Testate amoebae (Protozoa: Rhizopoda) of Deepor Beel (a Ramsar site), Assam, northeastern India

B.K. Sharma [1] & Sumita Sharma [2]

[1,2] Freshwater Biology Laboratory, Department of Zoology, North-Eastern Hill University, Permanent Campus, Shillong, Meghalaya 793022, India
Email: [1] probksharma@gmail.com (corresponding author), [2] sumitasharma.nehu@gmail.com

Testate amoebae or testaceans, a group of free-living Protozoa belonging to the superclass Rhizopoda, form an important micro-faunal component of aquatic, semi-aquatic and soil communities and provide integral links of the food chain in their respective environments. Taxonomic studies on Indian freshwater Rhizopoda were initiated by Naidu (1966) and followed by Mahajan (1971), Nair et al. (1971) and Mishra et al. (1977). In addition, certain contributions under the state fauna series (Das et al. 1993, 1995, 2000, 2003, 2004) dealt with limited freshwater collections. In spite of these studies freshwater Rhizopoda from different states of India are poorly documented, while their ecosystem diversity is practically neglected except for the works of Sharma & Sharma (2008), Bindu (2010) and Bindu & Das (2010). Our study on the Rhizopoda of Deepor Beel, a Ramsar site and an important floodplain lake of the Brahmaputra River basin of Assam, merits biodiversity interest in view of the stated lacunae. The listed species are briefly diagnosed and comments are made on the nature and composition of the Rhizopoda fauna.

Material and Methods: Qualitative samples were collected (August 2008–July 2010) by towing a nylobolt plankton net (No. 25) from the littoral and limnetic regions of Deepor Beel (91°35'–91°43'E & 26°05'–26°11'N; area 40km^2; altitude 42m), Assam and were preserved in 5% formalin. Special attention was paid to disturb aquatic macrophytes before sampling. Different species were sorted with a wild stereoscopic binocular microscope and permanent mount specimens were prepared in polyvinyl alcohol-lactophenol. Rhizopoda species were identified with a Leica DM 1000 image analyzer following the works of Cash et al. (1919), Deflandre (1929, 1959), Decloitre (1962), Ogden & Hedley (1980), and Chattopadhyay & Das (2003).

Systematic account

Sub Kingdom: Protozoa
Phylum: Sarcomastigophora
Sub Phylum: Sarcodina
Super Class: Rhizopoda
Class: Lobosea
Order: Arcellinida

Arcellidae

1. *Arcella discoides* Ehrenberg, 1843

Characters: Test yellow, smooth, flattened, circular in front view and plano-convex in lateral view; height about 1/3 to 1/4 of its diameter. Oral aperture large and circular.

Distribution: India - Assam, Meghalaya, Mizoram, Arunachal Pradesh, Tripura, Nagaland, Sikkim and West Bengal.

2. *Arcella hemispherica* Perty, 1809

Characters: Test yellow, distinctly hemispherical and circular in lateral and front views. Surface of test with more or less fine areoles.

Distribution: India - Assam, Manipur, West Bengal, Odisha and Andhra Pradesh.

Date of publication (online): 26 July 2011
Date of publication (print): 26 July 2011
ISSN 0974-7907 (online) | 0974-7893 (print)

Editor: Humphrey Smith

Manuscript details:
Ms # o2664
Received 31 December 2010
Final received 25 May 2011
Finally accepted 21 June 2011

Citation: Sharma, B.K. & S. Sharma (2011). Testate amoebae (Protozoa: Rhizopoda) of Deepor Beel (a Ramsar site), Assam, northeastern India. *Journal of Threatened Taxa* 3(7): 1947–1950.

Acknowledgements: The senior author is thankful to the Coordinator, UPE (Biosciences) and the Head, Department of Zoology, North-Eastern Hill University, Shillong for necessary facilities. One of the authors (SS) is also thankful to the Director, Zoological Survey of India, Kolkata and the Officer-in-charge, North Eastern Regional Centre, Zoological Survey of India, Shillong.

3. *Arcella vulgaris* Ehrenberg, 1830

Characters: Test light yellow, discoid or hemispherical in front or lateral views; height about half of its diameter; test surface with large areoles. Mouth circular and central.

Distribution: India - Assam, Meghalaya, Manipur, Arunachal Pradesh, Nagaland, Sikkim, Himachal Pradesh and West Bengal.

Centropyxidae

4. *Centropyxis aculeata* (Ehrenberg, 1830)

Characters: Test brownish, cap-shaped; encrusted with quartz crystals and sometimes with admixture of diatoms and sand particles. Fundus obtusely rounded and usually with 4-6 divergent spines at the border, arranged in a single and somewhat regular row.

Distribution: India - Assam, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, Nagaland, West Bengal, Andhra Pradesh and Himachal Pradesh.

5. *Centropyxis ecornis* (Ehrenberg, 1843)

Characters: Test large, discoid or elliptical; without any spine and covered with quartz grains. Dorsal surface slightly arched and more elevated at posterior part. Oral aperture circular and much eccentric.

Distribution: India - Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Sikkim, Himachal Pradesh, Uttarakhand and West Bengal.

6. *Centropyxis oblonga* (Deflandre, 1929)

Characters: Test grayish, oblong-elliptical or oval; with 3-6 divergent spines located in the distal part. Fundus of the test more elevated. Oral aperture elliptical and eccentric.

Distribution: India - Assam, Meghalaya, Manipur, Sikkim and Andhra Pradesh.

7. *Centropyxis orbicularis* Deflandre, 1929

Characters: Test almost circular in ventral view and semi-circular in lateral view, ventral surface flat; oral aperture semi-circular, plagiostomic; test with large stony particles.

Distribution: India - Assam, Uttarakhand and Andhra Pradesh.

8. *Cyclopyxis eurystoma* (Deflandre, 1929)

Characters: Test brownish, encrusted with quartz particles; hemispherical in lateral view. Oral aperture central, circular and slightly invaginated with regular smooth edge.

Distribution: India - Assam, Arunachal Pradesh and Odisha.

Difflugidae

9. *Difflugia acuminata* Ehrenberg, 1838

Characters: Test cylindrical, with pointed 'horn' like extension; horn straight and differentiated from the base. Quartz crystals big; some even projecting out of the margin.

Distribution: India - Assam, Meghalaya, Manipur, West Bengal and Andhra Pradesh.

10. *Difflugia corona* Wallich, 1864

Characters: Test broadly spherical, slightly narrow near oral aperture; with 5–10 smooth test spines formed by quartz crystals. Oral aperture wide and crenulated.

Distribution: India - Assam, Manipur and West Bengal.

11. *Difflugia oblonga* Ehrenberg, 1838

Characters: Test typically oblong, with smooth margins and rounded base; composed of big angular quartz crystals. Oral aperture circular and without any lobe.

Distribution: India - Assam, Meghalaya, Manipur, West Bengal and Andhra Pradesh.

12. *Difflugia tuberculata* (Wallich, 1864)

Characters: Test ovoid, with wide base; oral aperture hexagonal and surrounded by a short collar; test covered with tubercles and small platelets uniting the tubercles.

Distribution: India - Assam and Meghalaya.

13. *Difflugia urceolata* Carter, 1864

Characters: Test ovoid-spherical, composed of angular quartz crystals and diatoms. Oral aperture circular; its collar around re-curved or rolled towards exterior.

Distribution: India - Assam, Manipur and West Bengal.

Nebelidae

14. *Lesquereusia spiralis* (Ehrenberg, 1830)

Characters: Test transparent, semi-spiral and composed of closely arranged vermiform pellets;

neck continued in a straight line down to mouth. Oral aperture circular.

Distribution: India - Assam, Meghalaya, Manipur, West Bengal and Andhra Pradesh.

Class: Filosea
Order: Gromiida
Cyphoderiidae

15. *Cyphoderia ampulla* (Ehrenberg. 1840)

Characters: Test yellowish or brownish, covered with distinct circular or oval scales or plates; oral aperture circular, terminal, with a curved neck; fundus obtusely rounded.

Distribution: India - Assam, Uttarakhand and Maharashtra.

Euglyphidae

16. *Assulina muscorum* Greef, 1888

Characters: Test yellowish, oval, compressed and truncate anteriorly; composed of imbricate oval platelets usually arranged in alternating diagonal rows. Terminal, elliptical aperture bordered by a thin chitinous membrane with undulate margin.

Distribution: India - Arunachal Pradesh, Manipur, Mizoram, Sikkim, Tripura West Bengal and Himachal Pradesh.

17. *Assulina seminulum* (Ehrenberg, 1848) Leidy, 1879

Characters: Test yellow or brown, pyriform or ovoid, compressed and composed of imbricate oval or elliptical siliceous platelets. Aperture terminal, oval and bordered by a thin chitinous membrane with irregularly dentate margin.

Distribution: India - Manipur, Sikkim, Nagaland, West Bengal and Andhra Pradesh.

18. *Euglypha acanthophora* Dujardin, 1841

Characters: Test ovoid; aperture circular, bordered by finely serrated platelets. Test platelets elliptical, posterior half and at the base of fundus prolonged into 4-7 spines.

Distribution: India - Assam, Mizoram, Meghalaya, Nagaland, West Bengal and Andhra Pradesh.

19. *Euglypha laevis* (Ehrenberg, 1845)

Characters: Test oviform, glabrous and elliptical or sub-circular; aperture elliptical or sub-circular, bordered by a single row or platelets pointed terminally. Test platelets oval.

Distribution: India - Assam, Meghalaya, Tripura, Sikkim, Uttarakhand, West Bengal and Andhra Pradesh.

20. *Euglypha tuberculata* Dujardin, 1841

Characters: Test elongate-oviform, glabrous; test platelets round or oval, imbricating and forming a hexagonal pattern. Aperture circular, bordered by 8–12 finely serrated platelets.

Distribution: India - Assam, Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Tripura, Jammu and Kashmir, Himachal Pradesh, Sikkim, West Bengal and Andhra Pradesh.

21. *Trinema lineare* Penard, 1840

Characters: Test small, hyaline, elongate, composed of small circular platelets. Oral aperture circular, oblique, invaginated and bordered by toothed platelets.

Distribution: India - Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura, Himachal Pradesh, Sikkim and West Bengal.

Discussion

Our collections show 14 species of Lobosea and seven species of Filosea, the L/F ratio of 2 is close to the 3.0 reported by Sharma & Sharma (2008) from various floodplain lakes of Assam but exceeds the range of 0.5–1.4 reported for moss-dwelling rhizopods (Chattopadhyay & Das 2003). Euglyphidae > Centropyxidae = Difflugidae, three speciose families, comprise the dominant fraction (76.2%) of the reported species. Cyphoderiidae and Nebelidae, the least species-rich families, include one species each. Further, *Difflugia* > *Centropyxis* are relatively diverse genera (42.9%) while *Arcella* = *Euglypha* also form a notable fraction (28.6 %) in this study.

The total Rhizopoda richness of Deepor Beel is higher than the 16, 12, 7 and 19 species examined from the freshwater biotopes of Meghalaya (Das et al. 1995), Tripura (Das et al. 2000), Sikkim (Das et al. 2003) and Manipur (Das et al. 2004) respectively. Further, the richness is higher than the reports of 16 species from Loktak Lake - a Ramsar site (refer Das et al. 2004); 10 species from Melghat Wildlife Sanctuary (Bindu 2010), Maharashtra; 13 species from Pench National

Park, Maharashtra and also 7–16 species listed from 15 floodplain lakes of the Brahmaputra river basin of Assam (Sharma & Sharma 2008). However, we caution against over-emphasizing the importance of these comparisons without considering sampling intensity and the nature of different ecosystems. In analyzing the comparative species-richness of our and other communities, it also needs to be emphasized that the number of species recorded to date are yet provisional and these may well be revised in light of future research.

Whilst *Centropyxis orbicularis* and *Cyphoderia ampulla* currently exhibit restricted occurrence in India with reports from Sikkim and Uttarakhand respectively, their distribution ranges were extended recently to Assam (Sharma & Sharma 2008). The moss-dwelling *Cyphoderia ampulla* was recently observed in freshwater from Assam (Sharma & Sharma 2008) and Maharashtra (Bindu 2010); the present report re-affirming its occurrence in freshwater environs merits ecological interest. Our report also endorses an identical report (Sharma & Sharma 2008) of *Cyclopyxis eurystoma* which was known from soil and mosses in India (Chattopadhyay & Das 2003). *Arcella hemispherica, Centropyxis cassis, Difflugia corona, D. tuberculata, D. urceolata, Cyclopyxis eurystoma,* and *Euglypha laevis* comprise examples of local or regional distributional interest. Further, these species exhibit rare occurrence in our collections. On the other hand, *Arcella discoides, A vulgaris, Centropyxis aculeata, C. ecornis, Difflugia acuminata, D. oblonga, Euglypha acanthophora* and *E. tuberculata* exhibit relatively frequent occurrence.

The present report raises the total number of Rhizopoda so far known from different ecosystems of Assam to 49 species, affirming the biodiversity value of this Ramsar site. The observed association of Rhizopoda with different aquatic macrophytes merits future interest, and studies of this and other ecological aspects have been initiated by the authors.

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