

## Original Article

# Loktak Lake, Manipur, northeast India: a Ramsar site with rich rotifer (Rotifera: Eurotatoria) diversity and its meta-analysis

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**Abstract:** A total of 162 species (S) of Rotifera belonging to 40 genera and 20 families examined from Loktak Lake, an important floodplain lake of northeast India (NEI) that is one of the richest assemblages of the taxon known from the Indian sub-region. It merits biodiversity value as ~40.0% and ~62.0% of species recorded from India and NEI, respectively. One species is new to India, 23 species are new to Manipur and 14 species are new to Loktak basin. Biogeographically interesting elements included three Australasian, five Oriental, ten palaeotropical and one cosmo-subtropical species. Lecanidae > Lepadellidae > Brachionidae > Trichocercidae collectively comprised 65.4% of S; *Lecane* > *Lepadella* > *Trichocerca* are diverse genera; and paucity of *Brachionus* spp. is distinct. Loktak Rotifera indicated importance of cosmopolitan, the littoral-periphytonic and small-sized species, and 'tropical character'. ANOVA recorded significant variations of the rotifer richness amongst three sampling sites of Loktak during June 2010–May 2012 survey. The richness followed oscillating monthly variations and indicated lack of significant influence of any individual abiotic parameter at all three stations.

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## Introduction

Segers et al. (1993) hypothesized tropical and subtropical floodplain lakes to be globally rich habitats for the rotifer diversity. Sharma and Sharma (2014a, 2014b) extended this hypothesis to the floodplains lakes (beels) of the Brahmaputra river basin of northeast India (NEI) with Deepor beel, a Ramsar site and an important wetland of this basin, as one of the globally interesting Rotifera habitat (Sharma and Sharma, 2015).

Realizing biodiversity value of the floodplain lakes of NEI *vis-a-vis* the role of extensive sampling, we undertook meta-analysis of Rotifera diversity of Loktak Lake, a Ramsar site of India and another important floodplain lake of NEI, based on recent collections and our earlier reports (Sharma, 2007, 2009a). An inventory of 162 species recorded till date from this floodplain lake (pat) of Manipur is presented and interesting species are illustrated. The

nature and composition of the rotifer diversity are discussed with remarks on richness, new records and species of global and regional distribution value. This study merits importance for ecosystem diversity, biogeography and for following meta-analysis of the rotifer diversity of this second well sampled freshwater ecosystem of India.

## Materials and Methods

The present study is a part of limnological survey undertaken (June 2010 - May 2012) and collections on several occasions during 2013-2015 from Loktak Lake (93°46'–93°55'E, 24°25'–24°42'N; area: 286 km<sup>2</sup>; max. depth: 4.58 m, mean depth: 2.07 m) located in Bishnupur / Imphal districts of Manipur state (NEI). This wetland is characterized by floating mats of vegetation called "Phumdi" which are inhabited by an endangered brow-antlered deer (*Rucervus eldi eldi*). The common aquatic plants of

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Table 1. Variations in certain abiotic factors of Loktak Lake.

Parameters↓	Stations→	June 2010 – May 2012 (Present study)			Sharma (2009a)
		Loktak A	Loktak B	Loktak Barrage	Nov. 2002-Oct. 03
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Water temperature (°C)		23.1±3.0	22.6±3.2	23.4±3.4	21.4 ± 4.0
pH		6.9±0.3	6.8±0.2	7.0±0.3	6.38 ± 0.23
Specific Conductivity (µS cm <sup>-1</sup> )		80.9±21.7	86.1±21.7	113.1±24.1	98.9 ± 19.7
Free Carbon dioxide (mg l <sup>-1</sup> )		10.6±4.3	13.5±5.6	8.8±3.1	9.5 ± 2.1
Dissolved oxygen (mg l <sup>-1</sup> )		5.2±1.6	4.6±2.0	6.0±2.7	6.2 ± 1.1
Total Alkalinity (mg l <sup>-1</sup> )		65.2±16.5	72.8±24.7	72.6±12.3	16.0 ± 4.4
Total Hardness (mg l <sup>-1</sup> )		51.0±12.8	59.2±18.4	73.1±17.9	38.1 ± 8.2
Calcium (mg l <sup>-1</sup> )		33.7±9.8	37.4±18.9	38.1±9.6	8.9 ± 3.0
Chloride (mg l <sup>-1</sup> )		23.7±6.2	23.4±7.8	19.3±5.5	14.9 ± 3.1

this Ramsar site included *Ceratophyllum demersum*, *Eichhornia crassipes*, *Pistia stratiotes*, *Salvinia cucullata*, *Savinia natans*, *Euryale ferox*, *Hydrilla verticillata*, *Nymphoides cristatum*, *Trapa natans*, *Potamogeton crispus*, *Alternanthera philoxeroides*, *Rumex nepalensis*, *Ipomoea arguta*, *Polygonum pulchrum*, *Utricularia* sp., *Vallisneria* sp., *Oryza rufipogon*, *Spiranthes sinensis* and *Nelumbo nucifera*.

Water samples and qualitative plankton were collected, at regular monthly intervals during June 2010 - May 2012 limnological survey, at three sampling sites namely Loktak A (93°45'56.3"E; 24°32'13.5"N; alt. 726 m ASL), Loktak B (93°47'58.1"E; 24°30'39.1"N; alt. 714 m ASL) and Loktak Barrage (93°45'43.5"E; 24°32'46.9"N; alt. 718 m ASL). In addition, qualitative plankton samples were collected from different parts of Loktak basin during the study period. Water temperature, specific conductivity and pH were recorded with field probes; dissolved oxygen was estimated by Winkler's method; and total alkalinity, total hardness, calcium and chloride were analyzed following APHA (1992).

The plankton samples were collected by towing a nylobolt plankton net (#50 µm) and preserved in 5% formalin; aquatic vegetation was disturbed before each sampling to facilitate collection of planktonic and semi-planktonic rotifers. Individual collections were screened with a Wild stereoscopic binocular microscope; the rotifers were isolated and mounted in Polyvinyl alcohol-lactophenol, and observed with Leica (DM 1000) stereoscopic phase contrast microscope fitted with an image analyzer. The

measurements were given in micrometers (µm). The rotifer taxa were identified following Koste (1978), Segers (1995), Sharma (1983, 1998a), Sharma and Sharma (1997, 1999, 2000, 2008, 2013). The rotifer community similarities were calculated vide Sørensen's index (Sørensen, 1948) and Two-way ANOVA was used to analyze the significance of temporal variations of richness. Ecological relationships between abiotic factors and the rotifer richness were determined by Pearson's correlation coefficients (r); *P* values were calculated vide <http://faculty.vassar.edu/lowry/tabs.html> and significance was ascertained after use of Bonferroni corrections.

## Results

The variations (ranges, mean ±SD) of the recorded abiotic factors are presented in Table 1 in comparison with the report of Sharma (2009a). Water temperature at three sampling stations of Loktak Lake varied between 22.6±3.2 – 23.4±3.4°C, pH ranged between 6.8±0.2 – 7.0±0.3 and specific conductivity varied between 80.9±21.7 – 113.1±24.1 µS cm<sup>-1</sup> while dissolved oxygen and free carbon dioxide fluctuated between 4.6±2.0 – 6.0±2.7 mg l<sup>-1</sup> and 8.8±3.1 - 13.5±5.6 mg l<sup>-1</sup>, respectively. Total alkalinity, total hardness, calcium and chloride ranged between 65.2±16.5–72.8±24.7 mg l<sup>-1</sup>; 51.0±12.8 - 73.1±17.9 mg l<sup>-1</sup>; 33.7±9.8 - 38.1±9.6 mg l<sup>-1</sup> and 19.3±5.5 - 23.7±6.2 mg l<sup>-1</sup> between three sampling stations of Loktak, respectively.

We report a total of 162 species spread over 40 genera and 20 families from Loktak Lake (Appendix

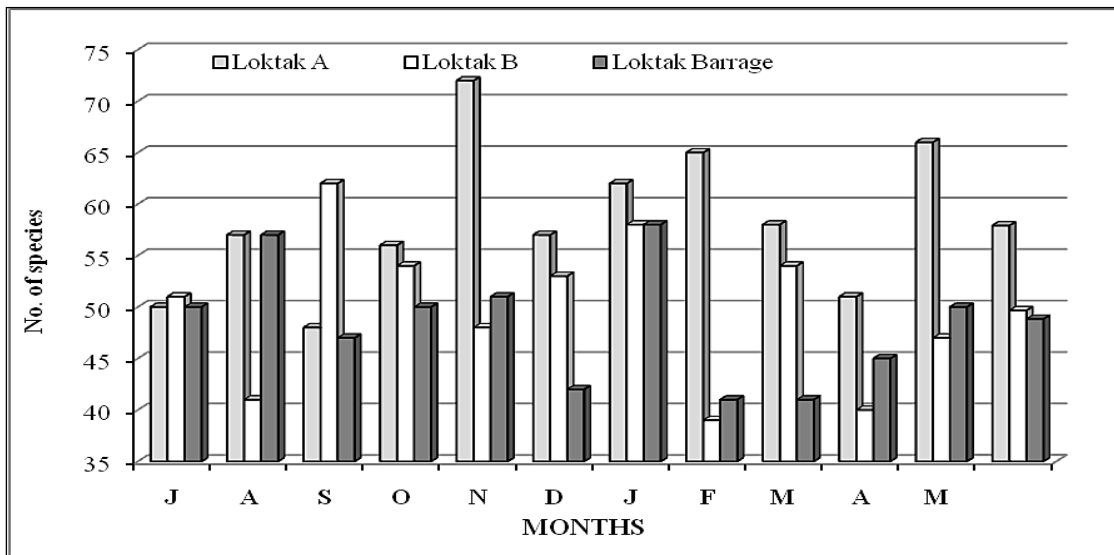


Figure 1. Species richness of Loktak Rotifera (2010-2011).

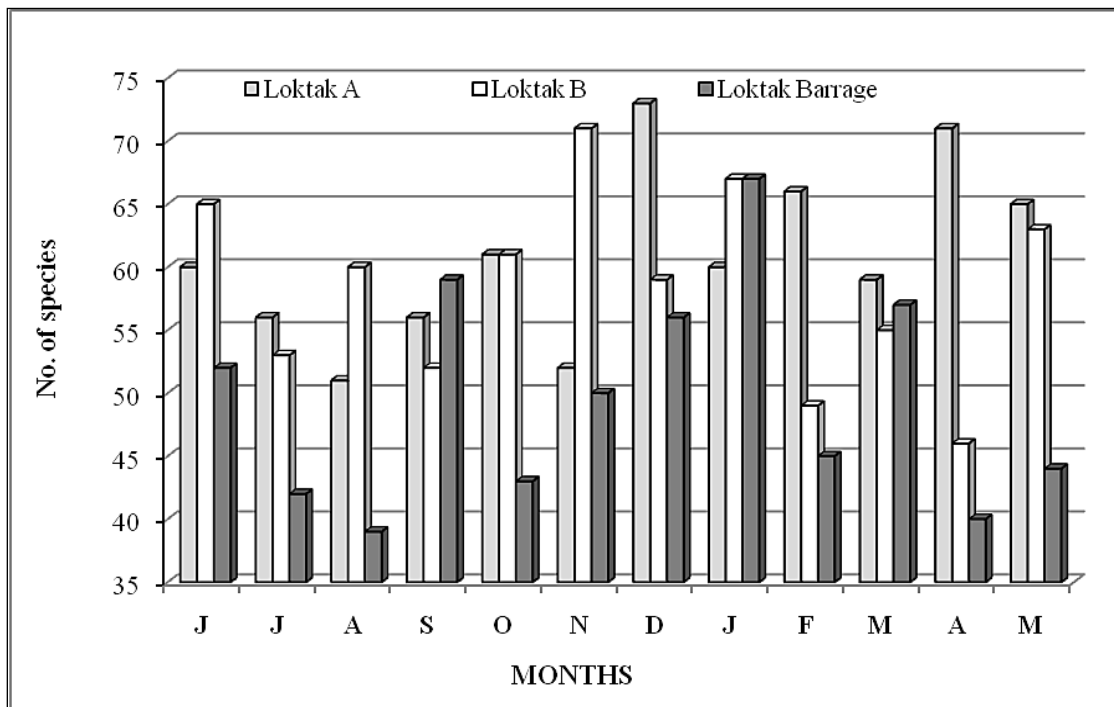


Figure 2. Species richness of Loktak Rotifera (2011-2012).

1) and interesting taxa are illustrated; of these, 152 species are observed in 2010-2015 collections. Further, 135 species are observed at three sampling stations namely Loktak A, Loktak B and Loktak Barrage during June 2010 - May 2012 survey. The rotifer richness (Figs. 1, 2) ranged between 44-79 ( $60 \pm 8$ ), 46-72 ( $58 \pm 7$ ) and 39-67 ( $50 \pm 8$ ) species at three stations, respectively and recorded 73.2-78.5% community similarities vide Sørensen's index. Peak richness is observed during December 2011, November 2011 and January 2012 at Loktak A,

Loktak B and Loktak Barrage, respectively.

*Mytilina lobata* (Fig. 3a) is a new record to the Indian Rotifera. *Brachionus caudatus*, *B. durgae*, *B. kostei* (Fig. 3b), *E. meneta*, *Keratella tecta*, *Lecane aspasia* (Fig. 3c), *L. bifurca*, *L. rhenana* (Fig. 3d), *L. rhytida* (Fig. 3e), *L. undulata*, *Lepadella minuta*, *L. quadricarinata* (Fig. 3f), *L. quinquecostata* (Fig. 3g), *Mytilina acanthophora* (Fig. 3h), *M. michelangellii* (Fig. 3i), *Trichocerca edmondsoni* (Fig. 3j), *T. hollaerti* (Fig. 3k), *T. maior* (Fig. 3l), *T. scipio*, *T. weberi* (Fig. 3m), *Sinantherina*

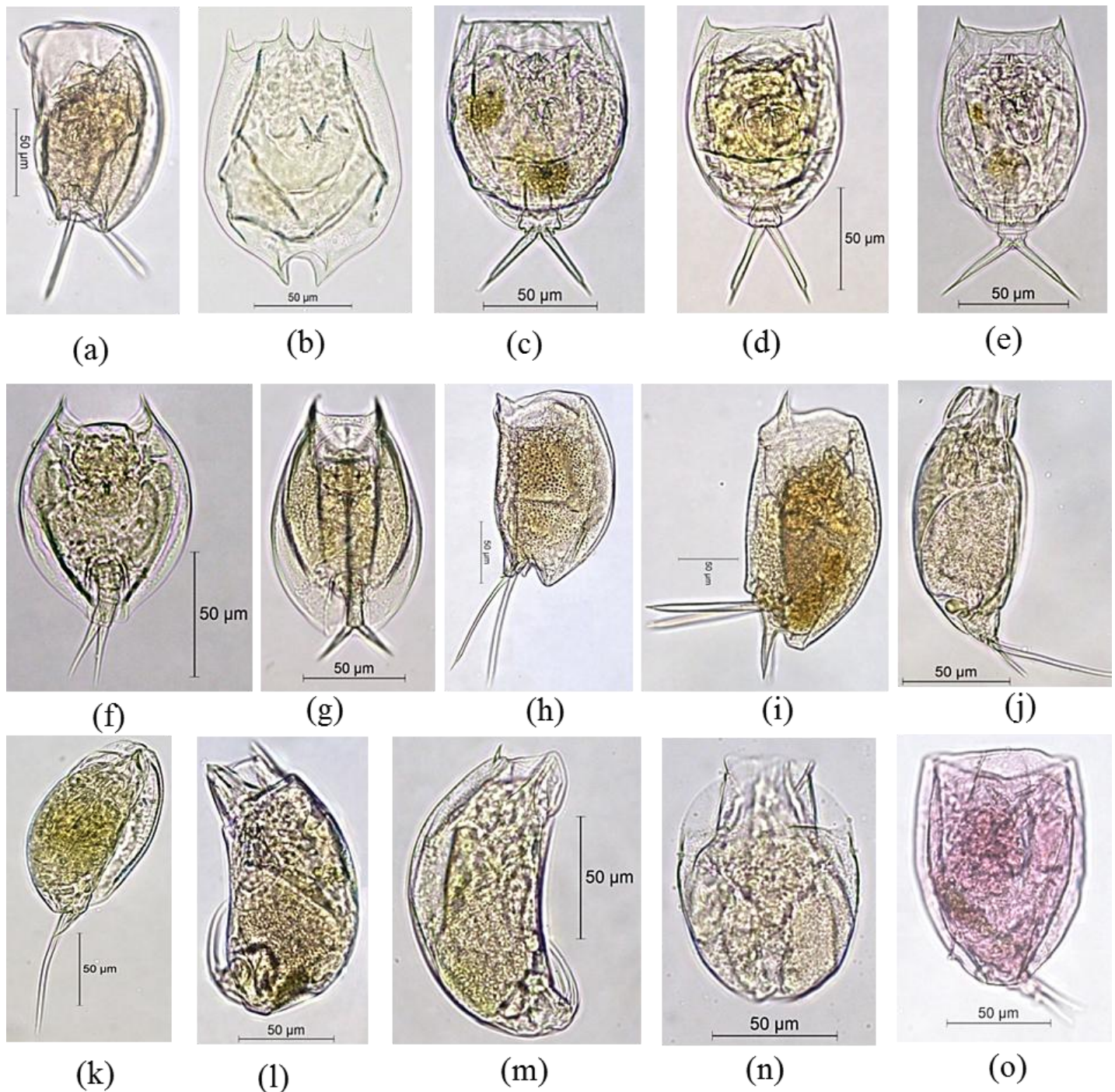


Figure 3. (a) *Mytilina lobata* Pourriot (lateral view), (b) *Brachionus bennini* Leissling (dorsal view), (c) *Lecane aspasia* Myers (dorsal view), (d) *Lecane rhenana* Hauer (dorsal view), (e) *Lecane rhytida* Harring & Myers (dorsal view), (f) *Lepadella quadricarinata* (Stenroos) (ventral view), (g) *Lepadella quinquecostata* (Lucks) (dorsal view), (h) *Mytilina acanthophora* Hauer (lateral view), (i) *Mytilina michelangellii* Reid & Turner (lateral view), (j) *Trichocerca edmondsoni* (Myers) (ventral view), (k) *Trichocerca hollaerti* De Smet (lateral view), (l) *Trichocerca maior* Hauer (lateral view), (m) *Trichocerca weberi* (Jennings) (lateral view); (n) *Testudinella amphora* Hauer (dorsal view), and (o) *Wolga spinifera* (Western) (dorsal view) .

*semibullata*, *Testudinella amphora* (Fig. 3n) and *Wolga spinifera* (Fig. 3o) are new records from Manipur. *Brachionus bidentatus*, *Epiphanes brachionus*, *E. incisa*, *K. lenzi*, *Lecane aeganea*,

*L. arcula*, *L. bulla diabolica*, *L. haliclysta*, *L. pusilla*, *L. thienemanni*, *Lepadella desmeti*, *L. triba*, *Platyias leloupi* and *Trochosphaera aequatorialis* are new records from Loktak Lake. *Euchlanis semicarinata*,

*Filinia brachiata*, *Floscularia ringens*, *Habrotrocha angusticollis*, *Lecane acanthinula* and *L. solfatara*, *Macrochaetus danneelae*, *Rotaria macroceros* and *R. tardigrada* are not observed in 2010-2015 collections.

### Discussion

Water temperature affirmed sub-tropical nature of Loktak Lake concurrent with its location. The slightly acidic-slightly alkaline, marginally hard and calcium-poor waters are characterized by low ionic concentration as indicated by specific conductivity at all three sampling stations; the latter warranted their inclusion under 'Class I' category of trophic classification vide Talling and Talling (1965). This study indicated well-oxygenated waters, low free CO<sub>2</sub> and low chloride content. Our report differed in pH, alkalinity, hardness and marginal increase in calcium and chloride values than an earlier report (Sharma, 2009a) based on sampling at one station (Sendra).

The present collections revealed a total of 152 rotifer species, including one species new to India, 23 species new to Manipur and 14 species new to Loktak basin. This is in contrast to an earlier report of 120 species from this wetland (Sharma, 2009a) with ~82% community similarity between two lists. Our report raised total richness (S) known to date from this Ramsar site to 162 species which, in turn, is one of the richest Rotifera assemblage known from any freshwater ecosystem of the Indian sub-region following the report of 171 species from Deepor beel (Sharma and Sharma, 2015) - another Ramsar site of India. The rotifer fauna of Loktak reflected 78.7% community similarity with the latter because of common occurrence of several cosmopolitan, cosmopolitan and pantropical species. Total richness (S) merits biodiversity value as ~ 40.0% and ~ 62.0% of species of Rotifera known from India and NEI, respectively. The report of 40 genera and 20 families from Loktak Lake reflected rich higher diversity as compared with 50 genera and 23 families as well as 65 genera and 25 families of this phylum known from NEI (Sharma and Sharma, 2014a) and

India (BKS, unpublished), respectively while it broadly concurred with 38 genera and 20 families known from Deepor Beel (Sharma and Sharma, 2015). The rich and diverse assemblage of Loktak Rotifera, affirming biodiversity value of this 'hot-spot', is hypothesized to habitat diversity and environmental heterogeneity of this Ramsar site. This generalization supported hypothesis of Segers et al. (1993) indicating (sub) tropical floodplains to be the world's rotifer rich habitats and also concurred with reports from the floodplains of Argentina (Jose De Paggi, 1993, 2001), Brazil (Bonecker et al., 1998), Australia (Shiel et al., 1998), and the Brahmaputra river basin of India (Sharma and Sharma, 2014b).

*Mytilina lobata* is a new addition to the Indian Rotifera. Known from Neotropical region (Segers, 2007), the present report extended its distributional limit to the Oriental region. Twenty-three species are new records from Manipur. Besides, this study extended distribution of fourteen species to Loktak Lake basin (Appendix 1).

A total of nineteen globally interesting elements (~12.0% of S) now known from Loktak Lake is of biogeography value than twelve species listed by Sharma (2009a). These included the Australasian *Brachionus kostei*, *Macrochaetus danneelae* and *Notommata spinata*; five Oriental endemics, namely *Filinia camasecla*, *Lecane acanthinula*, *Lecane bulla diabolica* and *L. niwati* and *L. solfatara*; the palaeotropical *Euchlanis semicarinata*, *Lecane lateralis*, *L. simonneae*, *L. unguitata*, *Lepadella bicornis*, *L. discoidea*, *L. vandenbrandei*, *Testudinella brevicaudata*, *Trichocerca abilioi* and *T. hollaerti* are palaeotropical species; and *Brachionus durgae* is a cosmo (sub) tropical species. Of these, *Brachionus kostei*, *Euchlanis semicarinata*, *Notommata spinata*, *Lecane niwati*, *L. solfatara*, *Lepadella vandenbrandei*, *Notommata spinata*, *Testudinella brevicaudata*, *Trichocerca abilioi* and *T. hollaerti* are interestingly restricted in their distribution in India exclusively to NEI.

*Ascomorpha ecaudis*, *Brachionus mirabilis*, *Filinia brachiata*, *F. saltator*, *Keratella lenzi*, *Lecane*

*aeganea*, *L. aspasia*, *L. bifurca*, *L. doryssa*, *L. elegans*, *L. haliclysta*, *L. rhenana*, *L. rhytida*, *L. simonneae*, *L. pusilla*, *L. tenuiseta*, *L. thienemanni*, *Lepadella benjamini*, *L. bicornis*, *L. costatoides*, *L. dactyliseta*, *L. desmeti*, *L. elongata*, *L. quadricarinata*, *L. quinquecostata*, *Lophocharis salpina*, *Mytilina acanthophora*, *M. bisulcata*, *M. michelangellii*, *Macrochaetus longipes*, *Platyias leloupi*, *Testudinella amphora*, *T. parva*, *T. emarginula*, *T. tridentata*, *Trichocerca bicristata*, *T. edmondsoni*, *T. insignis*, *T. flagellata*, *T. maior*, *T. scipio*, *T. tenuior*, *T. weberi*, *Tripleuchlanis plicata* and *Trochosphaera aequatorialis* are examples of regional distributional importance in the Indian sub-continent. Of these, *Testudinella amphora* is a recently reported from India from Assam (Sharma et al. 2015); *Lecane aeganea*, *Trichocerca hollaerti* and *T. maior* are new additions to the Indian Rotifera from Mizoram state of NEI (Sharma and Sharma 2015).

Our present tally of 152 species of Loktak Rotifera reflected its diverse nature than the reports of 111 species from the floodplains of Argentina (Jose De Paggi, 1993); 124 species (lake) and 136 species from Oguta and Iyi-Efi lakes, respectively of the Niger delta (Segers et al., 1993); 130 species from Lake Guarana, Brazil (Bonecker et al., 1994); 106 taxa from Thale-Noi Lake, a Ramsar site in Thailand (Segers and Pholpunthin, 1997); 104 species from Laguana Bufeos, Bolivia (Segers et al., 1998); and 114 taxa examined from the Rio Pilcomayo National park (a Ramsar site), Argentina (Jose De Paggi, 2001). The richness is higher than 67-103 species (Sharma, 2005), 69-93 species (Sharma and Sharma, 2008) and 60-100 species (Sharma et al., 2015) examined from various beels of the Brahmaputra river basin, Assam; and 62-73 species reported from 14 floodplain lakes (pats) of Manipur (Sharma, 2009b). We caution on over-emphasis on comparisons of richness as it was likely to be influenced by sampling intensity (Dumont and Segers, 1996). We attribute high richness of Rotifera of Loktak to the rotiferologist effect following Fontaneto et al. (2012) though our biodiversity

update is also the result of the sampling intensity.

Loktak Rotifera is characterized by diverse Lecanidae (47 species) > Lepadellidae (27 species) > Brachionidae (17 species) > Trichocercidae (15 species) which collectively formed 65.4% of S. It differed from the importance of Lecanidae > Lepadellidae > Trichocercidae > Brachionidae listed earlier from this Ramsar site (Sharma, 2009a) with distinct increase in the richness of the first two families in our recent collections. Nevertheless, marginal increase in the brachionid diversity deserved caution due to their yet restricted occurrence and of *Brachionus* spp. in particular. This feature differed from high Brachionidae richness (28 species) reported from Deepor beel (Sharma and Sharma, 2015). Notommatidae = Euchlanidae > Testudinellidae = Trochosphaeridae = Mytilinidae, other diverse families (~20.0% of S), deserved attention in Loktak Lake.

The littoral-periphytonic *Lecane* (47 species) > *Lepadella* (22 species) > *Trichocerca* (17 species), together, included ~52.0% of S of Loktak Rotifera and thus supported hypothesis of Green (2003) on the possibility of assemblage rules for the periphytic community. Interestingly, their significance broadly concurred with the reports from the floodplains of Niger delta (Segers et al., 1993), Broa reservoir, Brazil (Segers and Dumont, 1995), River Nan, Thailand (Sanoamuang, 1998), Bolivia (Segers et al., 1998) and Okavango Delta of South Africa (Green, 2003); it also concurred with the report from Deepor beel (Sharma and Sharma, 2015).

The rich diversity of 'tropic-centered' *Lecane*, more cosmopolitan species (~60% of S), and collective importance (~24% of S) of cosmopolitan and pantropical species assigned 'tropical character' to Loktak Rotifera. This conclusion is concurrent with several tropical faunas (Green, 1972; Pejler, 1977; Fernando, 1980; Dussart et al., 1984; Segers, 1996, 2001) globally as well as from India (Sharma, 1996, 1998b, 2005; Sharma and Sharma, 2008; 2014a, 2014b, 2015). These remarks are supported by relative paucity of 'temperate-centered' *Keratella* in our collections.

High richness of the littoral-periphytonic and fewer euplanktonic species in Loktak are hypothesized to paucity of definite limnetic habitats (De Manuel, 1994). The occurrence of both non-planktonic species and planktonic taxa in the littoral weedy margin of this Ramsar site affirmed occupation of different niches as hypothesized by Bonecker et al. (1998). These features concurred with the reports from Deepor beel (Sharma and Sharma, 2013, 2015) and other floodplain lakes of the Brahmaputra river basin (Sharma and Sharma, 2014b). Loktak Rotifera is notable for large number of small-sized species particularly of *Lecane*, *Lepadella*, *Trichocerca* and *Colurella*. This feature is hypothesized to predation by juvenile fish and invertebrates (Baumgartner et al., 1997) but specific observations are desired to confirm predation effect.

Our June 2010 - May 2012 limnological survey registered significant variations of the rotifer richness amongst three Loktak stations during the study period ( $F_{2, 46}=11.473$ ,  $P=9.07E-05$ ) as well as during two successive years ( $F_{2, 22}=4.327$ ,  $P=0.026$ ;  $F_{2, 22}=7.051$ ,  $P=0.004$ ) as against insignificant variations reported earlier (Sharma, 2009a). Further, it recorded significant monthly variations at two sampling sites: Loktak B ( $F_{1, 11}=3.536$ ,  $P=0.023$ ) and Loktak Barrage ( $F_{1, 11}=6.618$ ,  $P=0.002$ ) and followed oscillating variations with maxima during December 2011, November 2011 and January 2012 at Loktak A, Loktak B and Loktak Barrage, respectively. This study indicated lack of significant influence of any individual abiotic factor on the richness in contrast to inverse correlation with rainfall, pH, hardness, nitrate, chloride and total dissolved solids and positive correlation with dissolved oxygen recorded vide Sharma (2009a). The differences suggested that the rotifers are generalists in terms of abiotic factors vs. their occurrence with factors associated with microhabitat being more important.

To sum up, the specious and diverse Rotifer assemblage of Loktak Lake, with various new records and species of global and regional interest, imparted biodiversity and biogeography merit to our

meta-analysis. With our bias towards inclusion of monogonont plankton and semi-plankton taxa, this study suggested scope for further up-date of the rotifer inventory of this 'hot-spot' based on specific sampling of periphytic, sessile, colonial and benthic communities. We estimate the report of 220<sup>+</sup> species from this Ramsar site while analysis of the 'rotifer-macrophytes associations' merits biodiversity interest due to lack of such studies in India.

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**Appendix 1:** Systematic list of Rotifera recorded from Loktak**Phylum:** Rotifera**Super-class:** Eurotatoria**Class:** Monogononta**Order:** Ploimida**Family:** Brachionidae

1. *Anuraeopsis fissa* Gosse, 1851
2. *Brachionus angularis* Gosse, 1851
3. *B. bidentatus* Anderson, 1889 \*\*\*
4. *B. calyciflorus* Pallas, 1766
5. *B. caudatus* Barrois & Daday, 1894 \*\*
6. *B. falcatus* Zacharias, 1898
7. *B. durgae* Dhanapathi, 1974 \*\*
8. *B. kostei* Shiel, 1983 \*\*
9. *B. mirabilis* Daday, 1897
10. *B. quadridentatus* Hermann, 1783
11. *Keratella cochlearis* (Gosse, 1851)
12. *K. lenzi* Hauer, 1953 \*\*\*
13. *K. tropica* (Apstein, 1907)
14. *K. tecta* (Gosse, 1851) \*\*
15. *Platyias leloupi* (Gillard, 1967) \*\*\*
16. *P. quadricornis* (Ehrenberg, 1832)
17. *Plationus patulus* (O.F. Müller, 1786)

**Family:** Epiphanidae

18. *Epiphanes brachionus* (Ehrenberg, 1837) \*\*\*

**Family:** Euchlanidae

19. *Beauchampiella eudactylota* (Gosse, 1886)
20. *Dipleuchlanis propatula* (Gosse, 1886)
21. *Euchlanis dilatata* Ehrenberg, 1832
22. *E. incisa* Carlin, 1939 \*\*\*
23. *E. meneta* Myers, 1930 \*\*
24. *E. semicarinata* Segers, 1993 #
25. *E. triquetra* Ehrenberg, 1838
26. *Tripleuchlanis plicata* (Levande, 1894)

**Family:** Mytilinidae

27. *Lophocharis salpina* (Ehrenberg, 1834)
28. *Mytilina acanthophora* Hauer, 1938 \*\*
29. *M. bisulcata* (Lucks, 1912)
30. *M. lobata* Pourriot, 1996 \*
31. *M. michelangellii* Reid & Turner, 1988 \*\*
32. *M. ventralis* (Ehrenberg, 1830)

**Family:** Trichotriidae

33. *Macrochaetus danneelae* Koste & Shiel, 1983 #
34. *M. longipes* Myers, 1934)
35. *M. sericus* (Thorpe, 1893)
36. *Trichotria tetractis* (Ehrenberg, 1830)
37. *Volga spinifera* (Western, 1894) \*\*

**Family:** Lepadellidae

38. *Colurella adriatica* (Ehrenberg, 1837)
39. *C. obtusa* (Gosse, 1886)
40. *C. sulcata* (Stenroos, 1898)

41. *C. uncinata* (O. F. Müller, 1773)
42. *Lepadella acuminata* (Ehrenberg, 1834)
43. *L. apsicora* Myers, 1934
44. *L. apsida* Haring, 1916
45. *L. bicornis* Vasisht & Battish, 1971
46. *L. benjamini* Haring, 1916
47. *L. costatoides* Segers, 1992
48. *L. dactyliseta* (Stenroos, 1898)
49. *L. desmeti* Segers & Chittapun, 2001 \*\*\*
50. *L. discoidea* Segers, 1993
51. *L. eurysterna* Myers, 1942
52. *L. ehrenbergi* (Perty, 1850)
53. *L. heterostyla* (Murray, 1913)
54. *L. lindau* Koste, 1981
55. *L. minuta* (Weber & Montet, 1918) \*\*
56. *L. ovalis* (O.F. Müller, 1786)
57. *L. patella* (O.F. Müller, 1773)
58. *L. quadricarinata* (Stenroos, 1898) \*\*
59. *L. quinquecostata* (Lucks, 1912) \*\*
60. *L. rhomboidea* (Gosse, 1886)
61. *L. triba* Myers, 1934 \*\*\*
62. *L. triptera* Ehrenberg, 1832
63. *L. vandenbrandei* Gillard, 1952
64. *Squatinella mutica* (Ehrenberg, 1832)

**Family:** Lecanidae

65. *Lecane acanthinula* (Hauer, 1938) #
66. *L. aculeata* (Jakubski, 1912)
67. *L. aeganea* Haring, 1914 \*\*\*
68. *L. arcua* Haring, 1914 \*\*\*
69. *L. aspasia* Myers, 1917 \*\*
70. *L. bifurca* (Bryce, 1892) \*\*
71. *L. blachei* Berzins, 1973
72. *L. bulla* (Gosse, 1851)
  - L. bulla diabolica* (Hauer, 1936) \*\*\*
73. *L. closterocerca* (Schmarda, 1859)
74. *L. crepida* Haring, 1914
75. *L. curvicornis* (Murray, 1913)
76. *L. decipiens* (Murray, 1913)
77. *L. doryssa* Haring, 1914
78. *L. elegans* Haring, 1914
79. *L. flexilis* (Gosse, 1886)
80. *L. furcata* (Murray, 1913)
81. *L. haliclysta* Haring & Myers, 1926 \*\*\*
82. *L. hamata* (Stokes, 1896)
83. *L. hornemanni* (Ehrenberg, 1834)
84. *L. inermis* (Bryce, 1892)
85. *L. inopinata* Haring & Myers, 1926
86. *L. lateralis* Sharma, 1978
87. *L. leontina* (Turner, 1892)
88. *L. ludwigii* (Eckstein, 1883)
89. *L. luna* (O.F. Müller, 1776)
90. *L. lunaris* (Ehrenberg, 1832)
91. *L. monostyla* (Daday, 1897)

92. *L. nitida* (Murray, 1913)  
 93. *L. niwati* Segers, Kotheip & Sanoamuang, 2004  
 94. *L. obtusa* (Murray, 1913)  
 95. *L. ohioensis* (Herrick, 1885)  
 96. *L. papuana* (Murray, 1913)  
 97. *L. ploenensis* (Voigt, 1902)  
 98. *L. pusilla* Haring, 1914 \*\*\*  
 99. *L. quadridentata* (Ehrenberg, 1830)  
 100. *L. rhenana* Hauer, 1929 \*\*  
 101. *L. rhytida* Haring & Myers, 1926 \*\*  
 102. *L. ruttneri* Hauer, 1938  
 103. *L. signifera* (Jennings, 1896)  
 104. *L. simonneae* Segers, 1993  
 105. *L. solfatara* (Hauer, 1938) #  
 106. *L. stenroosi* (Meissner, 1908)  
 107. *L. tenuiseta* Haring, 1914  
 108. *L. thienemanni* (Hauer, 1938) \*\*\*  
 109. *L. undulata* Hauer, 1938 \*\*  
 110. *L. unguitata* (Fadeev, 1925)  
 111. *L. unguolata* (Gosse, 1887)

**Family: Notommatidae**

112. *Cephalodella forficula* (Ehrenberg, 1830)  
 113. *C. gibba* (Ehrenberg, 1830)  
 114. *C. mucronata* Myers, 1924  
 115. *Monommata longiseta* (O.F. Müller, 1786)  
 116. *M. maculata* Haring & Myers, 1930  
 117. *Monommata* sp.  
 118. *Notommata spinata* Koste & Shiel, 1991

**Family: Scaridiidae**

119. *Scaridium longicaudum* (O.F. Müller, 1786)

**Family: Gastropodidae**

120. *Ascomorpha ecaudis* Perty, 1850

**Family: Trichocercidae**

121. *Trichocerca abiloi* Segers & Sarma, 1993 #  
 122. *T. bicristata* (Gosse, 1887)  
 123. *T. cylindrica* (Imhof, 1891)  
 124. *T. edmondsoni* (Myers, 1936) \*\*  
 125. *T. elongata* (Gosse, 1886)  
 126. *T. flagellata* Hauer, 1938  
 127. *T. hollaerti* De Smet, 1990 \*\*  
 128. *T. insignis* (Herrick, 1885)  
 129. *T. longiseta* (Schränk, 1802)  
 130. *T. maior* Hauer, 1936 \*\*  
 131. *T. rattus* (O.F. Müller, 1776)  
 132. *T. scipio* (Gosse, 1886) \*\*  
 133. *T. similis* (Wierzejski, 1893)  
 134. *T. tenuior* (Gosse, 1886)

135. *T. weberi* (Jennings, 1903) \*\*

**Family: Asplanchnidae**

136. *Asplanchna priodonta* Gosse, 1850

**Family: Synchaetidae**

136. *Ploesoma lenticulare* Herrick, 1855  
 137. *Polyarthra vulgaris* Carlin, 1943  
 138. *Synchaeta pectinata* Ehrenberg, 1832

**Family: Dicranophoridae**

139. *Dicranophoroides caudatus* (Ehrenberg, 1834)  
 140. *Dicranophorus forcipatus* (O.F. Müller, 1786)

**Order: Flosculariaceae****Family: Flosculariidae**

141. *Floscularia ringens* (Linnaeus, 1758) #  
 142. *S. semibullata* (Thorpe, 1893) \*\*  
 143. *Sinatherina spinosa* (Thorpe, 1893)  
 144. *S. socialis* (Linnaeus, 1758)

**Family: Conochilidae**

145. *Conochilus unicornis* Rousset, 1892

**Family: Trochosphaeridae**

146. *Filinia brachiata* (Rousset, 1901) #  
 147. *F. camasecla* Myers, 1938  
 148. *F. longiseta* (Ehrenberg, 1834)  
 149. *F. opoliensis* (Zacharias, 1898)  
 150. *F. saltator* (Gosse, 1886)  
 151. *Trochosphaera aequatorialis* Semper, 1872 \*\*\*

**Family: Testudinellidae**

152. *Testudinella amphora* Hauer, 1938 \*\*  
 153. *T. brevicaudata* Yamamoto, 1951  
 154. *T. emarginula* (Stenroos, 1898)  
 155. *T. parva* (Ternetz, 1892)  
 156. *T. patina* (Hermann, 1783)  
 157. *T. tridentata* Smirnov, 1931

**Class: Bdelloidea****Order: Philodinida****Family: Philodinidae**

158. *Philodina citrina* Ehrenberg, 1832  
 159. *Rotaria macroceros* (Gosse, 1851) #  
 160. *R. neptunia* (Ehrenberg, 1830)  
 161. *R. tardigrada* (Ehrenberg, 1832) #

**Family: Habrotrochidae**

162. *Habrotrocha angusticollis* (Murray, 1905) #

\* New record from India; \*\*New record from Manipur state; \*\*\* New record from Loktak; # not observed in present collections