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ROTIFER COMMUNITIES (ROTIFERA : EUROTATORIA) OF RICE-FIELD ECOSYSTEMS OF MEGHALAYA : COMPOSITION AND DISTRIBUTION

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INTRODUCTION

Rice fields exhibit a rich mosaic of ecotones, changing in time and space seasonally and rapidly and are characterized by complex limnology not mirrored by any natural aquatic habitat (Fernando, 1995). In addition, they combine unique features of aquatic and semi-aquatic environs during different growth phases of paddy cultivation and are known to be biologically diverse biotopes colonized by a wide spectrum of aquatic organisms (Fernando *et al.*, 1979; Fernando, 1993) in general and micro-invertebrate communities in particular. The later, in turn, are invariably characterized by greater rotifer richness.

A review of the Indian literature reveals general lack of attention on micro-faunal diversity of Phylum Rotifera in rice-fields of this country (Sharma, 1998a). Sharma and Sharma (1999, 2005), however, remarked on occurrence of rotifers in these ecosystems and commented on importance of extensive faunal investigations in these interesting environs. The present study, an attempt to fill up the stated lacuna, provides a detailed account of the rotifer taxocoenosis of the rice-field ecosystems of Meghalaya based on collections examined from different parts of this state. Seventy-four species of Eurotatoria are documented in this account. Various rare and interesting species are briefly diagnosed and illustrated. Remarks are made on nature and composition of the examined rotifer fauna and on distribution of interesting elements.

MATERIALS AND METHODS

The present observations are based on plankton samples collected, during 2001–2003 and also those collected earlier (during 1988–1990) for the “State Fauna of Meghalaya : Zooplankton Survey”

from rice-fields located in different districts of Meghalaya state (Fig. 1, a-b). The material examined for this systematic survey included the samples deposited in Freshwater Biology Laboratory, Department of Zoology, North-Eastern Hill University, Shillong and those in the holdings of the Eastern Regional Station, Zoological Survey of India, Shillong.

The examined samples are collected, during the period of paddy-cultivation (May/June-October), with a nylobolt plankton net (No. 25) and preserved in 5% formalin. Various samples are screened, the rotifer taxa are isolated, and permanently mounted individually in Polyvinyl alcohol-lectophenol mixture. The drawings are made with a Leitz-Dialux phase contrast stereoscopic microscope using a drawing tube attachment and measurements are indicated in micrometers (μm).

The rotifer taxa are identified following the works of Kutikova (1970), Koste (1978), Sharma (1983, 1998b), Segers (1995) and Sharma & Sharma (1999, 2000). The recent system of nomenclature of Rotifera proposed by Segers (2002) is followed in this account. The distribution of the recorded taxa refers to their reports from Meghalaya and India and that from elsewhere refers to the global distribution.

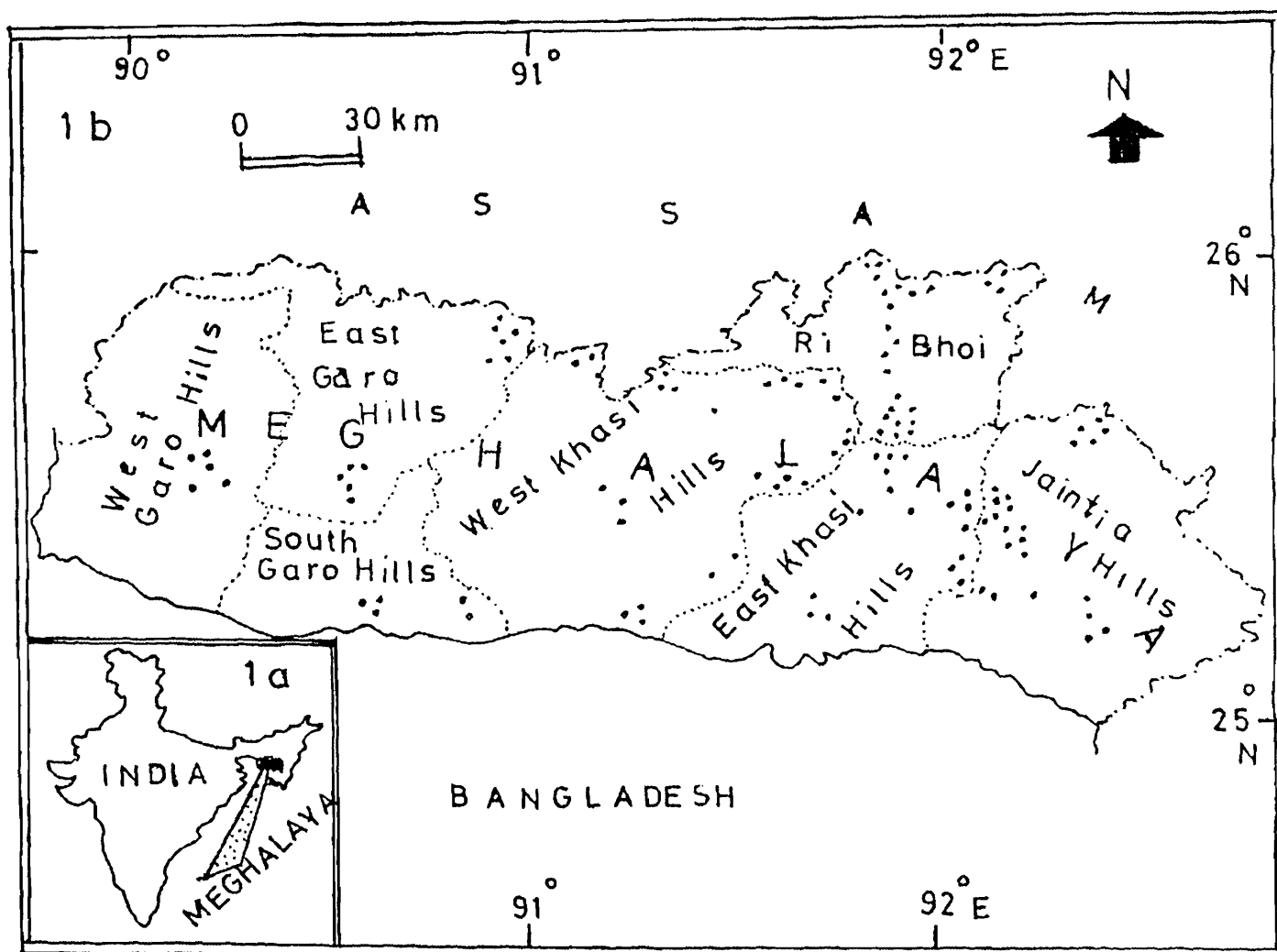


Fig. 1(a-b). : (a) Map of India indicating the state of Meghalaya; (b) Map of Meghalaya showing the sampling sites.

SYSTEMATIC LIST OF ROTIFERA RECORDED FROM RICE-FIELDS

Phylum ROTIFERA

Class EUROTATORIA

Subclass MONOGONONTA

Order PLOIMIDA

Family BRACHIONIDAE

<i>Brachionus angularis</i> Gosse, 1851	C
<i>Brachionus bidentatus</i> Anderson, 1889	Pt
<i>Brachionus falcatus</i> Zacharias, 1898	Pt
<i>Brachionus dichotomus reductus</i> Koste & Shiel, 1980	A
<i>Brachionus quadridentatus</i> (Hermann, 1783)	C
<i>Keratella cochlearis</i> Gosse, 1851	C
<i>Keratella tropica</i> (Apstein, 1907)	C
<i>Platylabus quadricornis</i> (Ehrenberg, 1832)	C
<i>Platylabus patulus</i> (O.F. Müller, 1786)	C
<i>Platylabus patulus macracanthus</i> (Daday, 1905)	N

Family EUCHLANIDAE

<i>Euchlanis dilatata</i> Ehrenberg, 1832	C
<i>Dipleuchlanis propatula</i> (Gosse, 1886)	C
<i>Manfredium eudactylota</i> (Gosse, 1886)	C

Family MYTILINIDAE

<i>Lophocharis salpina</i> (Ehrenberg, 1834)	C, NRM
<i>M. ventralis</i> (Ehrenberg, 1832)	C

Family TRICHOTRIIDAE

<i>Macrochaetus longipes</i> (Myers, 1934)	C, NRM
<i>Macrochaetus sericus</i> (Thorpe, 1893)	Pt
<i>Trichotria tetractis</i> (Ehrenberg, 1830)	C

Family LEPADPELLIDAE

<i>Colurella adriatica</i> Ehrenberg, 1831	C, NRM
<i>Colurella sulcata</i> (Stenroos, 1898)	C
<i>Colurella uncinata</i> (O.F. Müller, 1773)	C
<i>Lepadella acuminata</i> (Ehrenberg, 1834)	C

<i>Lepadella apsicora</i> Myers, 1934	C
<i>Lepadella apsidea</i> Haring, 1916	C
<i>Lepadella costatoides</i> Segers, 1993	Pt
<i>Lepadella discoidea</i> Segers, 1993	Pa, NRM
<i>Lepadella ehrenbergi</i> (Perty, 1850)	C
<i>Lepadella eurysterna</i> Myers, 1942	C, NRNE
<i>Lepadella heterostyla</i> (Murray, 1913)	C
<i>Lepadella ovalis</i> (O.F. Müller, 1786)	C
<i>Lepadella patella</i> (O.F. Müller, 1773)	C
<i>Lepadella rhomboides</i> (Gosse, 1886)	C
<i>Lepadella triptera</i> Ehrenberg, 1830	C

Family LECANIDAE

<i>Lecane aculeata</i> (Jakubski, 1912)	T
<i>Lecane arcula</i> Haring, 1914	T, NRM
<i>Lecane bulla</i> (Gosse, 1851)	C
<i>Lecane closterocerca</i> (Schmarda, 1898)	C
<i>Lecane curvicornis</i> (Murray, 1913)	T
<i>Lecane doryssa</i> Haring, 1914	T
<i>Lecane furcata</i> (Murray, 1913)	C
<i>Lecane hamata</i> (Stokes, 1896)	C
<i>Lecane hornemanni</i> (Ehrenberg, 1834)	T
<i>Lecane inermis</i> (Bryce, 1892)	C
<i>Lecane jaintiaensis</i> Sharma, 1987	END
<i>Lecane lateralis</i> Sharma, 1978	Pa, NRM
<i>Lecane leontina</i> (Turner, 1892)	T
<i>Lecane ludwigii</i> (Eckstein, 1883)	C
<i>Lecane luna</i> (O.F. Müller, 1776)	C
<i>Lecane lunaris</i> (Ehrenberg, 1832)	C
<i>Lecane monostyla</i> (Daday, 1897)	T, NRM
<i>Lecane ohioensis</i> (Herrick, 1885)	T, NRM
<i>Lecane papuana</i> (Murray, 1913)	T
<i>Lecane ploenensis</i> (Voigt, 1902)	C
<i>Lecane quadridentata</i> (Ehrenberg, 1832)	C
<i>Lecane signifera</i> (Jennings, 1896)	T
<i>Lecane unguitata</i> (Fadeev, 1925)	Pa
<i>Lecane ungulata</i> (Gosse, 1887)	C

Family NOTOMMATIDAE

<i>Monommata longiseta</i> (O.F. Müller, 1786)	C
<i>Monommata maculata</i> Myers, 1930	C, NRM

Family SCARIDIIDAE

<i>Scaridium longicaudum</i> (O.F. Müller, 1786)	C
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Family TRICHOCERCIDAE

<i>Trichocerca cylindrica</i> (Imhof, 1891)	Pa
<i>Trichocerca jenningsi</i> Voigt, 1957	C
<i>Trichocerca longiseta</i> (Schrank, 1802)	C
<i>Trichocerca rattus</i> (O.F. Müller, 1786)	T
<i>Trichocerca similis</i> (Wierzejski, 1893)	C

Family ASPLANCHNIDAE

<i>Asplanchna priodonta</i> Gosse, 1850	C
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Family SYNCHAETIDAE

<i>Pleosoma lenticulare</i> Herrick, 1855	C
<i>Polyarthra vulgaris</i> Carlin, 1943	C

Order GNESIOTROCHA

Family FILINIIDAE

<i>Filinia longiseta</i> (Ehrenberg, 1834)	C
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Family TESTUDINELLIDAE

<i>Testudinella emarginula</i> (Stenroos, 1898)	C
<i>Testudinella parva</i> (Ternetz, 1892)	C
<i>Testudinella patina</i> (Hermann, 1783)	C
<i>Testudinella tridentata</i> Smirnov, 1931	C, NRM

Subclass BDELLOIDEA

Family PHILODINIDAE

<i>Philodina citrina</i> (Ehrenberg, 1832)	C
<i>Rotaria neptunia</i> (Ehrenberg, 1832)	C

END – Endemic, C – Cosmopolitan, A – Australasian, Pa – Palaeotropical, T – Tropicopolitan, N – Neotropical, NRNE – New record from N. E. India, NRM – New record from Meghalaya.

SYSTEMATIC NOTES ON RARE AND INTERESTING TAXA

The examined collections revealed a number of rare and interesting elements. These taxa are briefly diagnosed below, with notes on their distribution :

Brachionus dichotomus reductus Koste & Shiel, 1980

(Fig. 2)

Diagnosis : Lorica firm, stippled, dorso-ventrally compressed and with maximum width in its posterior region. Anterior occipital margin with distinct median spines of variable length. Posterior spines moderately long and divergent.

Distribution : Meghalaya : reported earlier by Sharma and Sharma (1999). India : Meghalaya, Tripura and Assam. *Elsewhere* : Australasian, with records from Australia and Thailand.

Lophocharis salpina (Ehrenberg, 1834)

(Fig. 3)

Diagnosis : Lorica long, triangular in cross-section and anterior margin of lorica strongly serrated. Dorsal keel of lorica distinct and with transverse folds.

Distribution : Meghalaya : New record. India : Assam. *Elsewhere* : Cosmopolitan.

Colurella adriatica Ehrenberg, 1831

(Figs. 4 & 5)

Diagnosis : Lorica long and slender; length height ratio low. Posterior end of lorica with curved spines. Toes long.

Distribution : Meghalaya : New record. India : Assam. *Elsewhere* : Cosmopolitan.

Macrochaetus longipes (Myers, 1934)

(Fig. 6)

Diagnosis : Lorica serrated and characterized by 12 long spines. Specimens identical with those illustrated by Sharma (2005).

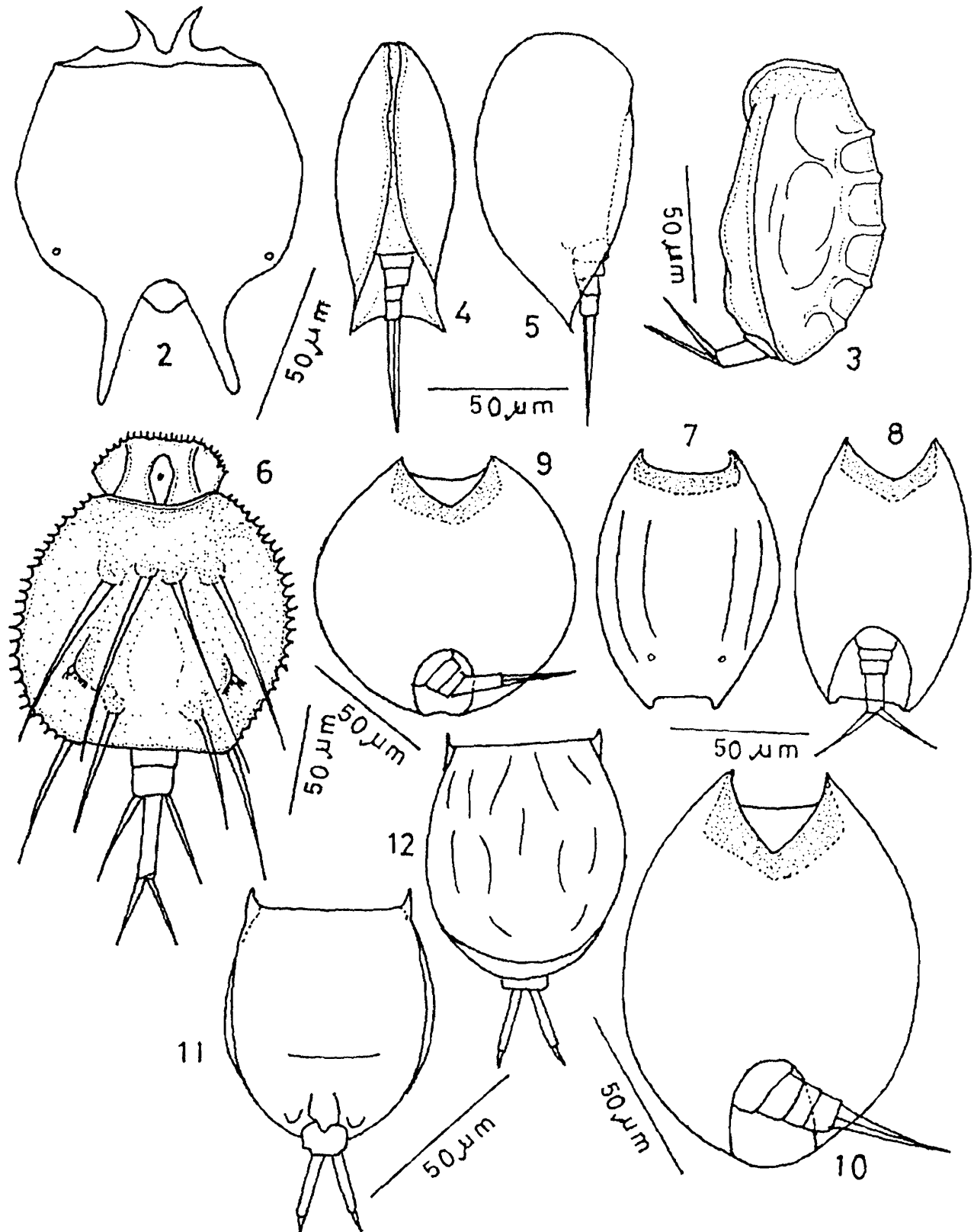
Distribution : Meghalaya : New record. India : Assam. *Elsewhere* : Cosmopolitan.

Lepadella costatoides Segers, 1993

(Figs. 7 & 8)

Diagnosis : Dorsal surface of lorica with three pairs of longitudinal ridges. Postero-lateral projections symmetrical. The specimens collected from a paddy-field near Thadlaskein are identical with the details given by Segers (1993).

Distribution : India : Meghalaya, recorded by Sharma (2004). *Elsewhere* : Pantropical.



Figs. 2-13. : 2. *Brachionus dichotomus reductus* Shiel & Koste, ventral view; 3. *Lophocharis salpina* (Ehrenberg), lateral view; 4. & 5. *Colurella adriatica* Ehrenberg, ventral and lateral views; 6. *Macrochaetus longipes* (Myers), dorsal view; 7. & 8. *Lepadella costatoides* Segers, dorsal and ventral views; 9. *L. discoidea* Segers, ventral view; 10. *L. eurysterna* Myers, ventral view; 11. & 12. *Lecane arcula* Hanning, dorsal and ventral views.

***Lepadella discoidea* Segers, 1993**

(Fig. 9)

Diagnosis : Lorica circular in outline and compressed dorso-ventrally; dorsum arched. Foot three segmented; distal foot-segment longest. Toes long.

Distribution : Meghalaya : new record. India : Delhi and Assam. *Elsewhere* : Palaeotropical.

***Lepadella eurysterna* Myers, 1942**

(Fig. 10)

Diagnosis : Differentiated from closely related *L. patella* by characteristic shape of posterior margin of its foot-opening. Toes elongated.

Distribution : N.E. India : new record. India : reported so far only from Delhi. *Elsewhere* : Cosmopolitan.

***Lecane arcula* Haring, 1914**

(Figs. 11 & 12)

Diagnosis : Differentiated from closely related *L. aculeata* by its relatively shorter and less elongated antero-lateral occipital spines.

Distribution : Meghalaya : new record. India : Assam. *Elsewhere* : Tropicopolitan.

***Lecane doryssa* Haring, 1914**

(Figs. 13 & 14)

Diagnosis : Lorica flexible and with fewer surface markings. Anterior occipital margins nearly straight and coincident; dorsal plate broader than ventral plate. Posterior segment large. Toes slender and with thin, pointed and undifferentiated claws.

Distribution : Meghalaya : recorded earlier by Sharma (1987). India : Meghalaya. *Elsewhere* : Tropicopolitan.

***Lecane jaintiaensis* Sharma, 1987**

(Figs. 15 & 16)

Diagnosis : Lorica elongate-oval, with coincident anterior margins and small triangular cusps at external angles. Ventral plate slightly narrow than dorsal plate. Posterior segment broad. Second foot-segment rectangular and projecting a little beyond lorica. Toes long, swollen at their bases, almost parallel-sided and terminating into acutely pointed tips.

Distribution : Meghalaya : described (Sharma, 1987) from a rice field at Nartiang, Jaintia Hills district and known so far only from its type locality. India : an endemic species.

Lecane lateralis Sharma, 1978

(Figs. 17 & 18)

Diagnosis : Lorica ovate, anterior dorsal margin concave and anterior ventral margin with a shallow sinus flanked by undulating sides. Dorsal plate smaller than ventral plate. Ventral plate with postero-lateral extensions. Toes long, parallel-sided along $\frac{3}{4}$ of their lengths, then tapering and terminating into stout claws; each claw with one basal spicule.

Distribution : Meghalaya : new record. India : Tripura, Orissa and West Bengal. *Elsewhere* : Palaeotropical.

Lecane monostyla (Daday, 1897)

(Fig. 19)

Characters : Lorica small, oval, with straight and coincident anterior margins; dorsal plate with characteristic lateral spine-like processes, ventral plate with very small spines at anterior external angles. Toe parallel-sided for $\frac{3}{4}$ of its length and then tapering to an acute point.

Distribution : Meghalaya : new record. India : Tripura and Assam. *Elsewhere* : Cosmopolitan.

Lecane ohioensis (Herrick, 1885)

(Fig. 20)

Characters : Lorica oval and with stout spines at anterior external margins; ventral plate narrower than dorsal plate. Posterior segment broad and with a spade-shaped process. Toes long, parallel-sided and with short, pointed tips.

Distribution : Meghalaya : new record. India : West Bengal and Tripura. *Elsewhere* : Tropicopolitan.

Monommata maculata Myers, 1930

(Fig. 21)

Characters : Body long, slender and integument striated. Foot two-segmented. Toes long and unequal. Trophi characteristic.

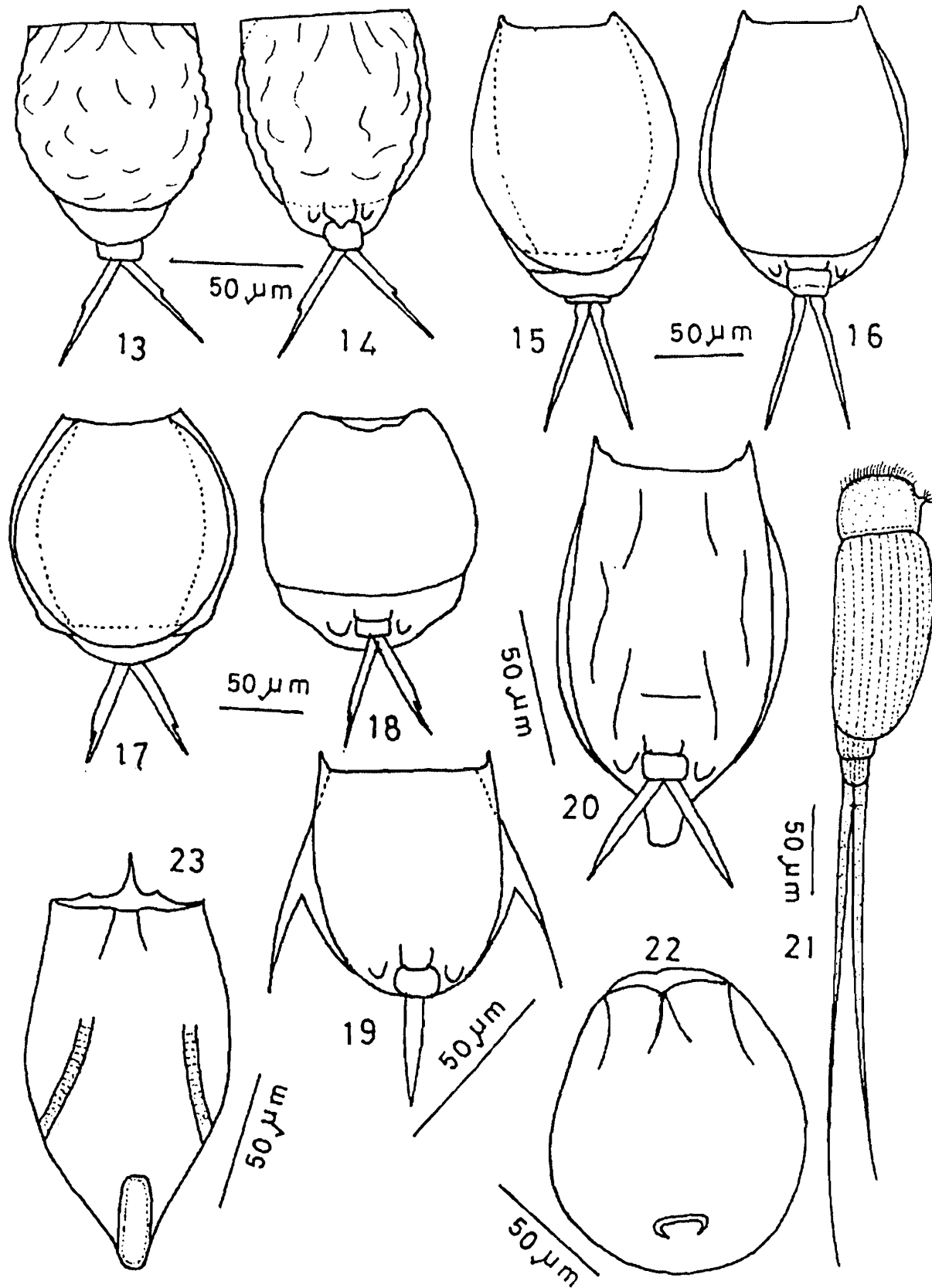
Distribution : Meghalaya : new record. India : Assam. *Elsewhere* : Cosmopolitan.

Testudinella parva (Ternetz, 1892)

(Fig. 22)

Characters : Lorica pear-shaped and with maximum width in the posterior region. Lateral antennae located behind the middle region of lorica. Foot-opening elliptical and located at a short distance from posterior margin of lorica.

Distribution : Meghalaya : recorded earlier by Sharma and Sharma (1999). India : Meghalaya, Assam, Orissa and West Bengal. *Elsewhere* : Cosmopolitan.



Figs. 13-23. : 13. & 14. *Lecane doryssa* Haring, dorsal and ventral views; 15. & 16. *L. jaintiaensis* Sharma, dorsal and ventral views; 17. & 18. *L. lateralis* Sharma, dorsal and ventral views; 19. *L. monostyla* (Daday), ventral view; 20. *L. ohioensis* (Herrick), ventral view; 21. *Monommata maculata* Myers, lateral view; 22. *Testudinella parva* (Ternetz), ventral view; 23. *T. tridentata* Smirnov, ventral view.

Testudinella tridentata Smirnov, 1931

(Fig. 23)

Diagnosis : Lorica vase-shaped, compressed, with maximum width behind its middle and then tapering gradually to a posterior lobate projection. Anterior dorsal margin with long median spine. Foot-opening elongated, located at posterior ventral end of lorica.

Distribution : Meghalaya : new record. India : Tripura and Assam. *Elsewhere* : Cosmopolitan.

REMARKS

Seventy-four species of Eurotatoria documented presently from rice fields of Meghalaya indicate fairly rich and diversified taxocoenosis. This salient feature reflects a greater environmental heterogeneity of the sampled habitats which, in turn, is attributed to their unique and complex limnological nature (Fernando, 1995), water level fluctuations, plantation and growth of paddy, and growth of aquatic weeds. Interestingly, the recorded richness represents the highest qualitative diversity of freshwater rotifers known till date from rice fields of any part of the Indian subcontinent and of the Oriental region and is followed by earlier reports (Fernando, 1980, 1995) of 71 and 51 species from rice fields of Sri Lanka and Thailand, respectively. The rich nature of the rotifer taxocoenosis is also supported by greater higher diversity of this phylum (30 genera and 17 families) which, in turn, certainly compares well with the reports of 39 genera and 20 families from N. E. India (Sharma and Sharma, 2005). Qualitative dominance of Rotifera over other groups of micro-invertebrates noticed in all the collections examined from rice fields of Meghalaya concurred with the trends noted in these biotopes from other parts of the world (Fernando, 1995).

Biogeographically interesting elements constitute a notable fraction (8.1%) of the listed species; these include the endemic *Lecane jaintiaensis*, the Australasian *Brachionus dichotomus reductus* and four palaeotropical species namely *Lepadella discoidea*, *Lecane lateralis*, *L. unguitata* and *Trichocerca cylindrica*. Among these, the endemic lecanid deserves special mention because of its rare occurrence in the Indian fauna and is so far known exclusively from its "type-locality" *i.e.*, a paddy field located in Nartiang, Jaintia Hills district of Meghalaya state. The second species represents one of the four Australasian elements recorded from India and is so far documented only from N. E. region (Sharma and Sharma, 2005). Further, this brachionid serves an interesting example to assign special affinity of the rotifer faunas of Meghalaya and N. E. India with that of S. E. Asia and tropical Australia (Sanoamuang *et al.*, 1995; Sanoamuang, 1998; Sharma, 2004, 2005). Segers (2001) commented on occurrence of *reductus* vicariant of *B. dichotomus* outside Australia, hypothesized recent expansion of these populations to Southeast Asia and hinted at a possible Australian origin of this taxon. The restricted occurrence of this brachionid in N. E. region (Sharma, 2005) lends additional support to Segers's hypothesis. Among the members of the last category, *Lepadella discoidea* has been described (Segers, 1993) from Africa while *Lecane lateralis*,

originally described from West Bengal (Sharma, 1978), is now known to be apparently widely distributed in sub(tropical) parts of the Old and New world.

Ten species namely *Lophocharis salpina*, *Macrochaetus longipes*, *Colurella adriatica*, *Lepadella discoidea*, *Lecane arcua*, *L. lateralis*, *L. monostyla*, *L. ohioensis*, *Monommata maculata* and *Testudinella tridentata* comprise new records to the rotifer fauna of the state of Meghalaya while *Lepadella eurysterna* is a new addition to the N. E. Indian Rotifera. Besides, several other species namely *Lepadella costatoides*, *Lecane arcua*, *L. furcata*, *Pleosoma lenticulare*, *Testudinella emarginula* and *T. parva* are elements of regional distributional importance. The present study raises overall rotifer richness from Meghalaya to 126 species which, in turn, represents the second largest diversity known from any state of India and follows the report of 148 species from West Bengal (Sharma, 1998b). Further, the presently documented species form an important component of the rotifer faunas of Meghalaya (58.7%) and that N. E. India (39.1%). Of the reported species, *Brachionus dichotomus reductus*, *Lecane monostyla* and *Testudinella tridentata* are till now known to occur only in N. E. India, *Lepadella costatoides* and *Lecane doryssa* are restricted to Meghalaya while five species viz., *Lophocharis salpina*, *Colurella adriatica*, *Macrochaetus longipes*, *Lecane arcua* and *Monommata maculata* so far occur only in Assam and Meghalaya.

The rotifer communities of rice fields of Meghalaya exhibit predominance of cosmopolitan species (71.6%); their overall contribution is higher than noticed earlier in the faunas of Meghalaya (Sharma and Sharma, 1999) and N. E. India (Sharma and Sharma, 2005), respectively. On the other hand, Tropicopolitan (14.9%) species are well represented while the present study indicates relatively fewer Pantropical elements (5.4%). The stated pattern, however, deviates than the observed richness of Pantropical > Tropicopolitan species in the faunas of Meghalaya and N. E. region. Lecanidae (23 species) > Lepadellidae (15 species) > Brachionidae (9 species) together constitute a significant component (63.3%) of the documented species. This stated pattern differs notably from that of Meghalaya and N. E. region Rotifera because of occurrence of distinctly fewer species of the last family in the examined collections.

Two genera namely *Lecane* (23 species) > *Lepadella* (12 species) depict distinctly higher diversity and are followed by *Brachionus* (5 species) = *Trichocerca* (5 species) > *Testudinella* (4 species). Qualitative predominance (31.1%) of 'tropic-centered' genus *Lecane* compares well with the reports of Segers *et al.*, (1993), Sanoamuang (1998), Sharma & Sharma (1997, 2001, 2005) and Sharma (2005). This salient feature imparts a general tropical character to the examined taxocoenosis and also concurs with the composition of tropical rotifer communities (Green, 1972; Pejler, 1977; Fernando, 1980; Dussart *et al.*, 1984; Segers, 1996, 2001; Sharma, 1998b). On the other hand, the relative paucity of the brachionids in general and that species of *Brachionus*, another important 'tropic-centered' genus in particular is a noteworthy feature of the present observations. The latter aspect is attributed to lack of typical limnetic conditions in shallow ephemeral rice fields

and also to general acidic to nearly neutral nature of waters of these biotopes (Sharma, personal communication).

Highest richness of upto 35 species/sample in subtropical rice-fields of Khasi (East and West) and Jaintia Hills districts of Meghalaya observed currently, with predominance of *Lecane* > *Lepadella* endorsed earlier results of Sharma (1987) and Sharma and Sharma (1987, 2005). On the contrary, the samples from Garo Hills region indicated relatively lower richness with maximum upto 22–25 species/sample. Though the present study did not make any systematic attempt to trace temporal changes in species richness during the whole paddy season (May/June–October), the analyzed collections indicate fewer pioneer *Lecane* species following ploughing and application of organic fertilizer (cow dung) during May/early June and the community heterogeneity increased with paddy plantation and its subsequent growth and peak richness was invariably observed in the samples collected during August–September. Such a generalization also concurred with the richness pattern reported by Fernando (1995).

The shallow nature of the sampled rice fields and the growth of paddy and some aquatic weeds apparently resulted in predominance of periphytic species in the studied collections, showed occurrence of very few facultative planktonic taxa and complete lack of any typical planktonic element. *Plationus patulus*, *Trichotria tetractis*, *Lepadella patella*, *L. ovalis*, *Lecane bulla*, *L. leontina*, *L. luna*, *L. lunaris*, *L. quadridentata* and *Testudinella patina* exhibited relatively common occurrence. The list of presently documented taxa, though fairly exhaustive as per the examined materials, may still provide scope for its up-dating based particularly on regular fortnightly/monthly collections from these interesting ecotones.

SUMMARY

Seventy-four species of Eurotatoria, belonging to 30 genera and 17 families, documented presently from sub-tropical rice fields of Meghalaya represent the richest species and higher diversity of Rotifera known till date from these habitats from any part of the Indian subcontinent. *Lepadella eurysterna* represents a new record from N. E. India while ten species are new records to the rotifer fauna of Meghalaya. Biogeographically interesting elements constitute a notable fraction (8.1%) of the listed species; these include the endemic *Lecane jaintiaensis*, one Australasian element and four palaeotropical species. Besides, this study indicates several elements of regional distributional importance including three species known to be so far restricted to N. E. India, two to Meghalaya and five recorded only from Meghalaya and Assam. Cosmopolitan species (71.6%) distinctly dominate Tropicopolitan (14.9%) > Pantropical (5.4%) species. The rotifer taxocenosis depicts general tropical nature characterized by richness of 'tropic-centered' genus *Lecane*, qualitative importance of Lecanidae > Lepadellidae, predominance of the littoral-periphytic elements and lack of typical planktonic taxa, paucity of *Brachionus* spp., and records highest richness of upto 35 species/sample.

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