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Rotifers from some tropical ponds in Bihar: species composition, similarities and trophic indicators

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Abstract

The rotifer communities of five fish ponds in Darbhanga City, North Bihar, contain 53 species (57 species and subspecies) belonging to 22 genera and 16 families and reflect a broadly tropical character. *Filinia longiseta saltator, Mytilina ventralis macracantha, Trichocerca bicristata* and *T rattus carinata* represent new records from India. Comments are made on species composition and similarities of the rotifer faunas of different ponds, their trophic status and on the distribution of various documented taxa. Some specimens of *Brachionus falcatus* infected by a microsporid, *Bertramia asperospora*, are also examined and these comprise the first report of parasitism of the rotifers from this country.

Key words: Rotifers, fish ponds, composition, similarities, distribution, bio-indicators, parasitism.

1. Introduction

Rotifers comprise an important component of lentic freshwater zooplanktonic communities, forming an integral link in food chain and significantly contributing to zooplankton dynamics and secondary production. Rotifers can also be used as indicators of water quality[1].

Although investigations on Indian Rotifera started about a century ago[2], few studies have so far been conducted on their distribution[3–5] and ecology[6–9] in Bihar State. This paper describes the species composition of the rotifer communities in five tropical fish ponds in Darbhanga City and compares their faunistic similarities. Comments are made on the distribution of some of the taxa examined and on the trophic status of various ponds applying Sladecek's $Q_{B/T}$ quotient. Some specimens of a planktonic brachionid infected by a microsporid are also examined.

2. Material and methods

Plankton samples were obtained monthly during March, 1985–February, 1986 and in

April, September and December, 1987 from five tropical fish ponds in Darbhanga City (26° 10'N; 85° 57'E), *i.e.*, Tinkonia pond, Mithila University pond, Nargauna pond, Raj Dighi and Harahi pond. Some features of water chemistry and aquatic vegetation of these ponds were described by Dudani *et al*[10]. The first two ponds contained *Ceratophyllum demersum, Euryale ferox, Eichhornia crassipes, Hydrilla verticillata* and *Potamogeton crispus* and Nargauna pond contained only *Vallisnaria spiralis*. Harahi pond displayed permanent occurrence and abundance of *Microcystis* throughout this study period and was exclusively fed by sewage from adjoining densely populated areas while Raj Dighi also received some domestic refuse and sewage run-off. All the sampled ponds were used as fish ponds but in Tinkonia pond, Makhana *(Euryale ferox)* and fish were cultivated together.

Qualitative plankton samples were collected by towing a plankton net in individual ponds and preserved in 5% formalin. Various collections were screened with a Wild stereoscopic binocular microscope. Individual specimens were mounted in polyvinyl alcohol lectophenol mixture and were examined using a Leitz–Dialux phase-contrast microscope. Different taxa (species and subspecies) were identified following the works of Voigt[11], Edmondson[12], Kutikova[13], Ruttner–Kolisko[14], and Koste[15]. The system of classification used in this text follows Koste[15]. The examined reference specimens were deposited in the Department of Zoology, North-Eastern Hill University, Shillong.

Percentage similarities between the rotifer communities of different ponds were calculated *vide* Sorenson Index[16]. The trophic status of these ponds was presently assessed applying $Q_{B/T}$ quotient, where

B = number of *Brachionus* spp occuring in a pond; and
T = number of *Trichocerca* spp. occuring in the same pond.

3. Results and discussion

Comments on the trophic status of different ponds in terms of physico-chemical parameters and the gastropod fauna were made earlier by Dudani *et al* [10]. The mean annual variations (± S.E.) in certain abiotic factors were, however, included in Table I to depict differences in their water chemistry. Accordingly, hypereutrophic Harahi pond[10] exhibited maximum biochemical oxygen demand and higher values of total alkalinity and hardness. The lower penetration of light in this pond was due to 'shading or blanketing effect' of abundance of *Microcystis*. The eutrophic Raj Dighi showed relatively lower total alkalinity, hardness and B.O.D. than the former. Higher chloride concentrations in these two ponds, however, could be attributed to the influx of sewage waters. The other three ponds reflected mesotrophic status[10]. Of these, Nargauna pond was characterized by soft waters as indicated by lower values of its total hardness and lowest calcium and magnesium contents.

53 species (57 species and subspecies) of Rotifera belonging to 22 genera and 16 eurotatorian families were identified (Table II) thereby indicating a well-diversified community structure. The common occurrence of the members of the families

Table I

Mean annual variations (± S.E.) of physico-chemical conditions in different ponds during March 1985–February 1986 (partly modified after Dudani *et al* [10])

Parameters	*Tinkonia pond*	*Mithila Univ. pond*	*Nargauna pond*	*Raj Dighi*	*Harahi pond*
pH	7·34 ± 0·61	7·70 ± 0·51	7·40 ± 0·51	7·85 ± 0·41	7·87 ± 0·62
Transparency (cm)	69·16 ± 6·25	72·20 ± 8·81	52·20 ± 5·81	45·21 ± 6·20	29·91 ± 2·57
Total alkalinity (mg/l)	101·38 ± 8·68	100·51 ± 14·72	115·79 ± 17·05	175·59 ± 15·41	306·41 ± 31·75
Free carbondioxide (mg/l)	9·75 ± 1·01	5·53 ± 0·92	–	–	–
Dissolved oxygen (mg/l)	7·58 ± 0·95	8·41 ± 0·25	6·25 ± 0·85	5·01 ± 10·80	9·94 ± 0·86
B.O.D. (mg/l)	1·86 ± 0·29	1·41 ± 0·52	1·56 ± 0·25	2·38 ± 0·21	14·04 ± 1·21
Total hardness (mg/l)	47·00 ± 3·97	45·21 ± 5·83	20·50 ± 2·35	85·56 ± 7·25	104·16 ± 8·87
Calcium (mg/l)	10·67 ± 0·92	12·21 ± 1·25	4·41 ± 0·75	20·04 ± 2·20	25·71 ± 2·19
Magnesium (mg/l)	5·20 ± 0·47	5·50 ± 0·85	2·01 ± 0·51	8·29 ± 0·85	8·82 ± 0·80
Chlorides (mg/l)	24·78 ± 2·14	17·21 ± 1·75	16·41 ± 3·21	75·55 ± 4·21	96·85 ± 8·27

Brachionidae and Lecanidae in general[17] and the predominance of *Brachionus* species in particular[18–20] imparted a broadly tropical character to this fauna. Cosmopolitan elements[13,15] formed a dominant component (73·7%) of the documented taxa while a notable fraction (19·2%) comprised (Table II) various tropical and subtropical elements[15,21]. The examined material also included a number of warm stenothermal forms (Table II). A majority of the presently listed species exhibited common occurrence in alkaline waters[14,15] even though some of these eurytopic forms were known to tolerate wide range of pH variations. *Keratella tropica* and *Brachionus calyciflorus* indicated cyclomorphic variations; *B. falcatus, B. forficula* and *B. quadridentatus* exhibited different morphotypes while infraspecific variations were noticed in *Brachionus caudatus* in the present observations.

Filinia longiseta saltator (Fig. 1), *Mytilina ventralis macracantha* (Fig. 2), *Trichocerca bicristata* (Figs 3–4) and *T. rattus carinata* (Fig. 5) comprised new additions to Indian Rotifera. The reports of the first two taxa, however, deserved special mention because of their restricted global distribution[15]. Of these, *F. longiseta saltator* has previously been reported only from the Antilles, South America and West Africa and, hence, its presence in India extended its range into the Oriental region. *M. ventralis macracantha,* first described by Gosse[22], was recorded subsequently only from Venezuela[23]. *T. bicristata* and *T. rattus carinata* were apparently considered as cosmopolitan but these two taxa represented new reports from the Indian subcontinent. Some other species, *i.e., Horaella brehmi, Brachionus mirabilis, Epiphanes macrourus, Euchlanis triquetra, Beauchampiella eudactylota, Lecane signifera* and *L. thalera* depicted regional distributional interest because of their so far restricted occurrence in India[21]. Among these, *H. brehmi* was described from Bihar and has also been documented from West Bengal, Orissa, Assam and Punjab. In addition, it

Table II
Composition of rotifer communities in different ponds

Rotifer taxa	*Ponds*					*Distribution/ Remarks*
	1	*2*	*3*	*4*	*5*	
Family: Brachionidae						
Anuraeopsis fissa (Gosse)	–	–	–	+	–	c, ws
Brachionus angularis (Gosse)	–	–	+	+	+	c
B. calyciflorus dorcas (Gosse)	–	–	–	+	+	c
B. calyciflorus anuraeiformis (Brehm)	–	–	–	+	+	c
B. caudatus personatus (Ahlstrom)	–	–	–	+	+	t & s
B. caudatus aculeatus (Hauer)	–	–	–	+	–	t, ws
B. diversicornis (Daday)	–	–	+	+	–	t & s
B. falcatus (Zacharias)	+	+	–	+	+	t & s
B. forficula Wierzejski	–	–	–	+	+	t & s, ws
B. mirabilis (Daday)	–	–	+	–	–	t, ws
B. patulus (Müller)	+	+	–	–	–	c
B. quadridentatus Hermann	+	+	–	+	–	c
B. rubens Ehrenberg	–	–	–	+	+	c
Keratella tropica (Apstein)	–	–	+	+	+	c
Platyias quadricornis Ehrenberg	+	+	–	+	+	c
Family: Epiphanidae						
Epiphanes macrourus (Barrois & Daday)	–	–	–	+	–	t & s
Family: Euchlanidae						
Euchlanis dilatata Ehrenberg	+	+	–	–	–	c
E. triquetra Ehrenberg	–	+	–	–	–	c
Dipleuchlanis propatula (Gosse)	+	+	–	–	–	c, ws
Beauchampiella eudactylota (Gosse)	+	–	–	–	–	c, ws
Family: Mytilinidae						
Mytilina ventralis (Ehrenberg)	+	–	–	–	–	c
M. ventralis macracantha (Gosse)	–	–	+	–	–	
Family: Trichotridae						
Trichotria tetractis (Ehrenberg)	+	+	–	–	–	c
Family: Colurellidae						
Colurella uncinata (Müller)	+	–	–	–	–	c
Lepadella patella (Müller)	–	+	–	–	–	c
L. ovalis (Müller)	+	–	–	–	–	c
L. acuminata (Ehrenberg)	+	–	+	–	–	c
L. heterostyla (Murray)	–	–	+	–	–	c
Family: Lecanidae						
Lecane (L.) curvicornis (Murray)	+	+	–	–	–	t & s
L. (L.) leontina (Turner)	+	+	+	–	–	t & s
L. (L.) ludwigi (Eckstein)	+	–	–	–	–	c, ws
L. (L.) luna (Müller)	+	+	–	–	–	c

Table II *(contd)*

Rotifer taxa	*Ponds*					*Distribution/ Remarks*
	1	*2*	*3*	*4*	*5*	
L. (L.) papuana (Murray)	+	+	–	–	–	t & s
L. (L.) signifera (Jennings)	+	–	–	–	–	c
L. (L.) ungulata (Gosse)	–	+	+	–	–	c
L. (Monostyla) bulla (Gosse)	+	–	–	–	–	c
L. (M.) closterocerca (Schmarda)	–	+	–	–	–	c
L. (M.) lunaris (Ehrenberg)	–	+	+	–	–	c
L. (M.) pyriformis (Daday)	–	+	+	–	–	c, ws
L. (M.) quadridentata (Ehrenberg)	+	+	–	–	–	c
L. (M.) unguitata (Fadeev)	+	+	–	–	–	
Family: Trichocercidae						
Trichocerca bicristata (Gosse)	–	–	+	–	–	c
T. rattus carinata (Ehrenberg)	+	–	–	–	–	c
T. pusilla (Lauterborn)	–	+	+	+	–	c
T. similis (Wierzejski)	+	+	+	+	–	c
Family: Notommatidae						
Scaridium longicaudum (Müller)	+	+	–	–	–	c, ws
Family: Synchaetidae						
Polyarthra vulgaris Carlin	–	+	–	+	+	c
Family: Asplanchnidae						
Asplanchna priodonta (Gosse)	–	–	–	+	+	c
Family: Hexarthridae						
Hexarthra mira (Hudson)	–	–	–	+	–	c
Family: Filiniidae						
Filinia longiseta (Ehrenberg)	–	–	–	+	+	c
F. longiseta saltator (Gosse)	–	–	+	–	–	
F. opoliensis (Zacharias)	–	–	–	+	+	c
F. pejleri Hutchinson	–	–	–	+	–	t & s
Family: Testudinellidae						
Testudinella patina (Hermann)	+	+	–	–	–	c
T. emarginula (Stenroos)	–	–	+	–	–	c
Family: Trochosphaeridae						
Horaella brehmi Donner	–	–	+	–	–	
Family: Philodinidae						
Rotatria neptunia (Ehrenberg)	–	–	–	–	+	c
Total no. of species	26	23	17	19	12	

Abbreviations: 1= Tinkonia pond; 2 = Mithila University pond; 3 = Nargauna pond; 4 = Raj Dighi; 5 = Harahi pond; – = absent; + = present; c = cosmopolitan; t & s = tropics and subtropics; t = tropics; ws = warm–stenothermal.

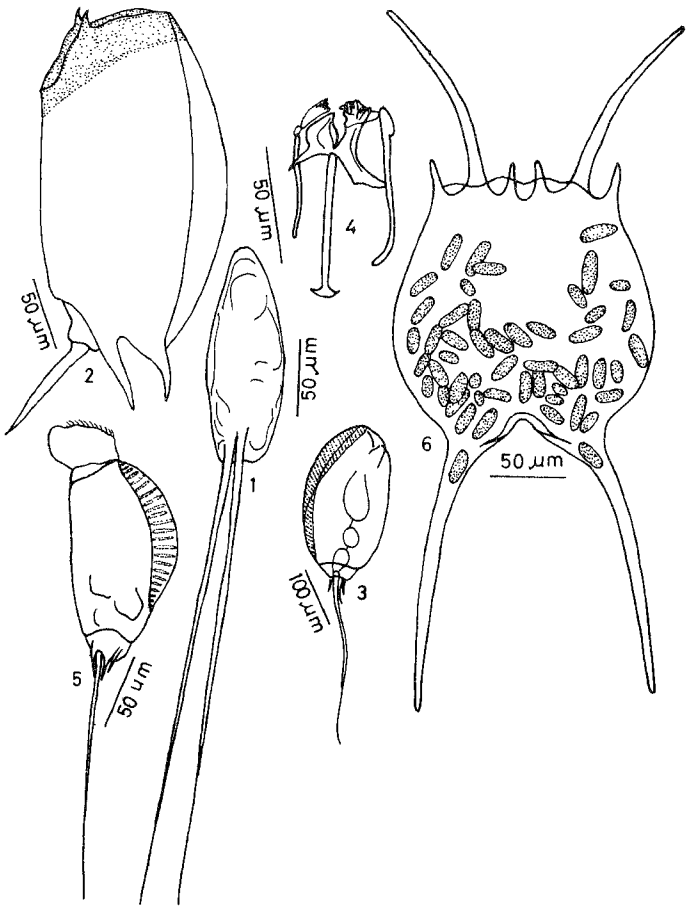

FIG. 1. *Filinia longiseta saltator* (Gosse), dorsal view; Fig. 2. *Mytilina ventralis macracantha* (Gosse), lateral view, Fig. 3. *Trichocerca bicristata* (Gosse), lateral view, Fig. 4. trophi; Fig. 5. *Trichocerca rattus carinata* (Ehrenberg), lateral view; Fig. 6. *Brachionus falcatus* Zacharias, ventral view, infected with zoospores of the microsporid, *Bertramia asperospora*.

was reported [24] from Sri Lanka, Equatorial Africa, Malayasia, Southeastern Australia and Tasmania. *Lacane signifera* and *Euchlanis triquetra* were reported previously from Meghalaya state in N.E. India; *Brachionus mirabilis* from West Bengal, Orissa and Assam; *Epiphanes macrourus* from Meghalaya and West Bengal; *Beauchampiella eudactylota* from Madhya Pradesh and Andhra Pradesh while *Lecane thalera* was recorded from Tamil Nadu, West Bengal and Andhra Pradesh.

The qualitative abundance of the rotifers indicated variations in different ponds (Table II). The mesotrophic Tinkonia and Mithila University ponds[10], containing a variety of aquatic macrophytes, showed higher rotifer diversity, predominance of species of *Lecane*–complex, the littoral elements of the families Euchlanidae, Trichocercidae, Trichotridae and Notommatidae and also some eurytopic Brachionids. The soft mesotrophic Nargauna pond[10], with only *Vallisnaria spiralis,* indicated only 17 species. Further, the diversity of 19 and 12 species was recorded in Raj Dighi and Harahi pond, respectively. Higher species abundance in mesotrophic ponds (except Nargauna) followed by a gradual decrease till the hypereutrophic condition broadly confirmed with the generalization proposed by Pejler[25].

The rotifer communities of Raj Dighi and Harahi pond included planktonic elements and were broadly comparable with the species studied from other fish ponds in Bihar[6–9] or elsewhere in peninsular India[21]. Lowest species abundance in hypereutrophic Harahi pond could be due to high abundance of *Microcystis*[10] as this bluegreen alga was reported to inhibit the development of the majority of sedimentator rotifers by eliminating the fine micro-algae which served as the basic food for the phytophagus sedimentators[1,26–28]. However, common occurrence of certain *Brachionus* species under such conditions and their coexistence with this bluegreen alga was considered to be a pre-supposition for their survival in tropical waters[17,29].

Percentage similarities[16] between the rotifer communities of various ponds ranged between 5·35 and 71·0% (Table III). The rotifer taxa of Raj Dighi and Harahi pond exhibited the maximum recorded (71%) similarity due to common occurrence of various planktonic elements in general and the branchionids in particular. The documented members of the family Brachionidae, in fact, comprised a dominant fraction of their species spectrum and alone resulted in 82.3% similarity. Further, the taxocenosis of these ponds differed notably from other ponds because of the differences in their water quality and absence of aquatic vegetation. High similarity (65·3%) was noticed between the faunas of Tinkonia and Mithila University ponds which resulted from occurrence of various taxa associated with a variety of aquatic macrophytes[15], predominance of *Lecane* species and more identical water-quality parameters. On the other hand, Nargauna pond with its soft waters and growth of only submerged *Vallisnaria spiralis,* differed distinctly from the rest of the ponds and indicated similarity values ranging between 13·8 and 27·8%.

Brachionus angularis, B. calyciflorus, B. caudatus personatus, B. falcatus, B. forficula, B. rubens, Anuraeopsis fissa, Keratella tropica, Polyarthra vulgaris, Asplanchna priodonta, Filinia longiseta and *F. opoliensis* invariably indicated abundance in

Table III
Percentage similarities (Sorenson Index) between total number of species in different ponds

	Tinkonia pond	*Mithila Univ. pond*	*Nargauna pond*	*Raj Dighi*	*Harahi pond*
Tinkonia pond	–	65·3	18·6	8·9	5·3
Mithila Univ. pond	–	–	25·0	19·0	11·4
Nargauna pond	–	–	–	27·8	13·8
Raj Dighi	–	–	–	–	71·0

Table IV
Values of $Q_{B/T}$ quotient for different ponds

	Tinkonia pond	*Mithila Univ. pond*	*Nargauna pond*	*Raj Dighi*	*Harahi pond*
Number of *Brachionus spp.*	3	3	3	7	5
Number of *Trichocerca spp.*	2	2	3	2	0
$Q_{B/T}$ ratios	1·5	1·5	1·0	3·5	5·0
Tropic status	Mesotrophic	Mesotrophic	Mesotrophic	Eutrophic	Hypereutrophic

sewage-fed Raj Dighi and Harahi pond. These were accordingly regarded as eutrophic indicators and broadly agreed with various previous reports[1,15,29–31]. *Epiphanes macrourus* was exclusively restricted to the eutrophic Raj Dighi. *Rotaria neptunia*, a typical inhabitant of heavily polluted waters[1], was confined to hypereutrophic 'Harahi pond. This study highlighted the presence of *Horaella brehmi* and *Filinia longiseta saltator* in soft mesotrophic environs of Nargauna pond. *Trichocerca bicristata* and *T. rattus carinata* and *T. pusilla*, known as oligotrophic indicators[15], were presently recorded in mesotrophic Tinkonia and Mithila University ponds while *T. pusilla* was also noticed in eutrophic Raj Dighi. Most of the documented members of the families Euchlanidae, Colurellidae and Lecanidae were noticed under mesotrophic conditions in this study.

Sladecek's $Q_{B/T}$ quotient, an analogon of five phytoplankton quotients proposed by Thunmark[32] and Nygaard[33], was useful to indicate trophic conditions of individual water bodies or even of individual water samples. According to this quotient[1], values less than 1·0 meant oligotrophy, between 1·0 and 2·0 indicated mesotrophy and those above 2·0 showed eutrophy. The values obtained *vide* Sladecek's quotient for the sampled ponds (Table IV) reflected mesotrophic status for Tinkonia, Mithila University and Nargauna ponds and eutrophic and hypereutrophic nature of Raj Dighi and Harahi pond, respectively. Lower value (1·0) in Nargauna pond than the first two ponds evidently coincided with its soft mesotrophic waters. The above conclusions, however, broadly corresponded with general trophic status of these ponds based on their water quality and gastropod indicator species[10].

The rotifers were reported to be infected by a number of bacteria, viruses and aquatic fungi, with parasitism common in benthic forms and rare in planktonic species[14]. However, a case of microsporid infection of a planktonic rotifer (*Brachionus* sp.) was recently observed from Australia[34]. In this study, three specimens of *Brachionus falcatus* (Fig. 6) were noticed to be infected by zoospores of the microsporid, *Bertramia asperospora*. This comprised the first report of parasitism of rotifers in India.

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