stenohaline, euryhaline, groups

### Abstract

The waters of Lagos Harbour have a salinity variation of 30‰, as a consequence of the annual rainfall regime and of the influx of Atlantic Ocean waters. We made monthly plankton hauls at 10 stations for 11 months starting in October 1986, and found 51 species of rotifers, with *Brachionus baylyi* Sudzuki & Timms, *Keratella hispida* Lauterborn, *Colurella obtusa* Gosse, and *Filinia pejleri* Hutchinson recorded for the first time in Nigeria. In distribution, species numbers decreased with increasing salinity. *Brachionus plicatilis*, *B. rubens*, *Hexarthra intermedia*, *Keratella americana*, *K. cochlearis* and *K. tropica* were classed as euryhaline. Stenohaline species were *Anuraeopsis fissa*, *Ascomorpha ovalis*, *Filinia longiseta*, *F. opoliensis*, *Gastropus* sp., *Lecane curvicornis* and *Monostyla stenroosi*. All other monogononts were restricted to waters of salinity below 1‰.

### Introduction

Records of rotifers from inland waters of north Nigeria were published by Bidwell & Clarke (1977), Donner & Adeniji (1977), Green (1960), Khan & Ejike (1984). Egborge (1972, 1974, 1981), Egborge & Chigbu (1988), Egborge & Tawari (1987), Imevbore (1965, 1967), and recently Segers (1992) and Segers *et al.* (1992) investigated the rotifers of freshwater bodies in east Nigeria. A survey of rotifers in north, west and east Nigeria was carried out by Jeje & Fernando (1986), while Hare & Carter (1987) provided a checklist for a small east Nigerian lake. This information is scanty, when viewed against the number of inland rivers, ponds and natural and artificial lakes in Nigeria, particularly in the coastal zone. In this zone the only records available are those of Chigbu (1987), Egborge & Tawari (1987) and Onwudinjo (1990). This communication not only

adds to the meagre knowledge of rotifers in these brackish waters, but also provides information on the salinity ranges of a number of species.

### Geography of study area and sampling stations

Lagos Harbour, Nigeria's most important seaport, is the first inlet from the Atlantic Ocean beyond the Republic of Benin. The topography and physical features of the harbour were described by Hill & Webb (1958), while Oyewo *et al.* (1982) investigated seasonal patterns in salinity and temperature. According to Egborge (1988), the 2 km wide harbour receives inland waters from the Lagos Lagoon in the east, and from Badagry Creek. This is a fresh/brackish water body originating from Lake Nokoue in the Republic of Benin and running eastwards and parallel to the Atlantic Ocean coast until it joins

Lagos Harbour at Tin Can island (Fig. 1). The dominant vegetation of the sandy coastline is *Cocos nucifera*, while more inland areas around the creek are dominated by mangrove. Seven sampling stations were selected along the stretch from Lagos Harbour (St. 1) through Tin Can Island (St. 2) along Badagry Creek to Gafara (St. 10) some 5 km to the Nigeria/Republic of Benin border. Three other stations, infested with *Eichhornia crassipes* and connected to the Harbour/Badagry Creek system were selected at Festac Creek (St. 3) and Yewa River (St. 8 and 9).

## Materials and methods

The stations were visited at monthly intervals from September 1986 to September 1987, usually starting at high tide from Lagos Harbour (Nigerian Navy, 1986, 1987). Water samples for the determination of salinity were taken just below the surface in 21 plastic jars. Rotifera were collected along with other zooplankton using a 55  $\mu$ m HydroBios plankton tow net, fixed to a twin outboard engine boat at low speed for 5 minutes. In the laboratory, salinity was deter-

mined with an MC 5 Oceanographic Salinity Bridge and confirmed by Silver Nitrate titrations according to Harvey (1969). For dilute samples, the titrimetric method only was used. Zooplankton and rotifers were sorted under a Wild M40 stereo microscope, identified and drawn under an Olympus Vanox Research microscope.

## Results

### Salinity

The salinity fluctuations were dictated partly by rainfall regime (Egborge, 1988). Records of rainfall at the Nigerian Institute of Oceanographic and Marine Research (NIOMR) located on the banks of Lagos Harbour showed little or no rainfall from November 1986 to April 1987 (Fig. 2A). During this dry season period salinity peaks were attained at the Harbour (35–39‰ in March), Tin Can Island (30–32‰ in March/May) and Ibese (35–39‰ in February, Fig. 2B). At Agaja, a progressive increase to a peak salinity of 23‰ in March was recorded, while at Epe, the waters remained fresh from October 1986 to January 1987 but became rapidly brackish between Feb-

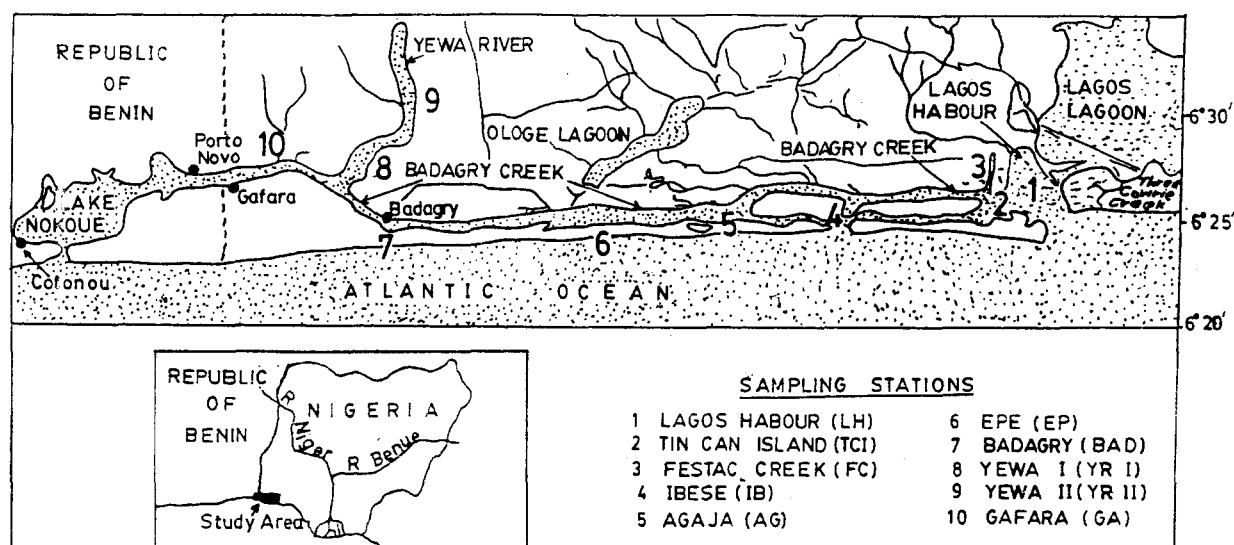


Fig. 1. Map of study area, showing the sampling stations.

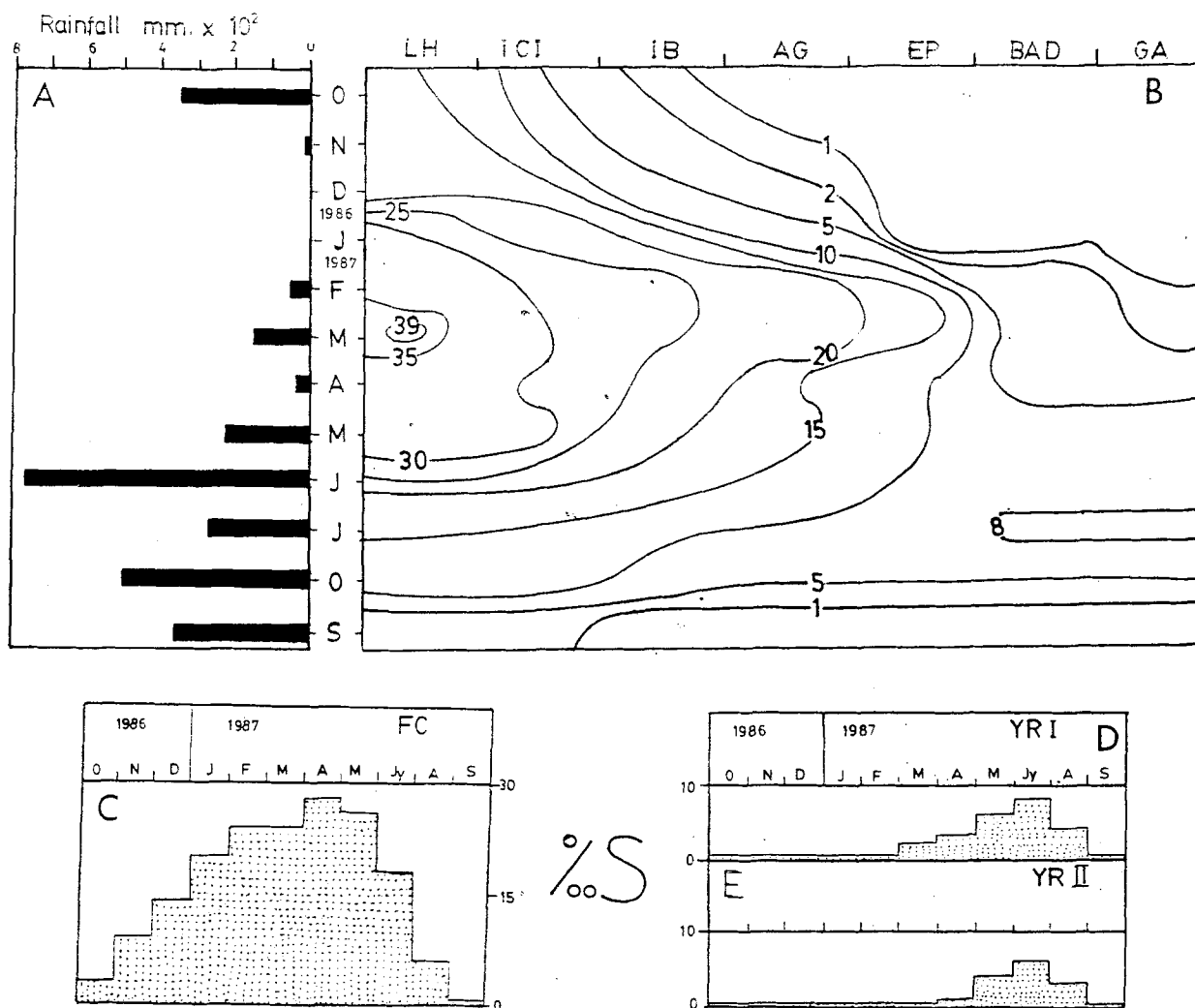


Fig. 2. A. Rainfall at Lagos Harbour, Nov. 1986– April 1987; B. Salinity variation at Lagos Harbour, same period; C. Salinity variation at Festac Creek (FC); D. Salinity variation at Badagry; E. Salinity variation at Gafara and Yewa river Station.

ruary and March 1987. Precipitation (200–750 mm) from May to September 1987 resulted in the dilution of Harbour and Badagry Creek waters up to Epe. The classical pattern of an inverse relationship between rainfall and salinity was observed at Festac Creek (See Fig. 2C). However, salinity peaks of 6–8‰ in July at Badagry, Gafara and Yewa River stations (Fig. 2B, 2D & 2E) were due to the influx of saline waters from Lake Nokoué in Benin Republic. The salinity fluctuations of Badagry Creek were therefore influenced by

precipitation and oceanic tidal fluxes of local and international origin.

### Species list

Fifty one species of rotifers were identified in the Lagos Harbour (LH), Badagry Creek (BC), Festac Creek (FC) and Yewa River (YR) system. The taxonomic list and occurrence of the species is given below.

	LH	BC	FC	YR
<b>ORDER PLOIMA</b>				
<b>Asplanchidae</b>				
<i>Asplanchna priodonta</i>	—	x	—	—
<b>Brachionidae</b>				
<i>Anuraeopsis fissa</i> (Gosse, 1850)	—	x	—	—
<i>A. navicula</i> Rousselet, 1910	—	x	—	—
<i>Brachionus angularis</i> Gosse, 1851	—	—	—	x
<i>B. baylyi</i> Sudzuki & Timms, 1977	—	—	—	x
<i>B. calyciflorus</i> Pallas, 176	—	x	x	—
<i>B. calyciflorus</i> 'f' <i>amphiceros</i> Ehrb, 1838	—	—	x	—
<i>B. caudatus</i> Barrois & Daday, 1894	—	x	—	x
<i>B. falcatus</i> Zacharias, 1898	—	x	—	x
<i>B. patulus</i> O. F. Muller, 1786	—	x	—	x
<i>B. plicatilis</i> (O. F. Muller, 1786)	x	x	x	x
<i>B. plicatilis</i> 'f' <i>longicornis</i> (Fadeew, 1925)	—	—	x	—
<i>B. quadridentatus</i> (Hermann, 1783)	—	x	—	x
<i>B. rubens</i> Ehrenberg, 1838	—	—	x	—
<i>Keratella americana</i> Carlin, 1943	—	x	—	x
<i>K. cochlearis</i> (Gosse, 1851)	—	x	x	x
<i>K. hispida</i> (Lauterborn, 1900)	—	x	—	x
<i>K. tropica</i> (Apstein, 1907)	—	x	—	x
<i>Keratella</i> sp.	—	—	—	x
<i>Platyias quadricornis</i> (Ehrenberg, 1832)	—	x	—	—
<b>Colurellidae</b>				
<i>Colurella obtusa</i> (Gosse, 1886)	—	x	—	—
<b>Euchlanidae</b>				
<i>Manfredium eudactylosum</i> (Gosse, 1886)	—	x	—	—
<i>Dipleuchlanis propatula</i> (Gosse, 1886)	—	x	—	—
<i>Euchlanis dilatata</i> Ehrenberg, 1832	—	—	x	—
<b>Gastropodidae</b>				
<i>Ascomorpha ovalis</i> (Bergendal, 1892)	—	x	x	x
<i>Gastropus hyptopus</i> (Ehrenberg, 1838)	—	x	x	—
<i>G. stylifer</i> Imhof, 1891	—	x	—	x
<b>Lecanidae</b>				
<i>L. curvicornis</i> (Murray, 1913)	—	x	x	—
<i>Lecane lunaris</i> (Ehrenberg, 1832)	—	x	—	x
<i>Monostyla bulla</i> (Gosse, 1886)	—	x	x	x
<i>M. decipiens</i> (Murray, 1913)	—	—	—	x
<i>M. quadridentata</i> (Ehrenberg, 1832)	—	x	—	—
<i>M. stenroosi</i> (Meissner, 1908)	—	—	x	—
<b>Mytilinidae</b>				
<i>Mytilina bisulcata</i> (Lucks, 1972)	—	—	—	x
<b>Notommatidae</b>				
<i>Cephalodella gibba</i> (Ehrenberg, 1838)	—	—	—	x
<b>Synchaetidae</b>				
<i>Polyarthra remata</i> Skorikor, 1896	—	x	—	—
<b>Trichocercidae</b>				

(Continued)

	LH	BC	FC	YR
<i>Trichocerca chattoni</i> (de Beauchamp, 1907)	—	x	—	—
<i>T. cylindrica</i> (Imhof, 1891)	—	—	—	x
<i>T. heterodactyla</i> (Tschugunoff, 1921)	—	x	—	—
<i>T. inermis</i> (Liuder, 1904)	—	—	—	x
<i>T. mus</i> Hauer, 1937/38	—	—	—	x
<i>T. rattus</i> (O. F. Muller, 1776)	—	—	—	x
<i>T. similis</i> (Wierzejski, 1893)	—	x	—	x
<b>ORDER MONIMOTROCHA</b>				
<b>Filinidae</b>				
<i>Filinia longiseta</i> (Ehrenberg, 1834)	—	x	x	x
<i>F. opoliensis</i> (Zacharias, 1898)	—	x	—	x
<i>F. pejeri</i> Hutchinson, 1964	—	—	—	x
<i>F. terminalis</i> (Plate, 1886)				
<b>Hexarthridae</b>				
<i>Hexarthra intermedia</i> Wiszniewski, 1929	—	x	—	x
<i>H. intermedia braziliensis</i> (Hauer, 1953)	—	—	—	x
<b>Testudinellidae</b>				
<i>Testudinella patina</i> (Hermann, 1783)	—	—	—	x
<b>ORDER BDELLOIDEA</b>				
<i>Rotaria rotatoria</i> (Pallas, 1766)	—	—	x	x
<i>R. neptunia</i> (Ehrenberg, 1832)	—	—	x	
<i>Philodina</i> sp.	—	—	x	x

## Distribution

Rotifers in the Lagos Harbour – Badagry Creek system fall into three groups. *Brachionus plicatilis* and *B. rubens*, found at salinity ranges of 0.27‰–32‰ are euryhaline. *B. plicatilis* was found in virtually all stations sampled, but *B. rubens* was restricted to Festac Creek samples of November 1986–April 1987, at salinities 8‰–28‰. (Fig. 3). *Keratella americana*, *K. cochlearis* and *K. tropica* occurred most often in Badagry Creek and Yewa River waters of low salinity (<1‰) but in February 1987, *K. americana* and *K. cochlearis* were found at Ibese (‰S = 26) and Agaja (‰S = 23), respectively, while *K. tropica* occurred at Epe in April 1987 (‰S = 16). The three species of *Keratella* are apparently euryhaline. Tolerance of a wide salinity range was also exhibited by *Hexar-*

*thra intermedia*, common in Badagry Creek and Yewa River waters from October 1986 to January/March 1987 (<1‰S), but also present at Tin Can Island in December 1986 when salinity was 18.7‰. *Lecane curvicornis* was rare in the system (Fig. 4). It first appeared in Festac Creek in July 1987 (‰S > 17) and again in Gafara in September when freshwater prevailed. Other well-known freshwater rotifers which were recorded once at medium salinities were *Anuraeopsis fissa* (Epe in April 1987 ‰S = 8.8), and *Mono-styla stenroosi* (Festac Creek in November 1986, ‰S = 9.5).

In the Lagos Harbour – Badagry Creek system, stenohaline species were few. *Ascomorpha ovalis* and *Gastropus* sp. were restricted to freshwaters of Yewa River in January (‰S = 0.42) and April (‰S = 2.9) 1987 and waters at Festac Creek

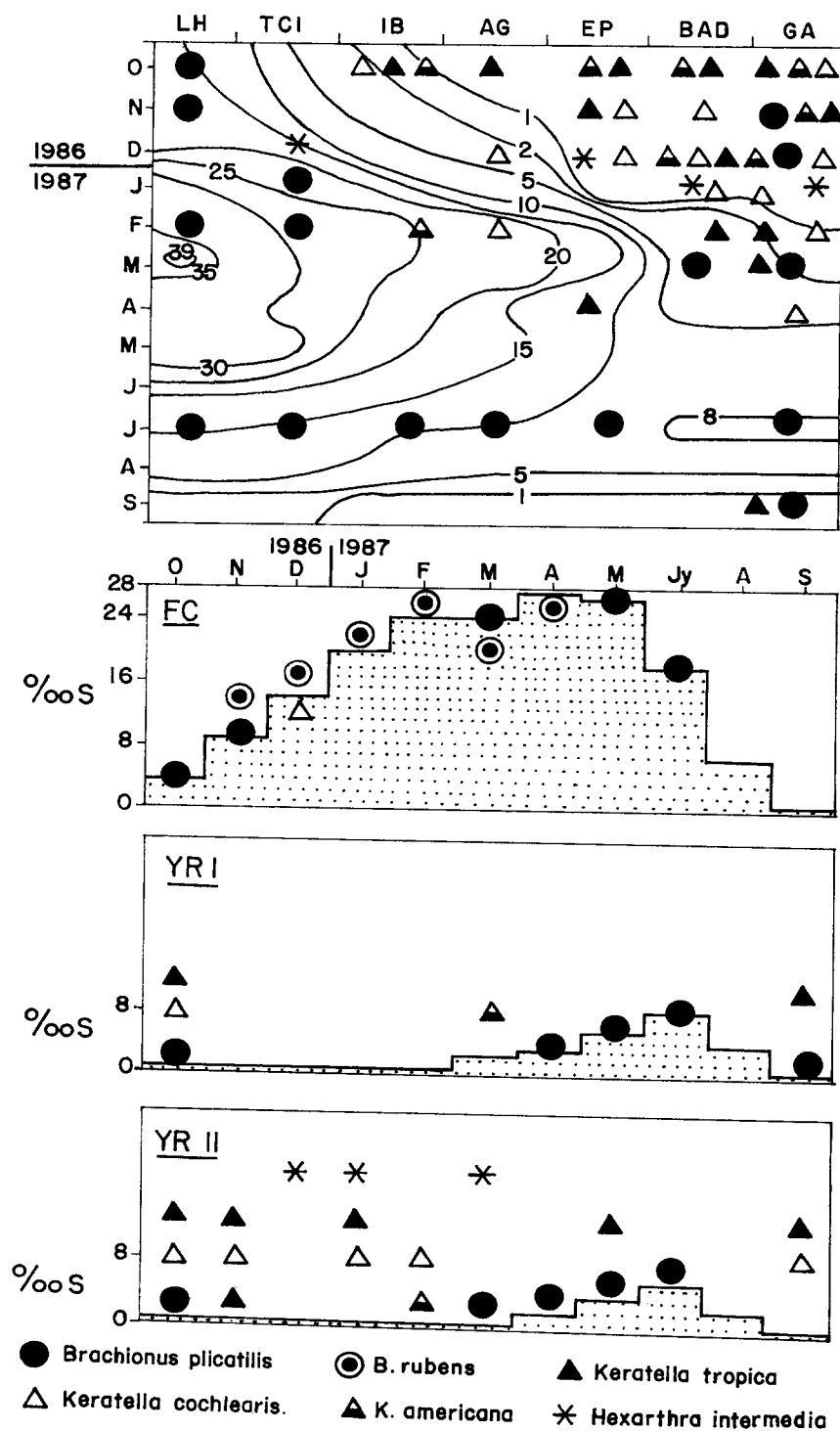


Fig. 3. Relationship between the distribution of selected rotifers and salinity at different stations (main channel), and at FC, YRI and YRII (Festac Creek and Yewa River I & II).

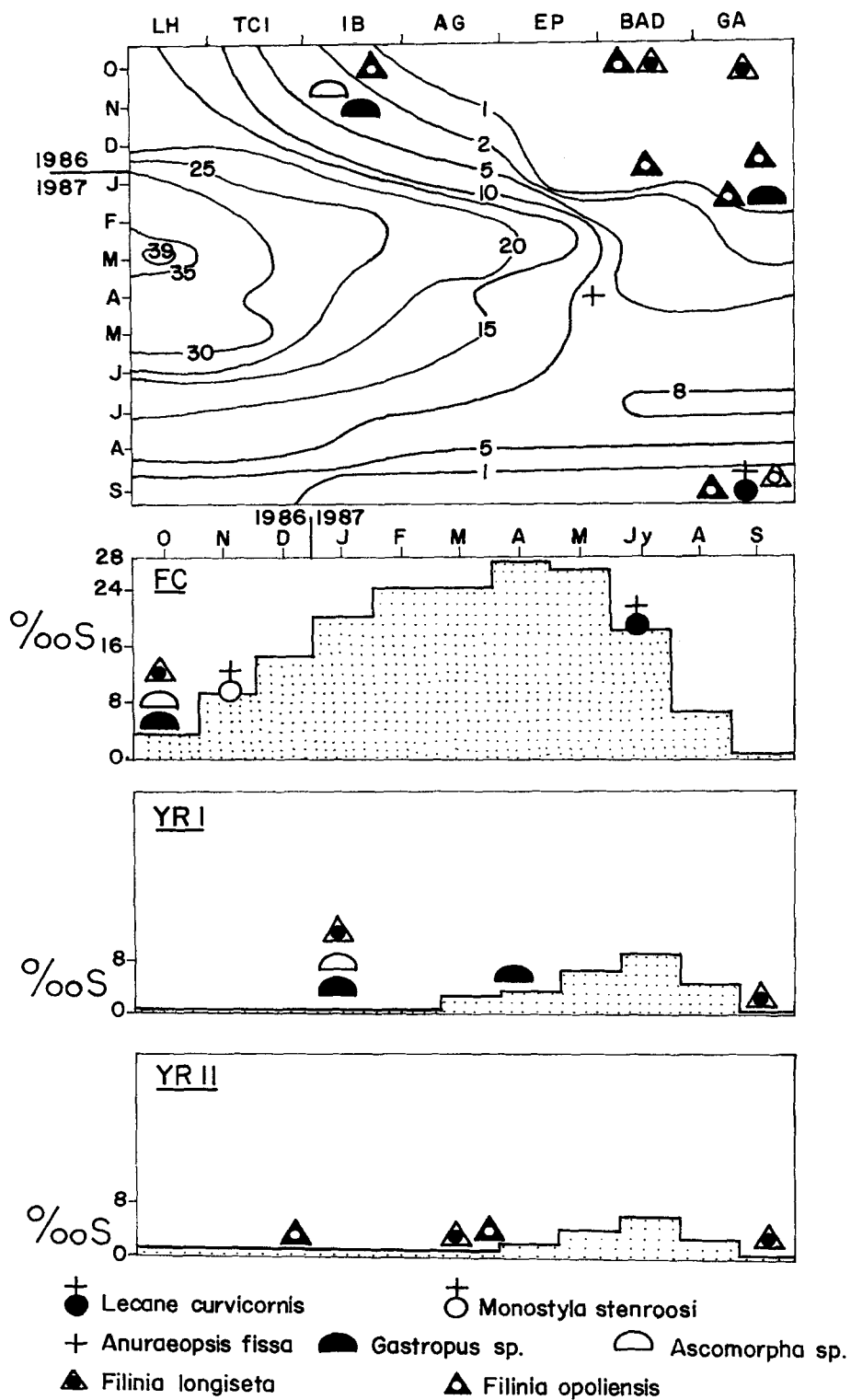


Fig. 4. Relationship between the distribution of selected rotifers and salinity (continuation of Fig. 3).

Table 1. Salinity and the distribution of species.

System	Mean salinity ‰	Number of species
Lagos Harbour	24.71	01
Festac Creek	15.01	13
Badagry Creek	9.67	30
TCI	18.28	02
IB	15.54	09
AG	13.56	04
EP	6.64	06
BAD	3.24	08
GA	2.80	26
Yewa River	1.89	34
YR I	2.39	17
YR II	1.40	30

and Ibese in October (‰S = 3.10) and November 1987. Both *Filinia longiseta* and *F. opoliensis* displayed an ability to tolerate small changes in salinity, having been found in Badagry Creek waters at Badagry and Gafara and in samples from Yewa River when freshwater salinities prevailed here (Fig. 4). However, they were also found in October in Festac Creek and Badagry Creek at Ibese.

## Discussion

The rotifer fauna of Nigeria consists of about 190 species (Egborge, 1972, 1974, 1981; Egborge & Chigbu, 1988; Egborge & Sagay, 1979; Egborge & Tawari, 1987; Green, 1960; Hare & Carter, 1987; Imevbore, 1965, 1967; Jeje & Fernando, 1986; Khan & Ejike, 1984; Onwudinjo, 1990). About 30% of these are here recorded from the brackish waters of Lagos Harbour – Badagry Creek. Four species, *Brachionus baylyi*, *Colurella obtusa*, *Filinia pejleri*, and *Keratella hispida* are first records for Nigeria. Species numbers (decreased with salinity Table 1). This is true within the same creek (e.g. Badagry), or a whole river (e.g. Yewa I & II). Chigbu (1987) observed this same relationship in the Forcados River, Odube Creek and Warri River coastal system. Here, as in the Lagos Harbour – Badagry Creek system, *Brachionus plicatilis* was ubiquitous and occurred between 0.27‰ and 32‰S. In Australia and North America, *B. plicatilis* even occurs at salinities between 0.4‰ and 50‰ (Galat *et al.*, 1981; Timms, 1981; Williams, 1987). Mass culture experiments at relatively low temperatures by Schluter (1980) revealed that *Brachionus rubens* dies in solutions of NaCl above 4 g l<sup>-1</sup>. Its occurrence at Festac

Table 2. Sonrensons Index of Similarity for rotifer species in the water bodies and stations of Badagry Creek.

Water body/station	Lagos Harbour	Festac Creek	Badagry Creek	Yewa River
Lagos Harbour	–			
Festac Creek	14.28	–		
Badagry Creek	6.45	46.51	–	
Yewa River	5.88	21.27	50*	–

Badagry Creek stations	TCI	IB	AG	EP	BAD	GAF
TCI	–					
IB	18.18	–				
AG	33.33	61.54	–			
EP	50.00*	66.66*	80.00*	–		
BAD	40.00	58.82*	50.00*	71.43*	–	
GAF	14.29	34.28	26.66	43.75	47.06	–

\* Significant.



Creek at 8–28‰S and 25 °C–33 °C thus supports the statement of Timms (1981), that factors other than salinity influence the distribution of rotifers. *B. rubens* was restricted to Festac Creek, a polluted water body with much organic matter, nitrate, and high phosphorus levels. Other species found in the brackish waters of Lagos Harbour – Badagry Creek system were *Keratella americana intermedia* (0.27‰–26‰), *K. cochlearis* (0.27‰–23‰), *Hexarthra intermedia* (0.27‰–19‰), *Lecane curvicornis* (0.27‰–17‰), *Keratella tropica* (0.27‰–10‰) and *Anuraeopsis fissa* (0.27‰–9‰). Chigbu (1987) recorded *Keratella cochlearis* and *K. tropica* at salinities of 15‰ in Forcados Estuary, while *Monostyla stenroosi* occurred in Warri River at salinities of 0.15–3‰. At a global level, more species of *Brachionus* (*caudatus*, *novae-zelandiae*, *plicatilis*, *pterodinoideus* and *quadridentatus*), *Hexarthra* (*fennica* and *jenkinae*) and *Keratella* (*cruciformis*, *eichwaldi*, *kamschatica* and *wirketissi*) are found in saline waters than in any other genus or family (de Ridder, 1981; Galat *et al.*, 1981; Walker, 1981; Williams, 1978).

The seasonal fluctuations of rotifer species and their numbers in these coastal brackish waters are different from patterns in inland rivers, lakes and ponds (Egborge, 1972, 1981; Green, 1960; Imevbore, 1965). In the Lagos Harbour – Badagry Creek system, rotifers were generally more abundant during floods, when salinities were lowest.

Spasmodic appearances and short – term multi-species successions also characterised the Lagos Harbour – Badagry Creek system. Different communities occupy the channels of Lagos Harbour, Festac Creek, Badagry Creek and Yewa River (Table 2). Within Badagry Creek, salinity probably account for the dissimilarity in the community of rotifers in the mouth (TCI), middle (IB–BAD) and upper reaches (GAF). Influx of saline waters of Atlantic Ocean origin from Benin Republic into the upper reaches of Badagry Creek at peak flooding results in salinity stratifications, and thereby creates the different rotifer communities in the four water bodies.

## Acknowledgements

Funds for the investigations were provided by the Federal Ministry of Science and Technology under the water hyacinth Scheme. I thank the former Minister, Adviser and the present Director General Professors E. J. Emovon, Awele Ma-duemezia and E. Okon, respectively.

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