



Research paper

Three newly recorded species join India's testate (Protozoa: Amoebozoa) fauna

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Abstract: Microbial communities living in mosses are known to constitute early indicators of ecosystem disturbances. Testate amoebae are a group of unicellular free-living protozoa which are characterized by morphologically distinct shells (tests) which play an important role in the natural ecosystems as bio-indicators. This communication reports 3 new additions of moss associated testate amoebae viz., *Arcella formosa* Nicholls, 2005; *Galeripora bathystoma* (Deflandre, 1928) Gonzalez-Miguens, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021 and *Galeripora scutelliformis* Playfair, 1918 to Indian testate fauna from the highly diversified ecosystem, The Himalaya.

Keywords : Moss, Protozoa, Testate amoebae, New records, Himalaya

Introduction:

Testate amoebae are free-living, unicellular eukaryotes in which amoeboid cell is covered by an extracellular test, with a single opening, through which extrude lobose (Arcellinida) or filose (Euglyphida) pseudopodia (Meisterfeld 2002a,b). They are present in most terrestrial, freshwater, brackish as well as

in marine habitats and in association with sphagnum mosses. The studies on this group have significantly increased over the past two decades due to their increasing use in various applied aspects. The characteristic test is a reliable taxonomic feature used for the diagnosis of the species. Even after the death of the amoeba the tests will remain preserved for a long time and are valuable in paleoenvironmental studies (Mitchell *et al.*, 2008; Swindles *et al.*, 2015). They are very abundant and diverse in sphagnum mosses and are considered as valuable bioindicators for ecological and environmental monitoring studies, (Booth 2002, 2007, Qin *et al.*, 2013; Payne *et al.*, 2016). It has been shown that testate amoebae play an important role in the cycling of carbon, nitrogen and silica in terrestrial ecosystems (Schroter *et al.*, 2003; Aoki *et al.*, 2007; Jassey *et al.*, 2015).

Arcella Ehrenberg, 1832 is a genus of testate amoebae and one of the most common testacean genera and the type species is *Arcella vulgaris* Ehrenberg, 1830 which comes under the family Arcellidae. Over 50 species have been described worldwide. Members of this

genus have more or less circular test with a central invaginated opening, surrounded by a collar in many species. Species with pores around the aperture are grouped in the genus *Galeripora* Gonzalez-Miguens, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021 with type species *Galeripora sitiens* González-Miguens, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021. The present communication reports the extended distribution of three species of testates to India viz., *Arcella formosa* Nicholls, 2005., *Galeripora bathystoma*(Deflandre, 1928) Gonzalez-Miguens, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021 and *Galeripora scutelliformis* Playfair, 1918 from moss habitats of Himachal Pradesh.

Materials and Methods:

The moss samples for the present study were obtained as part of the annual programme of Zoological Survey of India on fauna of Himalaya. Moss samples (100-200gms.) from tree barks and rocks were collected by scraping the upper surface by quadrant sampling (1m²) and brought to the laboratory in polythene envelops. The samples were cultured and processed in the lab with non-flooded petri dish method as described by Foissner (1992) and examined under the compound microscopes Nikon 50i and Leica DM 2000 for species level identification. Permanent slides were prepared for the identified specimens and deposited in the National Zoological collections of two regional centres of Zoological Survey of India viz., Marine Biology Regional Centre, Chennai, Tamil Nadu and Western Ghat Regional centre, Kozhikode, Kerala.

Results:

The details of new records of the testate species recorded for the first time from India are provided below.

Phylum Tubulinea Smirnov *et al.*, 2005

Class Elardia Kang *et al.*, 2017

Order Arcellinida Kent, 1880

Family Arcellidae Ehrenberg, 1843

Genus *Arcella* Ehrenberg, 1832

The genus is characterized with a circular test with a central invaginated opening surrounded by a collar from where finger-like pseudopodia arise. The aperture is normally circular and, in some species elliptical. Most species have hemispherical shells. Test is made up of organic building units arranged in a single layer and cemented together. The size of the building units differs per species. Usually young shells are colourless, older ones turn brown due to the storage of iron and manganese in the building units. *Arcella* species are either binucleated or multinucleated. Nuclei vesicular and contractile vacuoles present. Pores are absent around the aperture.

1. *Arcella formosa* Nicholls, 2005 (Fig.1)

Material examined : Reg. No. Mi.1161, 2 examples; date of collection , 10.i.2021(31.9264°N and 77.1142°E); Rock moss, Kullu, Himachal Pradesh, India.

Description of species

Test is irregular in outline and with an irregular pattern of rib-like structures and depressions and ribs appear darker when compared to the rest of the shell. Test is multinucleated; diameter of the test ranges from 126±128 µm (Fig. 1). This species was earlier recognized by Siemensma in 1982 with the name *Arcella robusta* and later Nicholls described it as *Arcella formosa* in 2005.

Genus *Galeripora* González-Miguéns, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021

The construction of test is with proteinaceous organic material; shape is more or less rounded with a central circular aperture and radial symmetry. The aperture is surrounded by pores which

differs this genus from *Arcella*. Usually two or more nuclei, situated at opposite sides of the cytoplasm. The type species is *Galeripora sitiens* González-Miguéns, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021.

2. *Galeripora bathystoma* (Deflandre, 1928) González-Miguéns, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021 (Fig.2)

Material examined : Reg. No. IV.21210, 1 ex., date of collection, 25.viii.2021 (32.6192°N and 77.3784°E); Tree moss, Lahaul and Spiti, Himachal Pradesh.

Description of species

Test hemispherical with slightly rounded basilar angles. Dorsal view of the test is slightly elliptical with an angular dorsal view. Aperture is rounded and deeply invaginated beyond the mid height of the shell. Shell reddish-yellow-brown with extremely fine areolation with two nuclei. Diameter of the test is 65 µm, height 30 µm and aperture 21-23 µm.

3. *Galeripora scutelliformis* Playfair, 1918 (Fig.3)

Material examined : Reg. No. Mi.1159/1, 2 exs; date of collection, 10. i. 2021 (31.9264°N and 77.1142°E), Rock moss, Kullu, Himachal Pradesh

Description of species

Test is rounded, pseudostome large and obliquely circular with a ring of fine pores. Pseudostome is slightly invaginated without pseudopodal tube. Diameter of the test is 65 µm and of the pseudostome is 24 µm.

Summary and Discussion:

The present communication reports the extended distributional range of three species of testate amoebae under the genera *Arcella* and *Galeripora* to Indian testate fauna from Himalaya and testate

amoebae studies were sporadic in these areas. Perusal of literature shows that 14 species under the genus *Arcella* and 6 species under the genus *Galeripora* have already been reported from various states of India (Bindu, 2013; Bindu *et al.*, 2014; Nair and Mukherjee, 1971; Chattopadhyay and Das, 2003; Das *et al.*, 1993, 1995, 2000; Bindu, 2013, 2019). The present study adds 3 more species to the Indian testate fauna, 1 species under the genus *Arcella* and 2 species under *Galeripora*. There is difficulty with several groups of individuals which shared common features and thus some of the individuals are designated as varieties. *Galeripora scutelliformis* was the variety of *Arcella discoidea* earlier and recently designated separated status. Even slight variations in the shell shape have resulted in the establishment of new forms or species regardless of the range of variability that individual taxon exhibits. Intensive studies on testate amoebae in India initiated only in the 2nd half of the 20th century. The recent estimate made by Zoological Survey of India is that the total number of testates in India is 116 (not published). Studies should be made in a wide spectrum and more workers should come forward to explore the actual diversity of testate fauna in India.

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Plate-1



Fig.1 *Arcella formosa* Nicholls, 2005



Fig.3 *Galeripora scutelliformis* Playfair, 1918

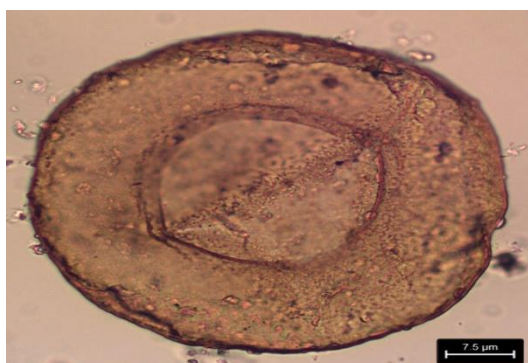


Fig.2 *Galeripora bathystoma* (Deflandre, 1928) Gonzalez-Miguens, Soler-Zamora, Villar-dePablo, Todorov & Lara, 2021