Zoological Studies **42**(2): 239-247 (2003)

Zoological Studies

Species Diversity of Planktonic and Epiphytic Rotifers in the Backwaters of the Delhi Segment of the Yamuna River, with Remarks on New Records from India

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(Accepted December 16, 2002)

Jyoti Arora and Naresh K. Mehra (2003) Species diversity of planktonic and epiphytic rotifers in the backwaters of the Delhi segment of theYamuna River, with remarks on new records from India. *Zoological Studies* **42** (2): 239-247. The backwaters of the Delhi segment of the Yamuna River are shallow, weedy, and perennially open lentic habitats that harbor a rich variety of zooplankton, particularly rotifers. The present study is based on planktonic and epiphytic rotifers collected from these backwaters once a month over a period of 1 yr (September 1997 to August 1998). Planktonic rotifers were obtained by filtering water from the littoral zone through a plankton net, while epiphytic specimens were collected from the roots of *Eichhornia crassipes* and from floating and submerged leaves of *Salvinia molesta*. In total, 110 species belonging to 39 genera of 20 eurotatorian families were identified. Of these, five species of monogonont rotifers are new records from India, of which 2 are new to the Oriental region. The majority of the species were monogononts, while bdelloids were represented only by *Rotaria* sp. The largest fraction (76%) belonged to the following families: Lecanidae > Collurelidae > Brachionidae > Trichocercidae > Notommatidae > Floscullariidae. The fauna consisted mainly of cosmopolitan and tropicopolitan taxa except for 3 pantropical, 2 paleotropical, 2 arctic-temperate, 1 eastern hemispheric, and 1 holarctic taxa. The relative composition of planktonic and epiphytic rotifer species as well as the preference of the latter for the roots of *Eichhornia* compared to the leaves of *Salvinia* are discussed. Comments are also provided on species of special taxonomic and/or zoogeographic interest.
http://www.sinica.edu.tw/zool/zoolstud/42.2/239.pdf

Key words: Rotifers, Biodiversity, Backwaters, New records, India.

Taxonomic investigations on Indian rotifers were initiated by Anderson (1889). Sharma and Michael (1980) reviewed the available information on the Indian rotifer fauna and concluded that this group was quite rich and varied. They confirmed the presence of 241 species of rotifers from the Indian subcontinent. Subsequently, another nearly 60 species have been added to the list (e.g., Sharma 1987 1990, Sharma and Sharma 1987, Sarma 1988, Patil and Gouder 1989, Segers et al. 1994). According to a conservative estimate, there are over 500 species of rotifers in Indian waters, although only 330 species belonging to 63 genera and 25 families have so far been authenticated (Sharma 1998). More recently, Segers and Babu (1999) and Sharma and Sharma (2001) have added 5 new taxa to the Indian checklist.

Although taxonomic studies of Indian rotifers began more than a century ago, information on rotifer biodiversity in Indian waters is still incomplete. Most investigations carried out on this group in India have usually been restricted to planktonic species collected from the pelagic zone, whereas the importance of littoral-periphytic habitats has generally been overlooked. There is an urgent need to conduct faunal surveys on a variety of aquatic habitats in this country.

In the present study, therefore, the backwaters of the Yamuna River were surveyed for rotifer fauna. These backwaters support extensive macrophytic vegetation throughout the year and thus provide an extensive variety of ecological

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niches to host diverse rotifer fauna.

MATERIALS AND METHODS

Study site: The investigation was conducted on the backwaters on the eastern bank of the Yamuna River, upstream of the Wazirabad Barrage in the National Capital Territory of Delhi (28°12'-28°53'N, 76°50'-77°23'E) (Fig. 1). These low-lying areas are inundated during the monsoon season (July-Sept.) due to heavy discharges from the headwaters. In addition, inflow of water from a reservoir situated upstream of the Barrage replenishes the backwaters throughout the year. The water quality is also influenced by influx from agricultural fields and from human settlements located to the north and northeast of the study site (Fig. 1). The study site supports a luxuriant growth of floating macrophytes such as *Eichhornia crassipes* (Mart.) Solms and *Salvinia molesta* Mitch and submerged macrophytes such as *Hydrilla* sp. and *Vallisnaria* sp. throughout the year.

Sampling procedure: Plankton samples and macrophytes i.e., *Eichhornia* and *Salvinia* for epiphytic rotifers were collected once a month over a period of 1 yr (Sept. 1997 to Aug. 1998) from 2 sampling sites (Sites I and II) located diagonally opposite each other (Fig. 1). Planktonic rotifers were collected by filtering water from the littoral zone through a 50μ mesh plankton net. Macrophytes were collected with minimal disturbance, placed individually in polyethylene bags along with water from the sampling site and transferred to polyethylene troughs in the laboratory. For epiphytic community analyses, a few roots of *Eichhornia* and floating and submerged leaves of *Salvinia* were separately placed into labeled plankton bottles containing filtered water collected from the respective sampling sites.

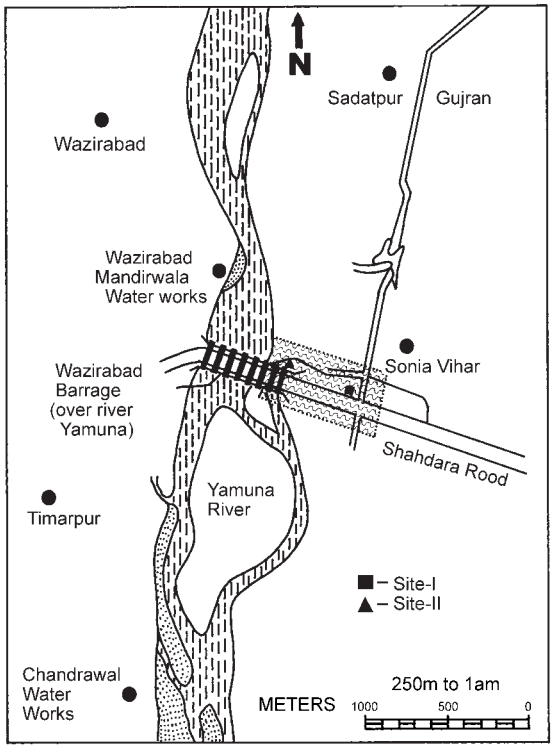


Fig. 1. Map showing a part of Delhi segment of Yamuna River near Wazirabad Barrage. The inset includes 2 sampling stations located on the backwaters of river towards the eastern side of Wazirabad barrage.

Before fixing with 4% neutral formalin, all samples were examined for identification of illoricate rotifers using a stereoscopic binocular microscope (Leitz Wetzlar). Trophi were isolated by dissolving the soft tissue with 4% sodium hypochlorite. Entire specimens and trophi were mounted in glycerol on a glass slide, sealed with lacquer and examined under a stereoscopic microscope. Drawings were made using an Olympus microscope fitted with a camera lucida (American Optical). All measurements are in micrometers and were made using a calibrated ocular micrometer (Kyowa, Tokyo, Japan). Identification of rotifers was mainly based on Koste (1978). In addition, more-recent literature, e.g., that of Koste and Shiel (1987 1989 1990 1991) and Segers (1995a), was also consulted.

RESULTS AND DISCUSSION

Rotifer species recorded during the present study are listed in table 1. In total, 110 species belonging to 39 genera and 20 eurotatorian families were identified; five of these species are new records from India. These are *Lepadella quinquecostata* (Lucks), *L. biloba* Hauer, *Lecane paxiana* (Hauer), *Ptygura barbata* (Edmondson), and *P. kostei* José De Paggi. Two species, *Lecane paxiana* (Hauer) and *Ptygura barbata* (Edmondson), are first record from the Oriental region.

The remarkably rich rotifer fauna in the backwaters of the Yamuna River is in accordance with the well-established concept that tropical systems generally support a high number of species (e.g., Segers et al. 1993a, Segers and Dumont 1995, Sarma and Elias-Gutierrez 1998). Moreover, it is well known that vegetated littoral habitats, such as the backwaters examined in the present study, are

inhabited by diverse rotifer taxocoenosis (e.g., Pennak 1966, Irvine et al. 1990, Havens 1991, Segers and De Meester 1994, Sanoamuang et al. 1995, Duggan et al. 1998). The high species diversity is probably also due to these habitats providing anchorage to the resting eggs carried by water from higher elevations, especially during increased flows as evidenced by the presence of *Notholca labis* Gosse, a cold stenotherm species, whose existence in the Delhi segment of the Yamuna River can be attributed to its drifting downstream from higher elevations (Sharma 1998).

A comparison of species composition between planktonic and epiphytic samples revealed that 47 species were holoplanktonic, 45 were mesoepiphytic, and 18 were euepiphytic. Also, *Eichhornia* supported more diverse rotifer fauna than did *Salvinia*, so much so that some species of sessile rotifers such as *Beauchampia crucigera* Dutrochet, *Sinantherina* sp., and *Collotheca* sp., were recorded exclusively in association with *Eichhornia* roots. Possibly, the thick bushy rhizoids of *Eichhornia* provide abundant food as well as protection from predators. In comparison, the floating and submerged leaves of *Salvinia* being small in size support a lesser diversity. Pennak (1966) and Pontin and Shiel (1995) studied the preferences of rotifer species for various macrophytes that differed in architecture and surface characteristics (which affect the ability of rotifer species to move over their surfaces, the availability of periphytic food, and the ability to provide refuge from predators), proliferation rates (that provide new surfaces for colonization), and release of chemical compounds. These studies showed that, in general, macrophytes with complex structures support a greater diversity of epiphytic fauna because they offer a larger variety of microhabitats for colonization (see also Edmondson 1944, Wallace 1977 1980, Duggan et al. 1998).

In the present study, the majority of the recorded species were monogononts, whereas bdelloids were represented only by *Rotaria* sp. The former was dominated by the order Ploima (95 species, 86.36%), while the other 2 orders, Flosculariacea (14 species, 12.73%) and Collothecacea (1 species, 0.91%), constituted a relatively small fraction of the reported species. Although, the observed pattern of species richness conforms to the generally reported composition of Oriental fauna, it may also be indicative of the paucity of information relating to bdelloids in particular (see Sharma and Michael 1980, Sharma 1998). An analysis of the family-wise representation of recorded species depicted the relative qualitative sequence to be Lecanidae > Collurelidae > Brachionidae > Trichocercidae > Notommatidae > Flosculariidae. These families comprised a significant fraction (76%) of the overall species richness. The "tropic-centered" genera i.e., *Lecane*, *Trichocerca*, and *Brachionus* were the most diverse, whereas the "temperate-centered" genera i.e., *Keratella*, *Cephalodella*, *Notholca*, and *Synchaeta* were represented by fewer species. Similar observations on the predominance of "tropic-centered" genera have been made on the Indian rotifer fauna in particular (Sharma 1998) and on (sub) tropical freshwater rotifer faunas in general (e.g., Fernando and Zankai 1981, Dussart et al. 1984, Segers et al. 1993a, Segers and Dumont 1995, Vasquez et al. 1998, Segers 2001, Sharma and Sharma 2001).

In general, most rotifer species are known to be cosmopolitan, either eury- or steno-therms, while some are pantropical, and only a few have restricted distributions (Segers et al. 1993a, Segers 1995b). This generalization holds true for Indian rotifers as well (Sharma 1998). An analysis of the species recorded during the present study also shows that the majority of species are common and cosmopolitan (70 taxa, 63.64%) or are widely distributed with thermophilic characters (tropicopolitans 18 taxa, 16.36%). The paleotropical *Lecane unguitata* (Fadeev) (Fig. 5) and *Lepadella discoidea* Segers (Fig. 6); the pantropical *Lepadella lindaui* Koste (Figs. 7, 8), *Cephalodella mucronata* Myers, and *Ptygura kostei* José De Paggi (Fig. 20); the eastern hemispheric *Lecane paxiana* (Hauer) (Fig. 2); the holarctic *Lecane elongata* Harring and Myers (Fig. 4), and the arctic-temperate *Notholca labis* Gosse (Fig. 21) and *Filinia terminalis* (Plate) represent taxa of particular zoogeographic relevance (Table 1). In addition, the presence of such species as *Lepadella costatoides* Segers (Figs. 9, 10) and *L. triba* Myers (Fig. 11) in the collections made during the present study conducted in the northern region of India is noteworthy as these species were earlier reported from Kerala in southern India by Segers et al. (1994).

The present study did not reveal even a single rotifer species that is endemic to India. This observation is in agreement with Nogrady et al. (1993) who pointed out that a remarkable fact about the Indian subcontinent is that while many new species have been described, endemism

seems to be absent. However, Sharma (1998) referred to 23 species endemic to India, but none of these was recorded during the present investigation.

Comments on some species, which are of special taxonomic and/or zoogeographic interest, are presented in the following paragraphs.

Lecane paxiana (Hauer)
(Fig. 2)

This species is the first record from the Oriental region. It can be confused with *L. nana* (Murray), but differs from the latter by its toes bearing distinct claws. In comparison, the toes of *L. nana* are without claws and have characteristically curved tips (see Figs. 2, 3). It is a rare species with records only from Europe and Africa (Egypt: Klimowicz 1962, Czech, Germany, and Nigeria: Segers 1995a, Burundi: Baribwegure and Segers 2000). The range of this eastern hemisphere taxon cannot be determined accurately due to its scarcity and the scattered records (Segers 1996).

Lecane elongata Harring and Myers
(Fig. 4)

This is a rare species with records from the US, Europe, and India (Segers 1995a). This holarctic taxon has been reported from submerged *Sphagnum* (Segers 1995a 1996), whereas in the present study it was found associated with floating and submerged leaves of *Salvinia* (Table 1).

Lepadella discoidea Segers
(Fig. 6)

This is a paleotropical species with records from Indonesia (Hauer 1937 1938), India (Sharma 1978, Sharma and Sharma 1987), Australia (Koste and Shiel 1989), Zaire (De Smet 1989), Nigeria (Segers 1993), and Papua New Guinea (Segers and De Meester 1994).

Lepadella lindaui Koste
(Figs. 7-8)

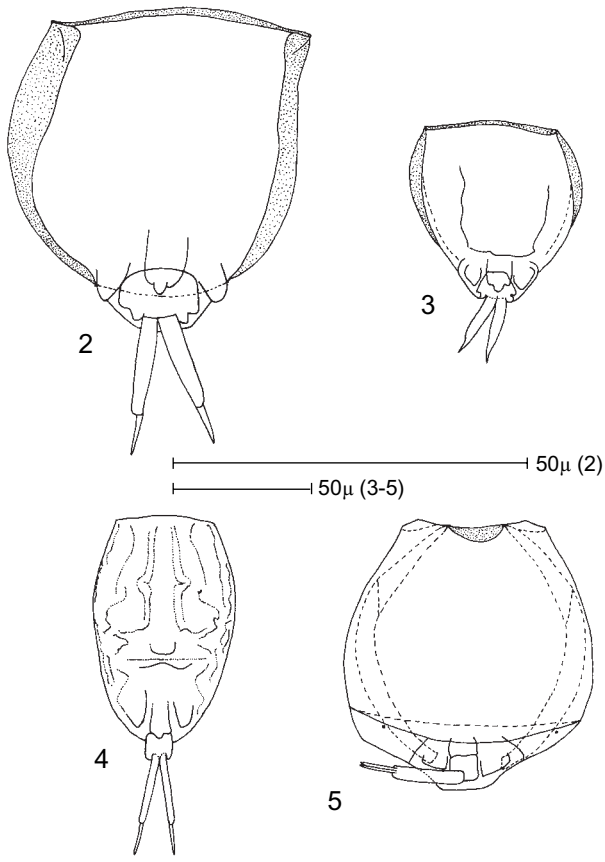
This pantropical species has been recorded from Africa (Kenya: Koste 1981, Nigeria: Segers et al. 1993a, Burundi: Baribwegure and Segers 2001), northern Australia (Koste 1981), Brazil (Segers et al. 1993b), and India (Sharma and Sharma 2001). Our record confirms its occurrence from the Delhi region; it had earlier been recorded from the tropical floodplain lakes of the Brahmaputra River basin in the northeastern state of Assam (Sharma and Sharma 2001).

Lepadella quinquecostata (Lucks)
(Figs. 12-13)

This is a cosmopolitan species and is commonly found among macrophytes in the littoral zone (Koste 1978). The general shape of the lorica conforms to the figures of Turkish specimens (see Fig. 10a-e in Segers et al. 1992) and Thai specimens (see Fig. 5a-b in Sanoamuang 1998). It has been recorded from Australia (Koste and Shiel 1989), Argentina (José De Paggi 1990), Turkey (Segers et al. 1992), Brazil (Segers and Sarma 1993), and Thailand (Sanoamuang 1998).

Lepadella eurysterna Myers
(Figs. 14-15)

The outline of the lorica of this species is



Figs. 2-5. *Lecane* spp, 2: *L. paxiana* (Hauer), ventral view; 3: *L. nana* (Murray), ventral view; *4: L. elongata* Harring and Myers, dorsal view; 5: *L. unguitata* (Fadeev), ventral view.

Table 1. List of rotifer species recorded from the backwaters of the Delhi segment of the Yamuna River

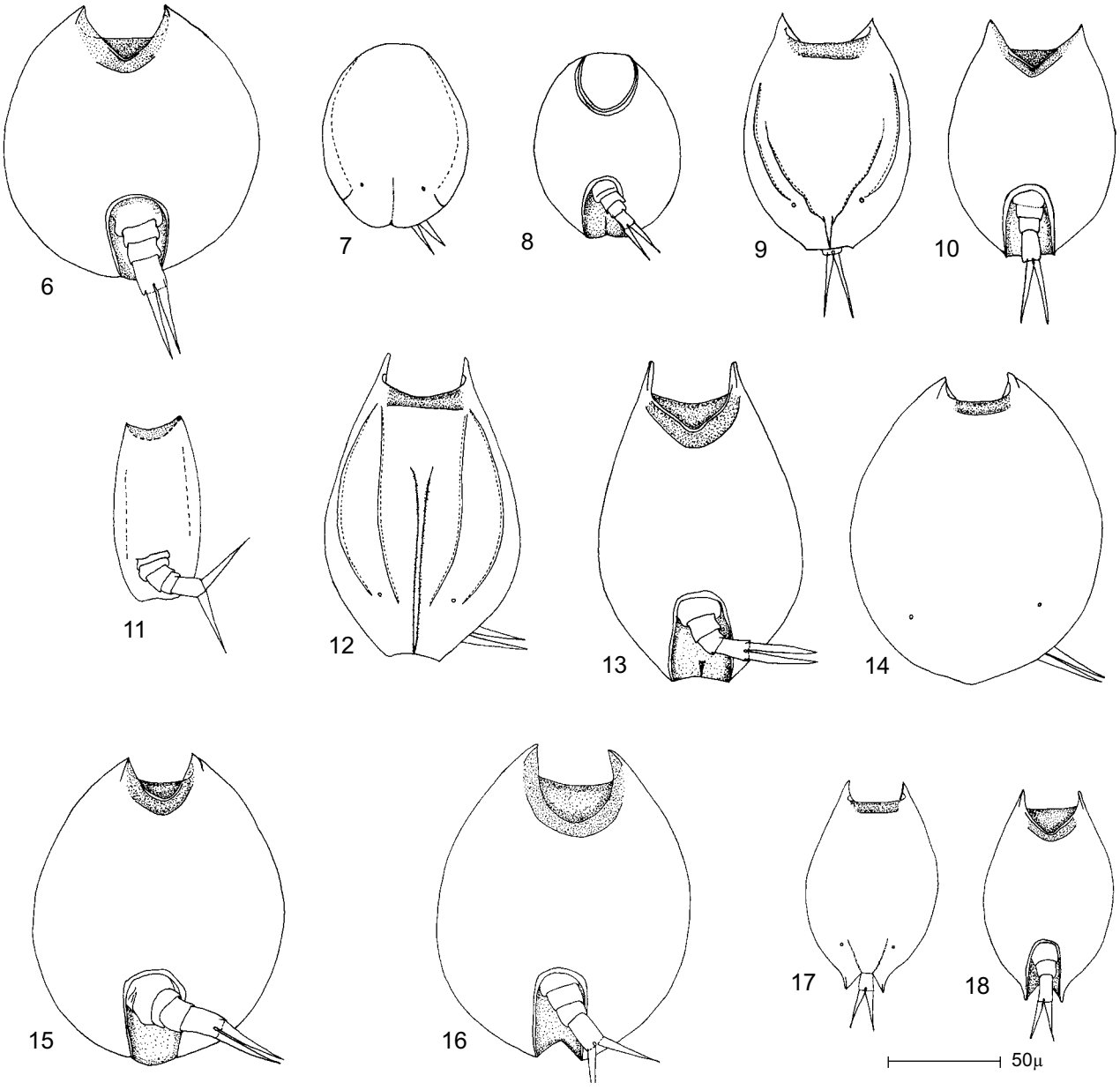
Anuraeopsis fissa (Gosse, 1851): P	Tp	*L. quadridentata* (Ehrb., 1832): P, S, E	C
Ascomorpha saltans Bartsch, 1870: P	C	*L. signifera* (Jennings, 1896): P, S, E	Tp
Asplanchna brightwelli Gosse, 1850: P	C	*L. stenroosi* (Meissner, 1908): P	C
A. intermedia Hudson, 1886: P	C	*L. ungulata* (Gosse, 1887): P, S, E	C
A. priodonta Gosse, 1850: P	C	*L. unguitata* (Fadeev, 1925): P, S, E	Pl
Beauchampia crucigera Dutrochet, 1812: E	C	*Lepadella acuminata* (Ehrb., 1834): S, E	C
Brachionus angularis Gosse, 1851: P	C	**L. biloba* Hauer, 1958: S, E	C
B. bidentatus Anderson,1889: P	Tp	*L. costatoides* Segers, 1992: P, S, E	Tp
B. caudatus aculaeatus (Hauer,1937): P	Tp	*L. discoidea* Segers, 1993: P, S, E	Pl
B. calyciflorus Pallas,1766: P	C	*L. eurysterna* Myers, 1942: P, S, E	Tp
B. falcatus Zacharias,1898: P, S	Tp	*L. heterostyla* (Murray, 1913): P, S, E	C
B. leydigi Cohn, 1862: P	C	*L. lindaui* Koste, 1981: S, E	Pn
B. plicatilis (Müller, 1786): P	C	*L. ovalis* (Müller, 1786): P, S, E	C
B. quadridentatus Hermann,1783: P	C	*L. patella* (Müller, 1786): P, S, E	C
Cephalodella catellina (Müller, 1786): P	C	**L. quinquecostata* (Lucks, 1912): P, S, E	C
C. forficula (Ehrb., 1838): P	C	*L. quadricarinata* (Stenroos, 1898): P, S, E	C
C. gibba (Ehrb., 1838): P, S, E	C	*L. triba* Myers, 1934: S, E	C(Th)
C. mucronata Myers, 1924: P	Pn	*Limnias melicerta* Weisse, 1848: P, S, E	C
Colurella uncinata bicuspidata (Ehrb., 1832): P, S, E	C	*Lophocharis salpina* (Ehrb., 1834): P	C
C. adriatica Ehrb., 1831: P	C	*Monommata* sp.: P, S, E	-
C. obtusa (Gosse, 1886): P, S, E	C	*Mytilina bisulcata* (Lucks, 1912): P	C
C. oxycauda Carlin, 1939: P, S, E	C	*M. mucronata* (Müller, 1773): P	C
Collotheca sp.: E	-	*M. ventralis* (Ehrb.,1832): P, S, E	C
Conochilus sp.: E	-	*Notholca labis* Gosse, 1887: P	At
Dicranophorus epicharis Harring & Myers, 1928: P	C	*Notommata copeus* Ehrb., 1834: P	C
Dipleuchlanis propatula (Gosse, 1886): P	C	*Notommata* sp.: P, S, E	-
Encentrum sp.: P	-	*Plationus patulus* Müller, 1786: E	C(Th)
Eosphora najas Ehrb., 1830: P	C	*Platyias leloupi* (Gillard, 1957): P	Tp
Euchlanis dilatata Ehrb., 1832: P, S, E	C	*P. quadricornis* (Ehrb., 1832): P	C
Filinia opoliensis (Zacharias, 1898):P	C	*Polyarthra* sp: P, E	-
F. longiseta (Ehrb., 1834): P	C	*Pompholyx sulcata* (Hudson, 1885): P	C
F. terminalis (Plate, 1886): P	At	*Proales* sp.: P	-
Floscularia ringens Linnaeus, 1758: P, E	C	**Ptygura barbata* (Edmondson, 1939): E	?
Keratella cochlearis (Gosse, 1851): P, S, E	C	**P. kostei* José De Paggi, 1996: P, E	Pn
K. quadrata (Müller, 1786): P	C	*Rotaria* sp.: P, S, E	-
K. tropica (Apstein, 1907): P, S, E	C(Th)	*Scaridium longicaudum* (Müller, 1786): P, S, E	C
Lecane aculeata (Jakubski, 1912): E	Tp	*Sinantherina* sp.: E	-
L. arcula Harring, 1914: P, S, E	Tp	*Squatinella lamellaris mutica* (Ehrb., 1832): P	C
L. bulla (Gosse, 1886): P, S, E	C	*Synchaeta oblonga* Ehrb., 1831: P	C
L. closterocerca (Schmarda, 1859): P, S, E	C	*Testudinella emarginula* (Stenroos, 1898): P, S, E	C
L. crepida Harring, 1914: S	Tp	*T. patina* (Hermann, 1783): P, S, E	C
L. curvicornis (Murray, 1913): P, S, E	Tp	*Testudinella* sp.:P, S, E	-
L. doryssa Harring, 1914: E	Tp	*Trichocerca braziliensis* (Mürray, 1913): P	Tp
L. elongata Harring & Myers, 1926: S	H	*T. brachyura* (Gosse, 1851): P	C
L. furcata (Murray, 1913): P, S, E	C	*T. bicristata* (Gosse,1887): P	C
L. hamata (Stokes, 1896): P, S, E	C	*T. cavia* (Gosse, 1886): P	C
L. inermis (Bryce, 1892): S, E	C	*T. capucina* Wierzejski & Zacharias, 1893: P	C
L. inopinata (Harring & Myers, 1926): E	Tp	*T. iernis* (Gosse,1887): P	C
L. leontina (Turner, 1892): P, S, E	Tp	*T. longiseta* (Schrank, 1802): P	C
L. ludwigii (Eckstein, 1893): P, S, E	C	*T. porcellus* (Gosse, 1886): P, S	C
L. luna (Müller, 1776): P, S, E	C	*T. rattus* (Müller,1776): P	C
L. lunaris (Ehrb., 1832): P, S, E	C	*T. similis* (Wierzejski, 1893): P	Tp
L. nana (Murray, 1913): P	C	*T. tigris* (Müller, 1776): P	C
**L. paxiana* (Hauer, 1940): E	Eh	*Trichocerca* sp.: P	-
L. pusilla Harring, 1914: S, E	Tp	*Trichotria tetractis* (Ehrb., 1830): P, S, E	C
L. pyriformis (Daday, 1905): P, S, E	C		

(* = New record; P = Planktonic; E = Epiphytic on the roots of *Eichhornia*; S = Epiphytic on the floating and submerged leaves of *Salvinia*; C = Cosmopolitan; Tp = Tropicopolitan; Pn = Pantropical; Pl = Paleotropical; H = Holarctic; Eh = Eastern hemisphere taxa; At = Arctic-temperate; Th = Thermophilic; ? = Distribution insufficiently known)

rather variable, but it can be recognized by its being relatively flat, as in *L. ovalis* Müller. However, it differs from the latter in having a convex rather than a deeply concave posterior lorica margin (see Figs. 14-16). Recently, Baribwegure and Segers (2001) reported this tropicopolitan species from Burundi in Africa for the first time since its original description by Myers (1942). In addition, they have confirmed its presence from northeastern Saudi Arabia and Nigeria as *L. arabica* and in collections made from 2 ponds in New Delhi. Our report supports the presence of this species in aquatic ecosystems of the Delhi region.

Lepadella biloba **Hauer**
(Figs. 17-18)

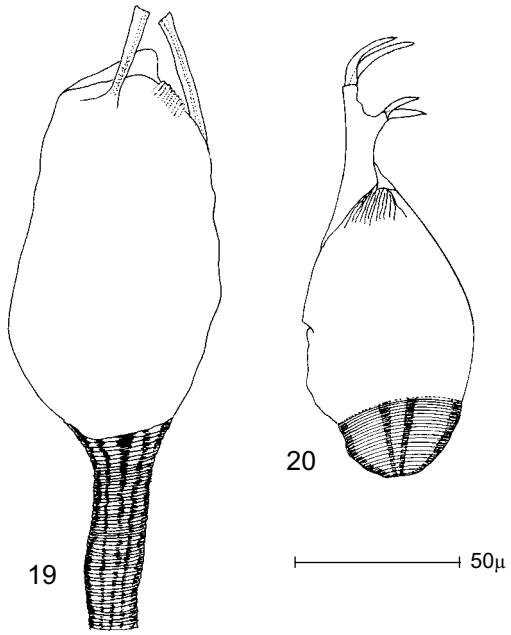
This species is characterized by the shape of its foot aperture having more or less parallel lateral margins and by a pair of acutely pointed triangular



Figs. 6-18. *Lepadella* spp, 6: *L.discoidea* Segers, ventral view; 7-8: *L. lindaui* Koste, 7: dorsal view, 8: ventral view; 9-10: *L. costatoides* Segers, 9: dorsal view; 10: ventral view; 11: *Lepadella triba* Myers, ventral view; 12-13: *L. quinquecostata* (Lucks), 12: dorsal view, 13: ventral view; 14-15: *L. eurysterna* Myers, 14: dorsal view, 15: ventral view; 16: *Lepadella ovalis* Müller, ventral view; 17-18: *Lepadella biloba* Hauer, (17) dorsal view, (18) ventral view.

distal projections. The species is closest to *L. patella* (Müller), which has a posterior distal margin with smoothly rounded projections. This cosmopolitan species was found in epiphytic samples from both *Eichhornia* and *Salvinia* (Table 1).

***Ptygura barbata* (Edmondson)**
(Fig. 19)



Figs. 19-20. *Ptygura* spp., 19: *P. barbata* (Edmondson), lateral view; 20: *P. kostei* José De Paggi, lateral view.

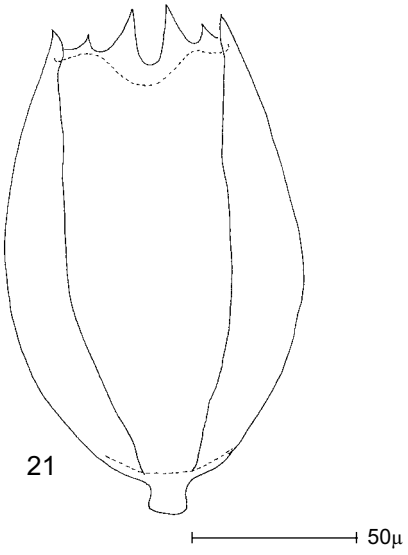


Fig. 21. *Notholca labis* Gosse, dorsal view.

Distribution of this species is insufficiently known. It has been reported from North and South America (Koste 1978) and Tasmania (Koste and Shiel 1986). The present record is the first from the Oriental region. In the present study, this species was found associated with the roots of *Eichhornia* (Table 1).

***Ptygura kostei* José De Paggi**
(Fig. 20)

This species had earlier been observed on the roots of *Eichhornia* from Thailand (Koste 1978). Also, there are records from Africa (Congo and Nigeria; Segers et al. 1993a) and Argentina (José De Paggi 1996). In the present study, it was found associated with the roots of *Eichhornia.* However, a few specimens that probably had been dislodged from the roots were found in the plankton samples.

CONCLUSIONS

The results obtained during the present study clearly demonstrate the richness of the rotifer component of the zooplankton in the backwaters of the Yamuna River probably due to high microhabitat diversity. The rotifer records consist mainly of cosmopolitan species together with some species with circumscribed or erratic distributions. However, no endemic species were recorded. The most diverse genera were *Lecane*, *Trichocerca*, and *Lepadella*, which were represented predominantly by littoral-periphytic species such as *Lecane furcata* (Murray), *L. paxiana* Hauer, *Lepadella quinquecostata* (Lucks), and *L. quadricarinata* (Stenroos). This illustrates the importance of littoral and periphytic habitats for undertaking future faunistic and zoogeographical studies. In addition, the presence of some species, especially sessile rotifers, exclusively in association with *Eichhornia* emphasizes the importance of macrophytes in influencing the distribution of rotifers.

Acknowledgments: We thank Dr. Hendrik Segers (Ghent Univ., Belgium) for his assistance in the identification of rotifers and also for providing some recent literature.

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