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Rotifers from some tropical flood-plain lakes of Assam (N.E. India)

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Abstract: Sixty-four species of Rotifers, belonging to 15 families and 26 genera, are recorded from five flood-plain lakes of the Brahmaputra river basin, Upper Assam (N.E. India). The examined taxocoenosis depicted general tropical character and indicated various biogeographically interesting, acidophilic and warm-stenothermal elements. The rotifer communities of the different lakes registered 37.3 - 68.9% similarities and their individual species richness ranged between 24 - 35 species.

Resumen: Sesenta y cuatro especies de rotíferos, pertenecientes a 15 familias y 26 géneros, fueron registrados en cinco lagos de planicie de inundación en la cuenca del río Brahmaputra, Alto Assam (NE de la India). La taxocenosis examinada mostró en general un carácter tropical e indicó la presencia de varios elementos acidofilicos, cálido-estenotérmicos, interesantes desde una perspectiva biogeográfica. Las communidades de rotíferos de los diferentes lagos mostraron similitudes de entre 37.3 y 68.9%, y sus riquezas específicas individuales variaron entre 24 y 35 especies.

Resumo: Sessenta e quatro espécies de Rotíferos, pertencendo a 15 familias e 26 géneros, foram registadas em cinco lagos de alagamento na bacia do rio Brahmaputra na zona alta de Assam (N.E. Índia). O exame taxonómico reflectiu o carácter tropical geral e mostrou vários elementos acidófilos e estenotermais quentes biogeograficamente interessantes. A communidade de rotíferos dos diferentes lagos registaram 37,3 – 68,9% de semelhança e a sua riqueza individual específica variou entre as 24 – 35 espécies.

Key words: Biodiversity, ecology, flood-plain lakes, rotifers, Upper Assam.

Introduction

Rotifers have been studied from a wide range of freshwater biotopes of India since more than one century but so far little is known about their biodiversity in the flood-plain lakes of this country (Sharma 1996) in general and North-Eastern region in particular. The flood-plain lakes, locally called as 'beels', comprise about 81% of total lentic area of the Assam state (Dey 1981). However, information about their rotifer communities is restricted only to few unpublished reports (Goswami 1985; Goswami 1997; Lahon 1983; Yadav 1987) from lower Assam. The present study deals with qualitative diversity of Rotifera in five flood-plain lakes of upper Assam. Comments are made on general nature and composition of the examined fauna and on distribution and ecology of various taxa. In addition, remarks are made on species richness and percentage similarities of the rotifer communities in the different lakes.

Materials and methods

The observations were undertaken in five flood-plain lakes, namely, Balak, Dhekia, Senijan, Naruathan and Samuajan beels located in the Dhemaji district (Long. 94° 56 E; Lat. 26° 75 N) in the upper region of the Brahmaputra valley of As-

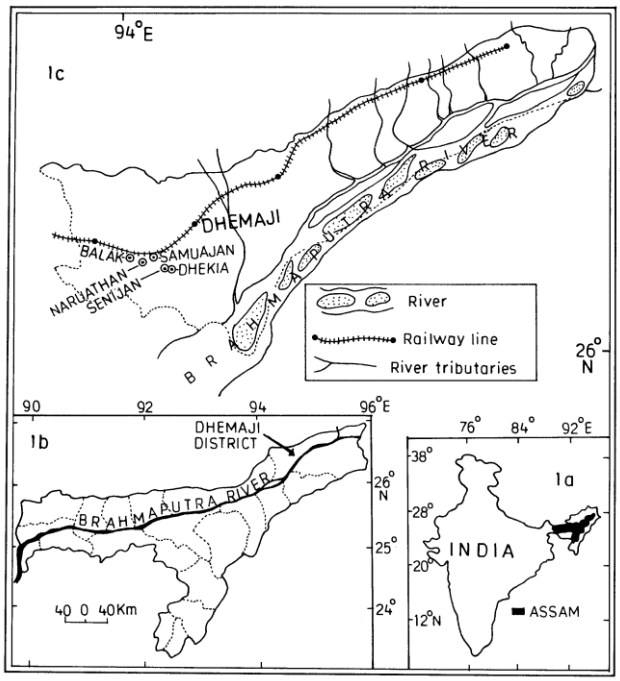

Fig. 1. (a) Map of India indicating Assam State; **(b)**. Map of Assam State indicating Dhemaji district; **(c)** Map of Dhemaji district (enlarged) indicating the sampled five flood-plain lakes.

sam State (Figs. 1 a-c). The first four beels covered an area between 6-11 ha and Samuajan beel had an area of 54 ha, while their depths ranged between 0.8-4 m. All these beels exhibited growth of *Eichhornia crassipes, Lemna major, L. minor, Hydrilla verticellata, Vallisnaria* sp., *Potamogeton natans* and *Nymphaea stellata*. Water samples, collected from the stated beels during summer (May 1994), monsoon (July 1994), post-monsoon (October 1994) and winter (January 1995) seasons, were examined for water temperature, specific conductivity, pH, dissolved oxygen and total alkalinity. Qualitative plankton samples were collected simultaneously by towing a nylobolt plankton net (no. 25) and were preserved in 5% formalin. Various rotifer taxa were isolated, mounted in Polyvinyl alcohol-lectophenol mixture and identified following Koste (1978), Sharma (1983), Sharma & Sharma (1987) and Segers (1995). Percentage similarities between the rotifer communities were calculated vide Sorensen index.

Results and discussion

Abiotic factors of the sampled beels (Table 1) exhibited tropical range of water temperature (17-33°C), acidic to slightly alkaline nature (pH 5.5-7.2) of water and their dissolved oxygen concentration ranged between 3.2-8.8 mg l^{-1}. They, however, differed notably in their specific conductivity values - Samuajan (143.0 31.0 S cm^{-1}) > Naruathan (117.0 33.0 S cm^{-1}) > Dhekia (115.0 19.0 S cm^{-1}) > Senijan (43.5 4.5 S cm^{-1}) >Balak beel (16.5 4.5 S cm^{-1}) can thus be assigned to 'Class I' category (Talling & Talling 1965). Of these, Balak beel is characterized by very low ionic concentration; the rest compared broadly with other beels from Assam (Dey 1981; Dey & Kar 1987; Goswami 1985; Lahon 1983; Yadava & Dey 1990) but their conductivity values are distinctly lower than the flood-plain lakes from Kashmir valley (Khan 1987) and West Bengal (Vass 1989). Total alkalinity, exclusively attributed to bicarbonate ions, depicted 'very-soft' and 'soft' character (Moyle 1946) of Balak beel (6-14 mg l^{-1}) and Senijan beel (28-40 mg l^{-1}), respectively; the former, however, corresponded with the lowest total alkalinity so far reported from India (Sharma 1995). Dhekia (56-76 mg l^{-1}), Naruathan (50-76 mg l^{-1}) and Samuajan beels (40-90 mg l^{-1}) indicated 'hard-water' character with nearly identical mean alkalinity values.

The rotifer communities of the five flood-plain lakes revealed in all sixty four species (Table 2) and, hence, comprised about one-fifth of the known species of Indian Rotifera (Sharma 1996). Out of 25 families and 63 genera of Eurotatoria so far known from India, 15 families and 26 genera are recorded presently. This study, therefore, showed fairly rich and diversified rotifer taxocoenosis. In addition, overall species richness in the beels from upper Assam presented a distinct contrast to only 29 species listed recently (Goswami 1997) from six beels of lower Assam as well as other unpublished reports from the Brahmaputra basin (Goswami 1985; Lahon 1983; Yadava 1987).

This study indicated several examples of biogeographical interest. Of these, the Australasian *Brachionus dichotomus reductus* Koste & Shiel is an interesting addition to the Indian Rotifera; this brachionid was described (Shiel & Koste 1983) from Australia and has since been reported only from Thailand (Sanoamuang *et al.* 1995). Besides, *Ascomorpha ovalis* Bergendal, *Pleosoma lenticulare* Herrick and *Mytilina acanthophora* Hauer are important new reports from North-Eastern India. The first two species have recently been reported from the river Narmada, Central India (Sharma & Naik 1996) while *M. acanthophora* is known to

Table 1. Seasonal variations in some abiotic factors in the different flood-plain lakes.

Seasons	Summer (April 1994)	Monsoon (July 1994)	Post monsoon (October 1994)	Winter (January 1995)
Balak beel				
Water temp. (°C)	24.0	31.0	28.0	20.0
pH	6.2	5.5	5.5	6.0
Conductivity (S cm^{-1})	17	21	18	12
Dissolved oxygen (mg l^{-1})	4.0	4.8	5.6	8.0
Total alkalinity (mg l^{-1})	14	10	14	6
Senijan beel				
Water temp. (°C)	24.0	31.0	29.0	19.0
pH	6.5	6.2	6.5	5.5
Conductivity (S cm^{-1})	47	39	40	48
Dissolved oxygen (mg l^{-1})	3.2	3.2	5.6	4.8
Total alkalinity (mg l^{-1})	28	30	30	40
Dhekia beel				
Water temp. (°C)	23.5	33.0	26.0	20.5
pH	6.6	5.5	6.5	7.2
Conductivity (S cm^{-1})	102	101	134	96
Dissolved oxygen (mg l^{-1})	4.8	4.0	4.0	8.8
Total alkalinity (mg l^{-1})	56	60	76	62
Naruathan beel				
Water temp. (°C)	26.0	33.0	30.0	21.0
pH	7.2	6.5	5.5	6.5
Conductivity (S cm^{-1})	150	99	123	84
Dissolved oxygen (mg l^{-1})	4.8	4.8	5.6	8.0
Total alkalinity (mg l^{-1})	70	62	72	56
Samuajan beel				
Water temp. (°C)	23.0	31.0	27.0	17.0
pH	6.2	6.5	6.5	7.2
Conductivity (S cm^{-1})	174	112	142	120
Dissolved oxygen (mg l^{-1})	7.2	4.8	7.2	8.0
Total alkalinity (mg l^{-1})	90	56	40	70

exhibit disjunct distribution in this country and has so far been reported from West Bengal, Orissa and Panjab. In addition, *Testudinella tridentata* (Smirnov) and *Ascomorpha saltans* Bartsch exhibited regional importance and are reported only from Meghalaya while *Brachionus mirabilis* (Daday), *Lepadella cristata* Rousselet, *Lecane pertica* Harring & Myers, *L. furcata* (Murray) and *Testudinella parva* Ternetz are examples of local distributional interest in India. On the other hand, cosmopolitan elements (48 species) comprised dominant fraction of the documented species and pantropical species (10 species) are also well represented in this account.

Lecanidae (17 species) and Brachionidae (13 species), together, comprised a notable component (46.9%) of overall rotifer biodiversity as well as of the taxocoenosis of individual beels (40.6-66.7%). The genus *Lecane* alone accounted for 26.9% of total species richness and, hence, broadly corresponded with its contribution (28.5%) in tropical flood-plain lakes of the river Niger, Africa (Segers *et al.* 1993). Qualitative importance of two 'tropic-centred' genera i.e., *Lecane* and *Brachionus* imparted a general tropical character to the studied fauna; such a generalization is in conformity with the reports by Green (1972), Pejler (1977), Fernando (1980), Dumont (1983), Dussart *et al.* (1984), Sharma (1987, 1991, 1996), Sharma & Naik (1996) and Segers (1996). This aspect is further supported by fewer species of 'temperate-centred' genera namely *Keratella* (2 species) and *Synchaeta* (1 species).

Acidic waters of the sampled flood-plain lakes are characterized by various acidophilic species namely, *Brachionus mirabilis, Euchlanis triquetra, Lepadella cristata, Lecane pertica, Testudinella tridentata* and *T. parva.* Such an affinity is in con-

Table 2. Species composition of Rotifera in different flood-plain lakes.

Beels	Balak	Senijan	Dhekia	Naruathan	Samuajan
Family: Brachionidae					
Anuraeopsis fissa (Gosse)	-	-	-	-	+
Brachionus angularis Gosse	-	-	+	+	+
B. diversicornis (Daday)	-	-	-	+	-
B. falcatus Zacharias	-	-	-	-	+
B. forficula Wierzejski	-	-	-	+	-
B. dichotomus reductus Koste & Shiel	+	-	-	-	-
B. mirabilis (Daday)	-	-	-	+	-
B. patulus (Müller)	+	+	+	+	+
B. plicatilis (Müller)	-	-	-	-	+
B. quadridentatus Hermann	+	+	+	+	+
Platyias quadricornis (Ehrenberg)	+	+	+	+	+
Keratella cochlearis (Gosse)	+	-	+	+	-
K. tropica (Apstein)	+	-	+	+	+
Family: Euchlanidae					
Euchlanis dilatata Ehrenberg	+	+	+	+	+
E. triquetra Ehrenberg	+	-	-	-	-
Dipleuchlanis propatula (Gosse)	+	+	-	+	+
Family: Mytilindiae					
Mytilina acanthophora Hauer	-	+	-	-	-
M. ventralis (Ehrenberg)	+	-	+	+	+
Family: Trichotridae					
Macrochaetus sericus (Thorpe)	+	-	-	-	-
Trichotria tetractis (Ehrenberg)	+	+	+	+	-
Family: Colurellidae					
Lepadella patella (Müller)	-	+	-	+	+
L. ehrenbergi (Perty)	+	-	-	-	-
L. cristata (Rousselet)	+	-	-	-	-
Family: Lecanidae					
Lecane curvicornis (Murray)	+	+	+	+	-
L. hastata (Murray)	-	-	-	-	+
L. leontina (Turner)	+	+	+	+	+
L. luna (Müller)	-	-	+	+	-
L. pertica Harring & Myers	+	-	-	-	-
L. papuana (Murray)	+	+	+	+	-
L. ploenensis (Voigt)	+	-	+	+	+
L. ludwigi (Eckstein)	+	-	+	-	-
L. ungulata (Gosse)	+	+	+	+	+
L. (Monostyla) bulla (Gosse)	+	+	+	+	+
L. (M.) lunaris (Ehrenberg)	+	-	-	-	-
L. (M.) hamata (Stokes)	+	+	-	+	-
L. (M.) furcata (Murray)	-	+	-	+	-
L. (M.) closterocerca (Schmarda)	-	+	-	-	-
L. (M.) quadridentata (Ehrenberg)	-	+	+	+	-
L. (M.) stenroosi (Meissner)	-	+	-	-	-
L. (M.) unguitata (Fadeev)	-	+	+	+	-
Family: Notommatidae					
Scaridium longicaudum (Müller)	+	-	-	-	-
Cephalodela sp.	+	-	-	-	+
Monommata sp.	+	+	-	-	+
Family: Gastropodidae					
Ascomorpha saltans Bartsch	+	-	-	-	-
A. ovalis (Bergendal)	-	-	-	-	+

Table 2. *(Contd.)*

Beels	Balak	Senijan	Dhekia	Naruathan	Samuajan
Family: Trichocercidae					
Trichocerca cylindrica (Imhof)	+	-	-	-	+
T. elongata (Gosse)	-	-	-	-	+
T. porcellus (Gosse)	-	-	-	-	+
T. rattus (Müller)	-	+	-	-	-
Family: Asplanchnidae					
Asplanchna priodonta Gosse	-	+	+	+	+
Family: Synchaetidae					
Polyarthra vulgaris Carlin	+	+	+	+	+
Synchaeta oblonga Ehrenberg	-	-	+	-	+
Pleosoma lenticulare (Herrick)	+	-	+	-	+
Family: Hexarthridae					
Hexarthra mira (Hudson)	+	-	+	-	-
Family: Testudinellidae					
Testudinella patina (Hermann)	+	+	+	+	+
T. parva (Ternetz)	+	-	+	-	-
T. tridentata (Smirnov)	+	-	-	-	-
Family: Filiniidae					
Filinia longiseta (Ehrenberg)	-	-	-	+	-
F. terminalis (Plate)	-	-	+	-	-
F. opoliensis Zacharias	-	-	-	-	+
Pompholyx sulcata Hudson	-	-	+	+	-
Family: Philodinidae					
Philodina roseola Ehrenberg	-	-	-	-	+
Rotaria rotatoria Pallas	-	-	-	-	+
R. neptunia (Ehrenberg)	-	-	-	-	+
Total No. of Species	35	24	28	30	32

- = absent, + = present

formity with earlier reports from India (Sharma 1996). The paucity of *Brachionus* spp., yet another notable feature of this study, can also be attributed to acidic nature of these ecosystems and thus agreed with the remarks by Fernando & Zankai (1981) and Sharma (1983). *Anuraeopsis fissa, Brachionus forficula, Dipleuchlanis propatula, Lecane ludwigi* and *L. stenroosi* occurred only during warmer months and, hence, the present observations reaffirmed their warm-stenothermal nature (Koste 1978).

The analyzed rotifer communities registered qualitative abundance of littoral or periphytic elements (49 species; 76.6%) but indicated fewer planktonic taxa (15 species; 23.4%). This feature is attributed to lack of definite pelagic habitats (De Manuel 1994) in the sampled biotopes, their shallow nature and growth of various aquatic macrophytes. Further, the monogononts (61 species) predominated the documented taxa; while the digononts (3 species) are poorly represented. Interestingly, 26 species appeared to be restricted to individual beels and only nine species i.e., *Brachionus patulus, B. quadridentatus, Platyias quadricornis, Euchlanis dilatata, Lecane leontina, L. ungulata, L. bulla, Polyarthra vulgaris* and *Testudinella patina* occurred in all the beels.

The rotifers comprised dominant qualitative component of Zooplankton in all the beels and, therefore, agreed with earlier reports from the flood-plain lakes of Assam (Goswami 1985, 1997; Lahon 1983; Yadav 1987) and elsewhere in India (Khan 1987; Sanjer & Sharma 1995; Yousuf *et al.* 1986). Balak (35 species) > Samuajan (32 species) > Naruathan (30 species) > Dhekia (28 species) > Senijan (24 species) indicated the stated order of species richness (Table 2) and showed 19, 12, 14, 15 and 13 genera respectively. Very soft-acidic waters of Balak beel reflected maximum generic

Table 3. Seasonal variations in species richness of Rotifera in different flood-plain lakes.

Flood-plain lakes	Summer	Monsoon	Post-monsoon	Winter
Balak	20	13	13	17
Senijan	11	9	16	13
Dhekia	18	14	16	15
Naruathan	13	18	12	7
Samuajan	14	20	12	11

and species diversity but no other generalization is possible relating to the rest of the beels. Further, various flood-plain lakes depicted certain seasonal variations (Table 3) in their qualitative rotifer diversity but did not register any definite pattern. Dhekia and Balak beels indicated maximum number of species during summer, Naruathan and Samuajan beels recorded greater species richness during monsoon while Senijan beel showed such a feature in post-monsoon season.

Overall species richness in the flood-plain lakes from upper Assam exhibited low community similarities with their counterparts from lower Assam i.e., 39.6% (Goswami 1985) and 32.4% (Goswami 1997). Comparison with other Indian reports is not possible because of incomplete or uncertain species inventories. Further, the rotifer faunas of individual beels registered between 37.3 - 68.9% community - similarities (Table 4). Lowest similarity value noticed between Balak and Senijan beels is due to distinct differences in species composition in general and the brachionid diversity in particular. Samuajan registered relatively lower community - similarity (44.4 - 51.7%) with all other beels of upper Assam; it is attributed to the fact that all three species of the bdelloids and eight other monogonont species are exclusively confined to this beel. Besides, the rotifer faunas of individual beels recorded seasonal variations in their community - similarities (Table 5) i.e., Dhekia (52.9 - 77.4%), Senijan (48.0 - 62.1%), Naruathan (24.0 - 60.0%), Balak (26.5 - 48.5%) and Samuajan (17.4 - 56.2%)

Table 4. Percentage similarities (vide Sorensen index) between rotifer communities in different flood-plain lakes.

	Balak	Senijan	Dhekia	Naruathan	Samuajan
Balak	-	37.3	60.3	49.2	46.1
Senijan		-	57.7	64.8	44.4
Dhekia			-	68.9	48.3
Naruathan				-	51.7
Samuajan					-

Table 5. Seasonal variations in percentage similarities between rotifer communities in individual flood-plain lakes.

Seasons->	Summer	Monsoon	Post-monsoon	Winter
Balak beel				
Summer	-	48.5	36.4	48.5
Monsoon		-	38.5	26.5
Post-monsoon			-	40.0
Senijan beel				
Summer	-	50.0	59.3	58.3
Monsoon		-	48.0	45.4
Post-monsoon			-	62.1
Dhekia beel				
Summer	-	56.2	52.9	64.5
Monsoon		-	73.3	62.1
Post-monsoon			-	77.4
Naruathan beel				
Summer	-	25.8	24.0	40.0
Monsoon		-	60.0	24.0
Post-monsoon			-	42.1
Samuajan beel				
Summer	-	52.9	23.1	24.0
Monsoon		-	56.2	38.7
Post-monsoon			-	17.4

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