



Diversity of testate amoebae (Amoebozoa and Cercozoa) in Western Ghats of Kerala with 8 new records to India

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Abstract

Studies were conducted in various parts of the Western Ghats of Kerala, covering five districts viz., Thiruvananthapuram, Kollam, Wayanad, Palakkad, and Idukki. The purpose of these studies was to explore the diversity of moss-inhabitant testate amoebae, which resulted in the identification of 90 species of testate amoebae spanning over 22 genera and 11 families. Out of 90 species, eight were new records of Indian fauna. This article provides a systematic list of the recorded species, details about the studied specimens, and information on the distribution of these species.

Keywords: Free-living, Kerala, Moss, Protozoa, Testate Amoebae, Western Ghats

Introduction

Testate amoebae consist of a group of protists having protective external tests which are morphologically distinct which allows them to be used in palaeoecological studies found to occur in aquatic to moist habitats. They inhabit the soil, moist places and also in association with moss habitats. They are known to be good indicators of several ecological parameters such as substrate moisture in soil and peat and water chemistry (Charman & Warner, 1992; Charman, 2001; Mitchell *et al.*, 2008). Even though the aerial habitats are dry testate amoebae are encysting in mosses and during favourable conditions, they will get revived. Several taxa are known for this unique habitat and many are undiscovered as this habitat is less studied by researchers. Among the different groups of protozoa, the testate amoebae are abundant and diverse in mosses dominated peatland (Warner, 1987). Mosses belong to the Class Bryopsida and grow on soil, rock, wall and tree barks, trunks of felled trees, butts of tree stumps and in moist environments. They provide suitable microhabitats by providing insulation against heat, cold and wind, particularly for free-living protozoa of which testate amoebae are most abundant (Jana *et al.*, 2008). Nguyen *et al.* (2004) suggested that testate amoebae might be considered potential biomonitors for atmospheric pollution. The application of biometrical analysis of

Testate amoebae has been widely used in taxonomical studies (Alves *et al.*, 2012; Davidova, 2012). Morphological criteria are prevalent to determine testate amoebae species and studies revealed that tests of testates are exhibiting cryptic speciation among populations (Bobrov & Mazei, 2004; Gomaa *et al.*, 2015). The intraspecific variation among testate amoebae denotes adaptations to environmental conditions and studies have shown that temperature and food source affect the morphology of shells (Bobrov *et al.*, 1995). Reports on moss-dwelling testate amoebae are fragmentary in India. Penard (1907), Nair and Mukherjee (1968 a, b) and Chattopadhyay and Das (2003) studied the taxonomy and ecology of moss dwelling testaceans from North and North-East India. The only published work on protozoa from Western Ghats of Kerala is the studies of Nair (2001) in the Nilgiri Biosphere Reserve which includes 111 species including free living, parasitic and symbiotic of which testate amoebae represented only 9 species under 3 genera. Also, Bindu and Saha (2012) and Bindu (2019) recorded some species from the Western Ghats of Maharashtra and Meghamalai WLS, Tamil Nadu respectively. While testate amoebae communities are known to play a crucial role in forest ecosystems, their diversity in the Western Ghats has not received thorough attention. This study aims to address this gap by providing comprehensive insights

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into the diversity of moss-inhabiting testate amoebae in one of India's biodiversity hotspots, the Western Ghats of Kerala. Herewith reports the presence of 90 species belonging to 22 genera and 11 families, shedding light on this previously understudied group.

Materials and Methods

A total of 303 moss samples (100–200g) were collected by quadrant sampling (1m²) and transferred to a polythene bag by scraping from rock, tree bark and soil from the survey conducted during 2016 and 2017 (Bindu L and Party and Jasmine P and party respectively) to various parts of Western Ghats of Kerala covering Thiruvananthapuram (N 8.524139 and E 76.936638), Kollam (N 8.893212 and E 76.614143), Wayanad (N 11.628705 and E 76.081251), Palakkad (N 10.784703 and E 76.653145) and Idukki (N 10.089167 and E 77.059723) districts (Figure 1). The samples were brought back to the laboratory and a portion of the sample (50g) was soaked in distilled water in a Petri dish (Non-Flooded Petri dish method) as described by Foissner (1987, 1992) and Mazei *et al.* (2011). The samples were then thoroughly stirred and filtered at 500µm sieve to remove all coarse debris. Subsequently, aqueous drops were extracted from the moss using a micropipette, placed on microslides, and

thoroughly examined under a light microscope. The testacids were isolated from the samples, air-dried after being washed two or three times in absolute alcohol, and then mounted in DPX. For each sample, 10–15 permanent mounts were prepared and examined under a Nikon 50i compound microscope for species-level identification. The classification is according to Ruggiero *et al.*, 2015. The slides with identified specimens were deposited at the National Zoological collections of Marine Biology Regional Centre, Chennai (Reg. Nos. with Mi.) and Protozoology section of Head Quarters, Kolkata (Reg. Nos. with Pt.).

Results

The present study reveals the occurrence of 90 species of moss dwelling testate amoebae under 22 genera and 11 families under 2 classes from various biotopes of the Western Ghats of Kerala. Also, the study constituted 8 species as new records to India. Of the 90 species recorded in the present study 82 species are recorded for the first time from Western Ghats, Kerala. The systematic details (as per Ruggiero *et al.*, 2015) of the taxa recorded and their biotopes, localities and collection details are provided in detail.

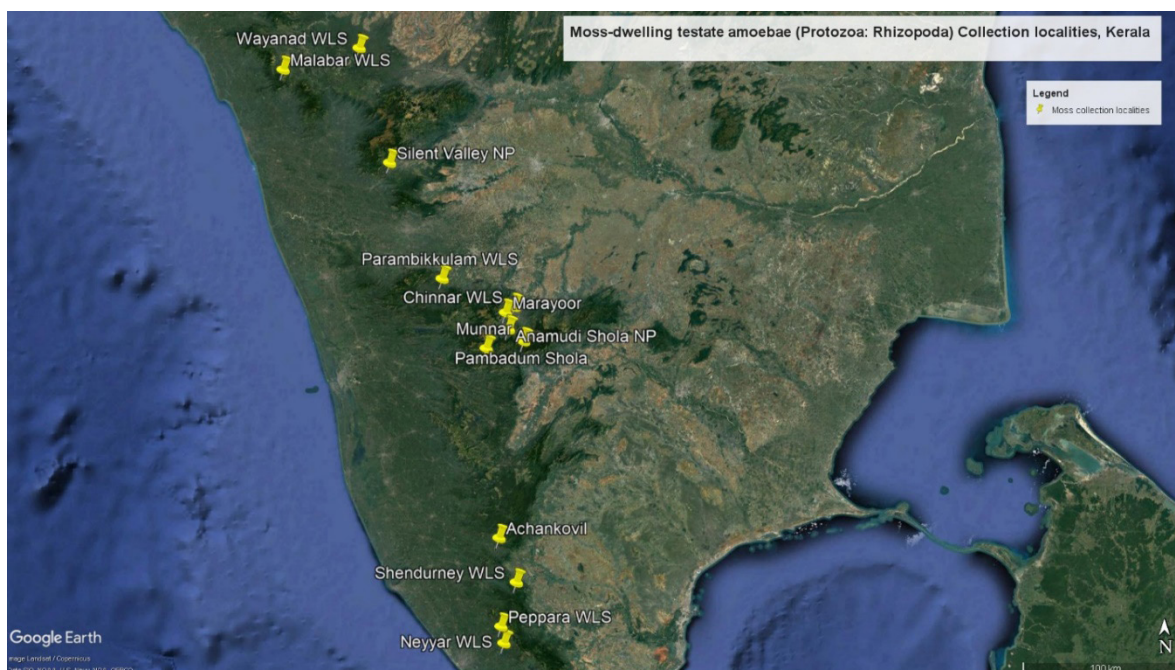


Figure 1. Map showing the collection localities of moss samples.

Phylum AMOEBOZOA Luhe, 1913

Class TUBULINEA Smirov, Bolivar & Pawlowski, 2005

Order ARCELLINIDA Kent, 1880

Family ARCELLIDAE Ehrenberg, 1832

1. *Arcella arenaria* Greeff, 1866

1866. *Arcella arenaria* Greeff, *Sitzb. Ges. Nat. Marburg*, 2: 52.

Material examined: Mi-493, 3exs., Wall moss, 1.xi.2017, Tholpetty, Wayanad WLS; Mi-523, 3exs., Wall moss, 4.xi.2017, Sungam range, Parambikkulam WLS; Pt.4155/1, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Assam, Himachal Pradesh and Kerala. *Elsewhere*: Cosmopolitan.

2. *Arcella artocrea* Leidy, 1876

1876. *Arcella artocrea*. Leidy: *Proc. Ac. Nat. Sci.*, 3: 57.

Material examined: Mi-494, 2 exs., Tree moss, 31.x.2017, Kakkayam, Malabar WLS; Mi-533, 5exs., Tree moss, 8.xi.2017, Shenthuriney WLS; Pt.4116/3, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Mi-533, 5 exs., Rock moss, 19.xii.2016, Mannavan Shola.

Distribution: India: Assam, Himachal Pradesh and Kerala. *Elsewhere*: Cosmopolitan.

3. *Arcella catinus* Penard, 1890

1890. *Arcella catinus* Penard; *Mem. Soc. Phys. & Hist. Nat. Geneve*, p. 15, figs. 78,87,92.
1928. *Arcella catinus* Penard: Deflandre, *Arch. Protistenkd.*, 64: 243.

Material examined: Pt.4113, 2 exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4112/1 2 exs., Tree moss, 8.xi.2017, Anamudi Shola; Mi-846, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Mizoram, Uttarakhand and Sikkim. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

4. *Arcella costata* Playfair, 1918

1918. *Arcella costata* Playfair, *Proc. Linn. Soc., New South wales*, 6: 34, figs, 16, 17.

Material examined: Pt.4137, 1ex., Tree moss, Anamudi Shola, 8.xi.2017.

Distribution: India: Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

5. *Arcella discoides* Ehrenberg, 1843

1843. *Arcella discoides* Ehrenberg, *Ber. k. Akad. Wiss.*, Berlin, 3: 139.
1928. *Arcella discoides* Ehrenberg: Deflandre, *Arch. Protistenkd.*, 64: 256.

Material examined: Mi-422, 4 exs., Tree moss, 19.xi.2016, Shenthuriney WLS; Mi-458, 2exs., Wall moss, 10.xi.2016, Neyyar WLS.

Distribution: India: Assam, Andhra Pradesh, Arunachal Pradesh, Chandigarh, Himachal Pradesh, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttarakhand and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Reported from Nilgiri BR (Western Ghats), Kerala.

6. *Arcella hemisphaerica* Perty, 1852

1852. *Arcella hemisphaerica* Perty, *Mit. Der Nat. Ges. in Bern.*, 1: 228.

Material examined: Mi-495, 2exs., Tree moss, 4.xi.2017, Bhawani range, Silent Valley NP; Mi.606, 2exs., Tree moss, 8.xi.2017, Pambadum shola.

Distribution: India: Assam, Andhra Pradesh, Manipur, Odisha and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

7. *Arcella vulgaris* Ehrenberg, 1832

1832. *Arcella vulgaris* Ehrenberg, *Abh. K. Akad. Wiss. Berlin*, p. 40.

Material examined: Mi-423, 3exs., Tree moss, 19.xi.2016, Shenthuriney WLS.

Distribution: India: Assam, Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh, Kerala, Manipur and Nagaland. *Elsewhere*: Cosmopolitan.

Remarks: Reported from Nilgiri BR (Western Ghats), Kerala.

Family CENTROPYXIDAE Jung, 1942

8. *Centropyxis aculeata* (Ehrenberg, 1832) Stein, 1857

1832. *Arcella* Ehrenberg, *Abh. Preuss. Akad. Wiss., Berlin*, p. 40.
1857. *Centropyxis aculeata* Stein, *Sitz. Bohm. Gesellsch. Wiss., Prague*, 5(10):41.

Material examined: Mi-391, 2exs., Rock moss, 19.xi.2016, Shenthuriney WLS; Mi-424, 6 exs., Tree moss, 19.xi.2016, Shenthuriney WLS; Mi.524, 2exs., Wall moss, 9.xi.2016, Ananirathy, Neyyar WLS; Mi-609, 5exs., 7. xi-2017, Chinnar WLS; Mi-699, 2exs., Tree moss, 12.xi.2016, Agastyamala foot hills, Peppara WLS; Mi-704, 3exs., Wall moss, 4.xi. 2017, Bhawani range, Silent Valley NP; Pt.4120, 8.xi.2017, 2exs., Tree moss, Anamudi Shola; Pt.4121, 2exs., Tree moss, 08.xi.2017, Anamudi Shola.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Maharashtra, Himachal Pradesh, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Rajasthan, Sikkim, Tripura and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Reported from Nilgiri BR (Western Ghats), Kerala.

9. *Centropyxis aculeata minima* Van Oye, 1958

1958. *Centropyxis aculeata minima* Van Oye, Etude sur les Rhizopodes des marais du-ouest d'Uvira (Congo-belge), *Hydrobiologia*, 10: 85-137.

Material examined: Mi-391, 2exs., Tree moss, 19. xi.2016, Shenthuriney WLS.

Distribution: India: Uttarakhand. *Elsewhere*: Cosmopolitan.

Remarks: Present record from India.

10. *Centropyxis aerophila* Deflandre, 1929

1929. *Centropyxis aerophila* Deflandre *Arch. Protistenkd.*, 67: 330.

Material examined: Mi-431, 6 exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-525, 2exs, Wall moss, 9. xi.2017, Marayoor, Idukki; Mi-548, 2exs., Tree moss, 10.xi.201, Thalayar, Munnar, Idukki; Mi-610, 3exs., Tree moss, 7.xi.2017, Chinnar WLS.

Distribution: India: Andhra Pradesh, Kerala, Sikkim, Uttarakhand and West Bengal. *Elsewhere*: Cosmopolitan.

11. *Centropyxis aerophila sphagnicola* Deflandre, 1929

1929. *Centropyxis aerophila* Defaldre var. *sphagnicola* Deflandre, *Arch. Protistenkd.*, 67: 333.

Material examined: Mi-535, 3exs., Tree moss, 8.xi.2017, Mannavan shola;

Mi-548, 3exs., Tree moss, 5.xi.2017, Parambikkulam WLS; Mi705, 2exs., Wall moss, 4.xi.2017, Bhawani range, Silent Valley NP; Pt.4104/3, 3exs, 8. xi. 2017, Tree moss, Anamudi Shola; Pt.4115/1, 3exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Andhra Pradesh and Sikkim. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

12. *Centropyxis cassis* Deflandre, 1929

1929. *Centropyxis cassis* Deflandre, *Arch. Protistenkd.*, 67: 330.

Material examined: Mi-730, 2exs., Wall moss, 4. xi.2017, Bhawani range, Silent Valley NP; Pt.4124, 3exs., 8.xi.2017, Tree moss, Anamudi Shola; Pt.4133/3, 2exs., 8.xi.2017, Tree moss, Anamudi Shola.

Distribution: India: Assam, Andhra Pradesh, Meghalaya, Odisha, Uttarakhand and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

13. *Centropyxis constricta* Penard, 1902

1929. *Centropyxis constricta* Penard, *Faune Rhizopodique du bassin du Lemn*, Geneve, 32: 299.

Material examined: Mi-392, 4exs., Tree moss, 19. xi.2016, Shenthuriney WLS; Mi-432, 3exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-472, 6exs., Tree moss, 18. xi. 2016, Shenthuriney WLS; Mi-483, 5exs., Tree moss, 11.xi.2016, Peppara WLS; Mi-611, 4exs., Tree moss, 7.xi.2017, Chinnar WLS; Mi-706, 2exs., 16.xi.2016, Wall moss, Near Palaruvi, Thenmala; Mi-728, 2exs., Wall moss, 17.xi.2016, Manalar, Achencovil range, Kollam; Mi-741, 3exs., Wall moss, 17. xi. 2016, Kallippara, Achenkovil range, Kollam; Pt.4134/1, 1ex., 8. xi. 2017, Tree moss, Anamudi Shola.

Distribution: India: Sikkim, Andhra Pradesh, Assam, Chandigarh, Himachal Pradesh, Meghalaya, Mizoram, Tripura, Uttarakhand and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

14. *Centropyxis delicatula* Penard, 1902

1902. *Centropyxis delicatula* Penard, *Faune Rhiz. Du bass du Lemn*, 21: 309.

Material examined: Mi-350, 2exs., 10.xi-2016; Neyyar WLS.

Distribution: India: Assam and Tamil Nadu, Kerala.
Elsewhere: Cosmopolitan.

15. ***Centropyxis discoides*** Penard, 1902

1902. *Centropyxis discoides* Penard, *Faune Rhizopodique du bassin du Lemane, Geneve*, 21: 299.

Material examined: Mi-425, 3exs., Wall moss, 17. xi. 2016, Kallippara, Achenkovil range, Kollam; Mi-587. 5exs., 8. xi. 2017, Tree moss, Pampadum shola; Mi-425, 6exs., Wall moss, 19.xi.2016, Shenthuriney WLS.

Distribution: India: Tamil Nadu and Himachal Pradesh.
Elsewhere: Cosmopolitan.

Remarks: Present record from Kerala.

16. ***Centropyxis ecornis*** Leidy, 1879

1879. *Centropyxis ecornis* Leidy, *Freshwater Rhizopods of North America*, pl.30, figs.20-24.

Material examined: Pt.4134, 1ex., 8.xi.2017, Tree moss, Anamudi Shola.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Kerala, Maharashtra, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Uttarakhand and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Reported from Nilgiri BR (Western Ghats), Kerala.

17. ***Centropyxis elongata*** (Penard, 1890) Thomas, 1959

1959. *Centropyxis elongata* Thomas, *Bull. Soc. Zool. France*, 82: 259-263.

Material examined: Mi-473, 3exs., Wall moss, 18.xi.2016, Shendurney WLS.

Distribution: Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

18. ***Centropyxis hemisphaerica*** Deflandre, 1929

1929. *Centropyxis hemisphaerica* Deflandre, *Arch. Protistenkd.*, 67: 340.

Material examined: Pt.4135, 1ex., 8. xi. 2017, Tree moss, Anamudi Shola.

Distribution: India: Assam, Kerala and Tamil Nadu.
Elsewhere: Cosmopolitan.

19. ***Centropyxis kurakchayensis*** Snegovaya et Alekperov, 2005 [Plate-1 (D)]

2005. *Centropyxis kurakchayensis* Snegovaya et Alekperov, *Protistology*, 4(2): 149-183.

Material examined: Mi-618, 2exs., 8.xi.2017, Tree moss, Anamudi Shola; Mi-565, 2exs., Tree moss, 31.x.2017, Malabar WLS.

Diagnosis: The shell is large, elliptical in plan, and strongly flattened in profile, the ventral surface is concave, the aperture is very large, practically central, and oval in shape, the lateral edges of the aperture form bridges reaching the dorsal part of the shell; the shell is without spines; shell length 160 to 190 μm , width 90-110 μm , shell height 42-48 μm .

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: New record from India.

20. ***Centropyxis laevigata*** Penard, 1890 (Deflandre, 1929)

1890. *Centropyxis laevigata* Penard, *Mem. Soc. Phys., Geneve*, 31(2): 151.

1929. *Centropyxis laevigata* Deflandre, *Arch. Protistenkd.*, 67: 356.

Material examined: Mi-446, 5 exs., Rock moss, 18.xi.2016, Shenthuriney WLS; Mi-474, 4exs., Wall moss, 31.x. 2017, Kakkayam, Malabar WLS; Pt.4107, 6exs., 8.xi.2017, Tree moss, Anamudi Shola; Pt.4108/1, 4exs., 8.xi.2017, Tree moss Anamudi Shola; Pt.4157, 2exs. 8.xi. 2017, Tree moss, Anamudi Shola.

Distribution: India: Assam, Himachal Pradesh, Maharashtra, Sikkim, Mizoram and West Bengal.
Elsewhere: Cosmopolitan.

Remarks: Present record from Kerala.

21. ***Centropyxis loffleri*** Laminger, 1972 [Plate -1(A)]

1972. *Centropyxis loffleri* Laminger, 1972, *Archiv fur Hydrobiologie*, 70: 108-129.

Material examined: Mi.534, 2exs., 8. xi. 2017, Tree moss, Anamudi Shola; Mi-534, 2exs., Tree moss, 8.xi.2017, Mannavan shola.

Diagnosis: The shell is relatively large, in plan it resembles a figure eight, in profile the test is hemispherical, the anterior part is sharply separated from the rest of the

test and is located at an angle of 30% relative to the longitudinal axis of the shell; the mouth is oval; shell length 85µm, shell width 70µm and aperture width 45µm.

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: Present record from India.

22. *Centropyxis minuta* Deflandre, 1929

1929. *Centropyxis minuta* Deflandre, *Arch. Protistenkd.*, **67**: 366.

Material examined: Mi-475, 6exs., Rock moss, 18.xi.2016, Shenthuriney WLS; Mi-492, 4exs., Tree moss, 11.xi.2016, Peppara WLS; Mi-549, 5exs., Tree moss, 5.xi.2017, Prarambikkulam WLS; Pt.4144, 2exs., Tree moss, 18.xi.2017, Anamudi Shola; Mi-447, 3exs., Wall moss, 18.xi.2017, Shenthuriney WLS.

Distribution: India: Assam, Andhra Pradesh, Arunachal Pradesh, Maharashtra, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Jammu and Kashmir, Uttarakhand and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

23. *Centropyxis oblonga* Deflandre, 1929

1929. *Centropyxis aculeata* var. *oblonga* Deflandre, *Arch. Protistenkd.*, **67**: 349.

Material examined: Mi-433, 5 exs., Rock moss, 18. xi. 2016, Shenthuriney WLS; Pt. 4139/1, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Assam, Himachal Pradesh, Nagaland and Sikkim. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

24. *Centropyxis orbicularis* Deflandre, 1929

1929. *Centropyxis orbicularis* Deflandre, *Arch. Protistenkd.*, **67**: 334.

Material examined: Mi-448, 4exs., Wall moss, 18.xi.2016, Shenthuriney WLS; Mi-619, 2exs., Wall moss, 8.xi.2017, Chinnar, WLS; Pt.4110/2, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4154/1, 1ex., 8.xi.2017, Tree moss, Anamudi Shola.

Distribution: India: Andhra Pradesh, Assam, Himachal Pradesh, Maharashtra, Sikkim and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

25. *Centropyxis plagiostoma* Bonnet and Thomas, 1955

1955. *Centropyxis plagiostoma* Bonnet and Thomas, *Bull. Soc. Hist. nat. Toulouse*, **110**: 415.

Material examined: Mi-393, 3exs., Rock moss, 19. xi.2016, Shenthuriney WLS; Mi-612, 4exs., Tree moss, 7.xi.2017, Chinnar WLS.

Distribution: India: Assam, Mizoram, Nagaland and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

26. *Centropyxis platystoma* Deflandre, 1929

1929. *Centropyxis platystoma* Deflandre, *Arch. Protistenkd.*, **67**: 338.

Material examined: Mi-434, 2exs, Wall moss, 12.xi.2016, Peppara WLS; 2exs., Mi-550, 4exs., Tree moss, 5.xi.2017, Parambikkulam WLS; Pt.4121/1, 2exs., Tree moss, 8. xi.2017, Anamudi Shola; Mi-394, 2exs., Wall moss, 19. xi.2016, Shendurney WLS; Mi-434, 4 exs., Tree moss, 18. xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh, Uttarakhand, Sikkim, West Bengal, Assam, Manipur and Mizoram. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

Family Diffugiidae Wallich, 1864

27. *Diffugia brevicolla* Cash & Hopkinson, 1909

1909. *Diffugia brevicolla* Cash and Hopkinson. *The British Freshwater Rhizopod and Heliozoa*, **2**: 38, pl. 19, Fig. 12-13.

Material examined: Mi-436, 3exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

28. *Diffugia corona* Wallich, 1864

1864. *Diffugia corona* Wallich, *Ann. Mag. Nat. Hist.* **13**(3): 244.

Material examined: Mi-353, 2exs., 18.xi.2016, Neyyar WLS.

Distribution: India: Assam, Andhra Pradesh, Kerala, Tamil Nadu, Tripura and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Reported from Nilgiri BR (Western Ghats), Kerala.

29. *Diffugia globulosa* Penard, 1902

1902. *Diffugia globulosa* Penard, *Faune Rhizopodique du Bassin de Leman*. Geneve: Kundig, pp.714.

Material examined: Mi-508, 2exs., Wall moss, 11. xi. 2017, Eravikulam NP, Munnar; Mi-569, 6exs., Tree moss, 2.xi.2017, Wayanad WLS; Mi-484, 4exs., Tree moss, 11.xi.2016, Peppara WLS; Mi-537, 5exs., Tree moss, 11.xi.2017, Eravikulam NP, Munnar; Mi-553, 7exs., Tree moss, 5.xi.2017, Parambikkulam WLS; Pt.4106/1, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4106/2, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4107/1, 3exs., 8.xi.2017, Tree moss, Anamudi Shola; Pt.4107/3, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4109/3, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4118, 1ex., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4130, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Andhra Pradesh, Rajasthan, Meghalaya, West Bengal, Assam and Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

30. *Diffugia globularis* Wallich, 1864

1864. *Diffugia globularis* Wallich, *Ann. Mag. Nat. Hist.*, 3(13): 215-245.

Material examined: Mi.588, 4exs., Tree moss, 8. xi. 2017, Pampadum Shola.

Distribution: India: Tamil Nadu and Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

31. *Diffugia lithophila* Penard, 1902

1902. *Diffugia hydrostatica* var. *lithophila* Penard, *Fauna rhizopodique du basin du Leman*, Geneve, p. 274, Fig.1.

Material examined: Mi-438, 5exs., Rock moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Chandigarh, Meghalaya, Tripura and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

32. *Diffugia oblonga* Ehrenberg, 1838

1838. *Diffugia oblonga* Ehrenberg, *Infusionsthierchen*, p. 131, pl.2, figs. 3 a-d.

Material examined: Mi.412, 4exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-412, 4exs., Rock moss, 19.xi.2016, Shenthuriney WLS.

Distribution: India: Assam, Himachal Pradesh, Meghalaya, Sikkim and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

33. *Diffugia lebes* Penard, 1899

1899. *Diffugia lebes* Penard, *Les Rhizopodes de faune profonde dans le lac Leman*. *Rev. Suisse Zool.*, 7: 1-42.

Material examined: Mi-485, 3exs., Tree moss, 11.xi.2016, Peppara WLS.

Distribution: India: Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

34. *Diffugia lucida* Penard, 1890

1890. *Diffugia lucida*, Penard *Mem. Soc. Phys. Et. Hist. Nat. Geneve*, 31: 145.

Material examined: Mi-439, 4exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh, Nagaland, Sikkim and Uttarakhand. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

Family HYALOSPHEENIIDAE Schultze, 1877

35. *Certesella martiali* Jung, 1942

1942. *Certesella martiali* Jung, *Archiv fur Protistenkunde*, 95: 357-390.

Material examined: Mi-566, 3exs., Tree moss, 8.xi.2017, Pampadum Shola.

Distribution: India: Assam, Himachal Pradesh, Meghalaya, Sikkim and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

36. *Alabasta militaris* (Penard, 1890) Duckert *et al.*, 2018

1890. *Nebela militaris* Penard, *Etudes sur les rhizopodes d'eau douce*. *Mem. Soc. Phys. Hist. Geneve*, 31(2): 1-230.

2018. *Alabasta militaris* Duckert *et al.*, *Eur. J. Protistol.*, 66:156-165.

Material examined: Mi-417, 4exs., Tree moss, 19.xi.2016, Shendurney WLS.

Distribution: India: Himachal Pradesh and Sikkim.
Elsewhere: Cosmopolitan.

Remarks: Present record from Kerala.

37. *Nebela bohémica* Taranek, 1882

1882. *Nebela bohémica* Taranek, *Abh. Koni. bohém. Ges.d Wiss.* VI. pl. II, figs. 4-15.

Material examined: Mi-512, 4exs., Rock moss, 9.xi.2016, Neyyar WLS; Mi.566, 3exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-574, 2exs., Wall moss, 31.x.2017, Malabar WLS.

Distribution: India: Assam, Himachal Pradesh, Meghalaya, Sikkim and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

38. *Nebella collaris* (Ehrenberg, 1848) Leidy, 1879

1848. *Diffflugia collaris* Ehrenberg, *Monatsb. Akad. Wiss., Berlin*, p. 218.

1879. *Nebela collaris* Leidy, *Freshwater Rhizopods of North America*, p.145.

Material examined: Mi-488, 4exs., Wall moss, 11.xi.2016, Peppara WLS.

Distribution: India: Andhra Pradesh, Himachal Pradesh, Mizoram, Sikkim, Tripura and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

39. *Nebela dentistoma* Penard, 1890

1890. *Nebela dentistoma* Penard, *Mem. Soc. Phys. Et Hist. Nat. Geneve*, 31: 162.

Material examined: Mi-416, 5exs., Tree moss. 19.xi. 2016, Shenthuriney WLS; Mi-489, 4exs., 11.xi.2016, Peppara WLS.

Distribution: India: Assam, Arunachal Pradesh, Meghalaya, Sikkim and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

40. *Nebela parvula* Cash, 1909 [Plate-1(B)]

1909. *Nebela parvula* Cash, *The British Freshwater Rhizopoda and Heliozoa*, V. 89, pp i-xviii, 1-66.

Material examined: Mi.543, 2exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-418, 2 exs., Tree moss, 19.xi.2016, Shenthuriney WLS.

Diagnosis: The shell is relatively large, and ovoid in plan, and the spherical fundus gradually narrows towards the mouth. The aperture has a straight contour and is surrounded by a lip of organic matter. Shell length 75µm, shell width 55 µm and aperture width 18µm.

Distribution: Present record. *Elsewhere:* Cosmopolitan.

Remarks: Present record from India.

41. *Nebela tinctoria* (Leidy, 1879) Awerintzew, 1906

1879. *Hyalosphenia tinctoria* Leidy, *Freshwater Rhizopods of North America*, p.138, pl.20, figs. 11-17.

1906. *Nebela tinctoria* (Leidy) Awerintzew, *St. Petersburg Trav. Soc. Nat.* 36(2): 66.

Material examined: Mi-514, 3exs., Rock moss, 9.xi.2016, Neyyar WLS; Pt.4104/5, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Arunachal Pradesh, Manipur and Sikkim. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

42. *Nebela spumosa* Awerintzew, 1906 [Plate-1(C)]

1906. *Nebela spumosa* Awerintzew, *Archiv fur Protistenkunde*, 8: 85-111.

Material examined: Mi-575, 3exs., Wall moss, 8.xi.2017, Pampadum Shola.

Distribution: The shell is very large and broadly pear-shaped. The fundus is surrounded by a flat ridge extending to the anterior third of the height. The cross-section and mouth are elliptical. The shell is covered with large idiosomes surrounded and cross-sectioned by smaller plates. Shell length is 265-275 µm and width is 135-142µm.

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: New record from India.

43. *Padaungiella lageniformis* (Penard, 1890) Lara and Todorov, 2012 (In Kosakyan *et al.*)

1890. *Nebela lageniformis* Penard, *Mem. Soc. Phys. et Hist. nat. Geneve*, 31(2): 158.

2012. *Padaungiella lageniformis* Lara and Todorov, (In Kosakyan *et al.*), *Protist*, 136(3): 415-434.

Material examined: Mi-400, 4exs., Wall moss, 19. xi.2016, Shenthuriney WLS.

Distribution: India: Mizoram and Sikkim. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

44. ***Padaungiella tubulata*** (Brown, 1910) Lara and Todorov, 2012 (In Kosakyan *et al.*)

1909. *Nebela militaris* var. *tubulata* Brown, *Journ. Linn. Soc. Zool.*, **30**: 361.

1910. *Nebela tubulata* Brown, *Journ. Linn. Soc. Zool.*, **31**: 79.

2012. *Padaungiella tubulata* Lara and Todorov, (In Kosakyan *et al.*), *Protist*, **136**(3): 415-434.

Material examined: Mi-442, 3exs., Rock moss, 18.xi.2016, Shenthuriney WLS; Mi-516, 2exs., Tree moss, 11.xi.2016, Peppara WLS; Mi-530, 2exs., Wall moss, 18.xi.2016, Neyyar WLS.

Distribution: India: Sikkim. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

45. ***Padaungiella wailesi*** (Deflandre, 1936) Lara and Todorov, 2012 (In Kosakyan *et al.*)

1936. *Nebela wailesi* Deflandre, *Ann. Protist.*, **5**: 265.

2012. *Padaungiella wailesi* Lara and Todorov, (In Kosakyan *et al.*), *Protist.*, **136**(3): 415-434.

Material examined: Mi-419, 4 exs., Wall moss, 19. xi. 2016, Shenthuriney WLS; Mi-453, 4exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh and Meghalaya. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

46. ***Quadrullella quadrigera*** Deflandre, 1936

1936. Deflandre Deflandre, *Annales de Protistologie*, **5**: 201-302.

Material examined: Mi.560, 8exs., Tree moss, 8.xi.2017, Pampadum Shola.

Distribution: India: Himachal Pradesh and Sikkim. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

47. ***Quadrullella symmetrica*** (Wallich, 1864) Schulze, 1875

1864. *Diffugia symmetrica* Wallich, *An. Mag. Nat. Hist.*, **13**: 245.

1875. *Quadrullella symmetrica* (Wallich) Schulze, *Arch. Mik. Anat.*, p. 329.

Material examined: Mi-428, 3 exs., Tree moss, 19. Xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh, Meghalaya and Sikkim. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

48. ***Quadrullella tropica*** Wailes, 1912

1912. *Quadrullella tropica* Wailes, *J. Linn. Soc. London, Zool.*, **32**: 121-161.

Material examined: Mi.561, 4exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-577, 2exs., Tree moss, 4.xi.2017, Silent Valley NP; Mi-429, 2exs., Tree moss, 19.xi.2016, Shenthuriney WLS.

Distribution: India: Arunachal Pradesh, Himachal Pradesh and Mizoram. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

Family MICROCORYCIIDAE de Saedeleer, 1934

49. ***Diplochlamys fragilis*** Penard, 1909

1909. *Diplochlamys fragilis* Penard, *Archiv fur Protistenkunde*, **17**: 258-296.

Material examined: Pt. 4112/2, 2 exs., Tree moss. 8.xi-2017, Pambadum shola.

Distribution: India: Kerala. *Elsewhere:* Cosmopolitan.

50. ***Diplochlamys leidy*** Greeff, 1888

1888. *Diplochlamys leidy* Greeff, *Sitz. der Ges. Zur. der Ges. Nat. zu Mar.*, **3**: 90-158.

Material examined: Pt.4105/5, Pt. 4107/2, Pt. 4108., 3exs, Tree moss, 8.xi.2017, Pambadum shola.

Distribution: India: Sikkim and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

Family PLAGIOPYXIDAE Bonnet and Thomas, 1960

51. ***Bullinularia indica*** Penard, 1907

1907. *Bullinella indica* Penard, *J. Roy. Micr. Soc.*, **10**: 274.

Material examined: Pt.4119,3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4140, 1ex., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4153, 4exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4155, 7exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Sikkim, West Bengal, Arunachal Pradesh, Assam and Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

52. ***Plagiopyxis callida*** Penard, 1910

1910. *Plagiopyxis callida* Penard, *Rev. Suisse Zool.*, **18**: 46.

Material examined: Mi-518, 3exs., Rock moss, 9.xi.2016, Neyyar WLS; Pt.4105/4, 4exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Assam, Arunachal Pradesh, Himachal Pradesh, Sikkim, Manipur and Mizoram. *Elsewhere:* Cosmopolitan. *Remarks:* Present record from Kerala.

53. ***Plagiopyxis declivis*** Bonnet & Thomas, 1955

1955. *Plagiopyxis declivis* Bonnet and Thomas, *Bull. Soc. Hist. Nat. Toulouse*, **90**: 420.

Material examined: Mi-454, 2 exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Arunachal Pradesh, Himachal Pradesh, Manipur, Nagaland, Sikkim and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

54. ***Phryganella acropodia*** Hopkinson, 1909

1909. *Phryganella acropodia* Hopkinson, *The British Freshwater Rhizopoda and Heliozoa*, **2**: 74, pl.20, figs.13-14.

Material examined: Mi-576, 3exs, Wall moss, 2.xi.2017, Wayanad WLS; Mi.593, 3exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-490, 3exs., Wall moss, 11.xi.2016, Peppara WLS.

Distribution: India: Andhra Pradesh and Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

Family TRIGONOPYXIDAE Loeblich and Tappan, 1964

55. ***Trigonopyxis arcula*** Penard, 1912

1912. *Trigonopyxis arcula* Penard, *Rev. Suisse Zool.*, **20**(1); 9,13, pl.1, figs.6,8.

Material examined: Mi-615, 3exs., Tree moss, 8.xi.2017, Pampadum Shola.

Distribution: India: Sikkim, Manipur, Himachal Pradesh and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

56. ***Cyclopyxis aplanata*** Deflandre, 1929

1929. *Cyclopyxis aplanata* Deflandre, *Archiv fur Protistologie*, **67**: 322-375.

Material examined: Mi-567, 3exs. 8.xi.2017, Tree moss, Pampadum Shola; Mi-449, 3exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Uttarakhand. *Elsewhere:* Cosmopolitan.

57. ***Cyclopyxis arcelloides*** Deflandre, 1929

1902. *Centropyxis arcelloides* Penard, *Faune Rhizopodique du bassin du Léman, Geneve*, p. 309.

1929. *Centropyxis (Cyclopyxis) arcelloides* Deflandre, *Arch. Protistenkd.*, **67**, p.367.

Material examined: Mi-476, 6exs., Wall moss, 18.xi.2016, Shenthuriney WLS; Mi-536, 2exs., Tree moss, 8. xi. 2017, Mannavan shola; Mi-601, 3exs., Wall moss, 7.xi.2017, Chinnar WLS; Pt.4105, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4110/1 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4112, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4116/1, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4120/1, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4123, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Assam, Arunachal Pradesh, Himachal Pradesh, Uttarakhand, Sikkim, West Bengal, Mizoram, Meghalaya and Tripura. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

58. ***Cyclopyxis eurystoma*** Deflandre, 1929

1929. *Centropyxis (Cyclopyxis) eurystoma* Deflandre, *Arch. Protistenkd.*, **67**: 370.

Material examined: Mi-390, 5 exs., Rock moss, 19.xi.2016, Shenthuriney WLS; Mi-437, 4exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-450, 5exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-477, 6exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-568, 3exs., Tree moss, 2.xi.2017, Wayanad WLS; Mi-613, 3exs., Tree moss, 7.xi.2017, Chinnar WLS; Pt.4117, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4124/1, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4126 3exs., Wall moss, 8.xi.2017, Anamudi Shola; Pt.4127, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4129, 1ex., 8.xi.2017, Tree

moss, Anamudi Shola; Pt.4154/2, 1ex., 8.xi.2017, Tree moss, Anamudi Shola.

Distribution: India: Assam, Maharashtra, Arunachal Pradesh and Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

59. ***Cyclopyxis kahli*** Deflandre, 1929

1929. *Centropyxis (Cyclopyxis) kahli* Deflandre, *Arch. Protistenkd.*, **67**: 371.

Material examined: Pt.4142, 1ex., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4143, 1ex., Tree moss, 8.xi.2017, Anamudi Shola; Mi-390, 5exs., Tree moss, 19. xi. 2016, Shenthuriney WLS; Mi-435, 5 exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-451, 3exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Jammu and Kashmir, Himachal Pradesh, Assam, Mizoram and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

60. ***Cyclopyxis leidy*** Couteaux and Chardez, 1981

1981. *Cyclopyxis leidy* Couteaux and Chardez, *Revue d' Ecologie et de Biologie du sol*, **18**: 193-208.

Material examined: Mi-478, 2exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

61. ***Cyclopyxis puteus*** Thomas, 1960

1960. *Cyclopyxis puteus* Thomas, *Linnene de Bordeaux*, **98**: 27-53.

Material examined: Mi-551,3exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-479, 3exs., Tree moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Uttarakhand. *Elsewhere:* Cosmopolitan

62. ***Cyclopyxis tronconica*** Godeanu, 1972

1972. *Cyclopyxis tronconica* Godeanu, *Revue Roumaine de Biologie*, **17**: 227-236.

Material examined: Mi-552,3exs., Tree moss, 8.xi.2017, Pampadum Shola.

Distribution: India: Uttarakhand. *Elsewhere:* Cosmopolitan

Incertae Sedis Arcellinida

63. ***Argynnia gertrudeana*** Jung, 1942 [Plate-2 (A)]

1942. *Argynnia gertrudeana* Jung, *Arch. Protistenkd.*, **95**: 357-390.

Material examined: Mi-820, 2exs., Wall moss, 18.xi.2016; Neyyar WLS.

Diagnosis: The test is large, pear-shaped in dorsal view and flattened in profile, neck sharply separated from the fundus with a covering of overlapping idiosomes; test length is 231 to 241 μm , and width is 121 to 140 μm .

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: New record from India.

64. ***Heleopera sylvatica*** Penard, 1890

1890. *Heleopera sylvatica* Penard, *Mem. Soc. Phys. Et. Hist. Nat. Geneve*, **31**(2): 168.

Material examined: Mi-441, 4exs., Rock moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh, Nagaland and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

65. ***Physochilla tenella*** Penard, 1893 [Plate-2(D)]

1893. *Physochilla tenella* Penard, *Arch. Sci.Phys. Nat. Geneve*, **29**: 165-184.

Material examined: Pt.4105/6, 2exs., Tree moss, 8.xi.2017, Pampadum shola.

Diagnosis: The test is medium, pear-shaped in dorsal view; the aperture is surrounded by a wide ridge consisting of small elliptical idiosomes, and partially overlapping edges. The shell is chitinous, slightly flattened, and has shallow pits on the surface. The mouth of the shell is broadly elliptical. Shell length 68-85 μm , width 40-60 μm .

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: Present record from India.

Phylum CERCOZOA Cavalier-Smith, 1998, emend. Adl *et al.*, 2005

Class IMBRICATEA Cavalier-Smith, 2011

Family ASSULINIDAE Lara *et al.*, 2007

66. *Assulina muscorum* Greef, 1888

1888. *Assulina muscorum* Greef, *Sitzber.Ges.Nat. Marburg*, 3: 117.

Material examined: Mi-564, 6exs., Tree moss, 31. x.2017, Malabar WLS; Mi-607, 3exs., Tree moss, 7.xi.2017, Chinnar WLS; Mi-633, 6exs., Wall moss, 1. xi. 2017, Wayanad WLS; Pt.4049, 1ex., Wall moss, 8.xi.2017, Anamudi Shola; Pt.4106/4, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4114, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4117/1, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4136, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4154, 1ex., Tree moss, 8.xi.2017, Anamudi Shola; Mi-411, 5exs., Wall moss, 19.xi.2016, Shenthuriney WLS.

Distribution: India: Andhra Pradesh, Assam, Manipur, Nagaland, Sikkim and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

67. *Assulina seminulum* Leidy, 1879

1879. *Assulina seminulum* Leidy, *Freshwater Rhizopods of North America*, pl. 39, p. 225.

Material examined: Mi-547, 6exs., Tree moss, 8.xi.2017, Pampadum shola; Mi-608, 3exs., Tree moss, 7.xi.2017, Chinnar WLS; Mi-617, 2exs., Wall moss, 31.x.2017, Malabar WLS.

Distribution: India: Sikkim, Manipur, Nagaland, Andhra Pradesh, West Bengal and Assam. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

Family EUGLYPHIDAE Wallich, 1864

68. *Euglypha acanthophora* (Ehrenberg, 1842) Perty, 1849

1842. *Diffflugia acanthophora* Ehrenberg, *Abh. Acad. Berlin*, 1842, pp. 413.

1849. *Euglypha acanthophora* Perty, *Mitth., Nat. Ges. Bern.*, 5: 45.

Material examined: Mi-354, 2exs., Tree moss, 18. ix. 2016; Neyyar WLS.

Distribution: India: Andhra Pradesh, Assam, Manipur, Meghalaya, Nagaland, Tamil Nadu and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

69. *Euglypha capsiosa* Couteaux, 1978

1978. *Euglypha capsiosa* Couteaux, *J. Protozool. Res.*, 25: 50A.

Material examined: Mi-570, 3exs., Wall moss, 4. xi.2017, Silent Valley NP; Mi-602, 4exs., Wall moss, 7.xi.2017, Chinnar WLS; Pt.4105/3, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4106/6, 2exs., Tree moss., 8.xi.2017, Anamudi Shola; Pt.4109/2, 2exs., Tree moss, 8. xi.2017, Anamudi Shola; Pt.4110, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4111/1, 4exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4113/1, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4138, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

70. *Euglypha ciliata* Leidy, 1878

1878. *Euglypha ciliata* Leidy, *Proc. Acad. Philad.*, 3: 172.

Material examined: Mi-554, 4exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-413, 4exs., Tree moss, 19. xi. 2016, Shenthuriney WLS; Mi-440, 5exs., Tree moss, 18.xi.2016., Shenthuriney WLS; Mi-538, 4exs., Tree moss, 8.xi.2017, Mannavan shola; Mi-614, 3exs., Tree moss, 7.xi.2017, Chinnar WLS.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Jammu & Kashmir, Sikkim, Tripura, Mizoram and West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

71. *Euglypha compressa* Carter, 1864

1864. *Euglypha compressa* Carter, *Ann. Nat. Hist.* (3) 13, p. 33, pl.1. Fig.13.

Material examined: Mi-452, 3exs., Tree moss, 18. xi. 2016, Shenthuriney WLS; Mi-539, 4exs., Wall moss, 8.xi.2017, Mannavan shola; Pt.4115, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Uttarakhand, Sikkim, West Bengal, Assam, Mizoram and Uttar Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

72. *Euglypha denticulata* Brown, 1912.

1912. *Euglypha denticulata* Brown, *Scottish Naturalist.*, p.181.

Material examined: Mi-414, 3 exs., Tree moss, 19. xi. 2016, Shenthuriney WLS.

Distribution: India: Meghalaya, Sikkim, Tripura and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala

73. *Euglypha filifera* Penard, 1890

1890. *Euglypha filifera* Penard, *Mem. Soc. Geneve*, 31: 69-73.

Material examined: Mi-540, 3exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-571, 2exs., Tree moss, 4. xi.2017, Silent Valley NP.

Distribution: India: Tripura, West Bengal and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

74. *Euglypha laevis* (Ehrenberg, 1845) Perty, 1849

1845. *Diffugia laevis* Ehrenberg, *Ber. Akad., Berlin*, p. 307.

1849. *Euglypha laevis* Perty, *Mitth. Nat. Ges. Bern.*, 3: 163.

Material examined: Mi-541, 3exs., Tree moss, 8.xi.2017, Mannavan shola; Mi-555, 5exs., Tree moss, 5. xi.2017, Parambikkulam WLS; Mi-572, 3exs., Wall moss, 2.xi.2017, Wayanad WLS; Mi-599, 4exs., Wall moss, 7.xi.2017, Chinnar WLS; Mi-625, 2exs., Rock moss, 8. xi. 2017, Chinnar WLS; Pt.4104/2, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4106, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4107/4, 4exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4109/1, 6exs., 8.xi.2017, Tree moss, Anamudi Shola; Pt.4112/3, 2exs., 8.xi.2017, Tree moss, Anamudi Shola; Pt.4116/2, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Assam, Andhra Pradesh, Himachal Pradesh, Tripura, Meghalaya, Sikkim, West Bengal and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

75. *Euglypha marginata* Van Oye, 1958 [Plate-2(B)]

1958. *Euglypha marginata* Van Oye, *Hydrobiologia*, 10(1): 85-137.

Material examined: Mi-556, 3exs., Tree moss, 8.xi.2017, Pampadum Shola.

Diagnosis: The shell is relatively large, broadly ovoid in dorsal view, along the edge of the shell there is a visible row of evenly spaced parietal idiosomes of the same size; shell length 111µm and width 80µm.

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: New record from India.

76. *Euglypha rotunda* Wailes and Penard, 1911

1911. *Euglypha rotunda* Wailes and Penard, *Proc. R. Irish Acad.*, 31: 60-62.

Material examined: Mi-398, 3exs., Tree moss, 19.xi.2016, Shenthuriney WLS; Mi-487, 3exs., Wall moss, 11.xi.2016, Peppara WLS; Mi-714, 2exs., Rock moss, 31.x.2017, Malabar WLS; Mi-736, 2exs., Rock moss, 1.xi.2017, Wayand WLS.

Distribution: India: Andhra Pradesh and Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

77. *Euglypha simplex* Decloitre, 1965

1965. *Euglypha simplex* Decloitre, *Bull. De la societe des sci. Nat. et. Phy. Du Maroc*, 45: 17-28.

Material examined: Mi-600, 4exs., Tree moss, Chinnar WLS; Mi-542, 3exs., Tree moss, 8.xi.2017, Mannavan shola; Mi-557, 3exs., Rock moss, 5.xi.2017, Parambikkulam WLS; Mi-573, 3exs., Wall moss, 2.xi.2017, Wayanad WLS; Mi-715, 2exs., Rock moss, 31.x.2017, Malabar WLS; Pt.4106/3, 5exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4141, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Himachal Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

78. *Euglypha strigosa* Leidy, 1878 [Plate-2(C)]

1878. *Euglypha strigosa* Leidy, *Proc. Acad. Philad.*, 5: 172.

Material examined: Mi-559, 4exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-480, 4exs., Wall moss, 18.xi.2016, Shenthuriney WLS.

Distribution: India: Himachal Pradesh, Sikkim and Uttarakhand. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

79. *Euglypha tuberculata* Dujardin, 1841

1841. *Euglypha tuberculata* Dujardin, *Zooph. Infus.* p. 251.

Material examined: Mi-415, 4exs., Tree moss, 19.xi.2016., Shenthuriney WLS.

Distribution: India: Assam, Andhra Pradesh, Arunachal Pradesh, Chandigarh, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya, Nagaland, Sikkim, Tripura and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

80. *Euglypha strigosa heterospina* Wailes, 1912

1912. *Euglypha strigosa heterospina* Wailes, *J. Linn. Soc. Zool.*, **32**: 121-161.

Material examined: Mi-558, 3exs., Tree moss, 5. xi.2017, Parambikkulam WLS.

Diagnosis: The shell is medium-sized, ovoid to broadly pear-shaped in dorsal view and flattened in profile, round aperture with a wide and rectangular posterior border; the spines are located over the entire surface, singly or in pairs; shell length 45-100µm; it differs from the typical form by the presence of spines of varying lengths from 6 to 20µm.

Distribution: India: Present record. *Elsewhere:* Cosmopolitan.

Remarks: New record from India.

Family TRINEMATIDAE Hoogenraad and Groot, 1940

81. *Corythion asperulum* Schonborn, 1988

1988. *Corythion asperulum* Schonborn, *Archiv fur protistenkunde*, **127**: 223-245.

Material examined: Mi-733, 2exs., Rock moss, 9.xi.2016., Neyyar WLS; Pt.4156, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Kerala and Uttarakhand. *Elsewhere:* Cosmopolitan.

82. *Corythion dubium* Taranek, 1881

1881. *Corythion dubium* Taranek. *Sitzb. bohm. Ges. Wiss.*: Fig.3, p. 232.

Material examined: Pt.4149, 3exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4155/2, 1ex., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Sikkim, Manipur, Nagaland, Andhra

Pradesh, Arunachal Pradesh, Tripura, Himachal Pradesh, West Bengal, Mizoram and Andhra Pradesh. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

83. *Trinema chardezi* Decloitre, 1981

1981. *Trinema chardezi* Decloitre, *Archiv fur protistenkunde*, **124**: 193-218.

Material examined: Mi-578, 4exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-605, 3exs., Tree moss, 7.xi.2017, Chinnar WLS.

Distribution: India: Arunachal Pradesh. *Elsewhere:* Cosmopolitan.

84. *Trinema complanatum* Penard, 1890

1890. *Trinema complanatum* Penard, *Mem. Soc. Geneve*, **31**: 187, pl.10, figs. 1-4.

Material examined: Mi-420, 5 exs., Tree moss, 19.xi.2016, Shenthuriney WLS; Mi-455, 6 exs., Rock moss, 18. xi. 2016, Shenthuriney WLS; Mi-481, 6exs., Tree moss, 18.xi.2016, Shenthuriney WLS; Mi-579, 4exs., Rock moss, 5.xi.2017, Silent Valley NP; Mi-603, 3exs., Wall moss, 7.xi.2017, Chinnar WLS; Mi-735, 2exs., Rock moss, Achencovil range, Kollam; Pt.4106/5, 2exs., 8.xi.2017, Tree moss, Anamudi Shola; Pt.4111, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4125, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh, Mizoram, Sikkim, Uttarakhand and Assam. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

85. *Trinema enchelys* (Ehrenberg, 1838) Leidy, 1878

1838. *Diffflugia enchelys* Ehrenberg, *Infusionsth.* p.132, pl.9. Figs.4 a,b.
1878. *Trinema enchelys* Leidy, *Proc. Acad. Philad.*, **5**: 172.

Material examined: Mi-731, 6exs., Wall moss, 12.xi.2016, Agastyamala foothills; Pt.4128/1, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4133, 3exs., 8.xi.2017, Tree moss, Anamudi Shola.

Distribution: Assam, Arunachal Pradesh, Himachal Pradesh, Mizoram, Tripura, Uttarakhand, Nagaland, Maharashtra and West Bengal. *Elsewhere:* Cosmopolitan.

Remarks: Present record from Kerala.

86. *Trinema grandis* Golemansky, 1963

1963. *Trinema grandis* Golemansky, *Academie bulgare des Sci.*, **19**: 57-59.

Material examined: Mi-580, 3exs., Wall moss, 31.x.2017, Malabar WLS; Mi-598, 4exs., Tree moss, 8.xi.2017, Pampadum Shola; Mi-630, 4exs., Rock moss, 8.xi.2017, Chinnar WLS; Mi-746, 4exs., Rock moss, 17. xi.2016, Manalar, Achencovil range.

Distribution: India: Himachal Pradesh and Mizoram. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

87. *Trinema leidy* Chardez, 1981

1981. *Trinema leidy* Chardez, *Les Naturalistes Belges*, **61**: 88-91.

Material examined: Mi-631, 3exs., Rock moss, 8. xi.2017, Chinnar WLS; Pt.4128, 2exs., Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Assam and Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

88. *Trinema lineare* Penard, 1890

1890. *Trinema lineare* Penard, *Mem. Soc. Geneve*, **31**: 5-17.

Material examined: Mi-604, 4exs., Wall moss, 7.xi.2017, Chinnar WLS; Pt.4116,8 exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4120/2, 3exs., Rock moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Arunachal Pradesh, Assam, Himachal Pradesh, West Bengal, Manipur, Mizoram, Tripura, Uttarakhand, Nagaland, Maharashtra, Meghalaya and Uttar Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

89. *Trinema penardi* Thomas & Chardez, 1958

1958. *Trinema penardi* Thomas and Chardez, *Cahiers des Naturalistes, Bull.*, **14**: 101.

1988. *Trinema penardi*: Lüftenegger et al. *Arch. Protistenkd.*, **136**, p. 185, figs. 24,25b.

Material examined: Mi-430, 5exs., Rock moss, 19.xi.2016, Shenthuriney WLS; Mi-581, 3exs., Rock moss, 31.x.2017, Malabar WLS; Mi-616, 3 exs., Tree moss, 7.xi.2017, Chinnar WLS; Pt.4105/1, 2exs., Tree moss, 8.xi.2017, Anamudi Shola; Pt.4145, 1ex. Tree moss, 8.xi.2017, Anamudi Shola.

Distribution: India: Uttarakhand, Assam and Himachal Pradesh. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

Incertae Sedis Euglyphida90. *Tracheleuglypha dentata* (Vejdowsky, 1832) Deflandre, 1928

1832. *Euglypha dentata* Vejdowsky, *Thier.org. Brunnenw Prag.*, **4**: 38.

1928. *Tracheleuglypha dentata* Deflandre, *Annales de Protistologie*, **1**: 37-43.

Material examined: Mi-362; 2exs., Tree moss, 22.ix.2016, Neyyar WLS.

Distribution: India: Assam, Arunachal Pradesh, Andhra Pradesh, Chandigarh, Himachal Pradesh, Mizoram, Manipur, Nagaland, Tripura, West Bengal. *Elsewhere*: Cosmopolitan.

Remarks: Present record from Kerala.

Summary and Discussion

Although Western Ghats is a highly diverse ecosystem the testate amoebae diversity has not been thoroughly investigated. The present study comes out with the results of 90 species of moss-inhabitant testate amoebae spanning over 22 genera and 11 families from various habitats of the Western Ghats of Kerala. Species diversity in different habitats changes in a wider range concerning the highly variable environment along the different regions of the forest ranges. The abundance and composition of the dominant testate amoebae complex are closely dependent on the moisture content. It is evident from the results that the moisture content directly correlates with the richness of species where rich diversity was observed in the high moisture habitats, the Shenthuriney WLS and in two shola forest ecosystems. Also, it is observed that more diversity of testate amoebae was found in tree mosses than in other biotopes. It is worthwhile to mention that of these 8 species viz., *Centropyxis kurakchayensis* Snegovaya et Alekperov, 2005., *Centropyxis loffleri* Laminger, 1972., *Nebela parvula* Cash, 1908., *Nebela spumosa* Awerintzew, 1906., *Physochilla tenella* Penard, 1893., *Euglypha marginata* Van Oye, 1958., *Euglypha strigosa heterospina* Wailes, 1912., *Argygnia gertrudeana* Jung, 1942., turned out to be a new record for India. Of these, the family Centropyxidae recorded the highest number of species

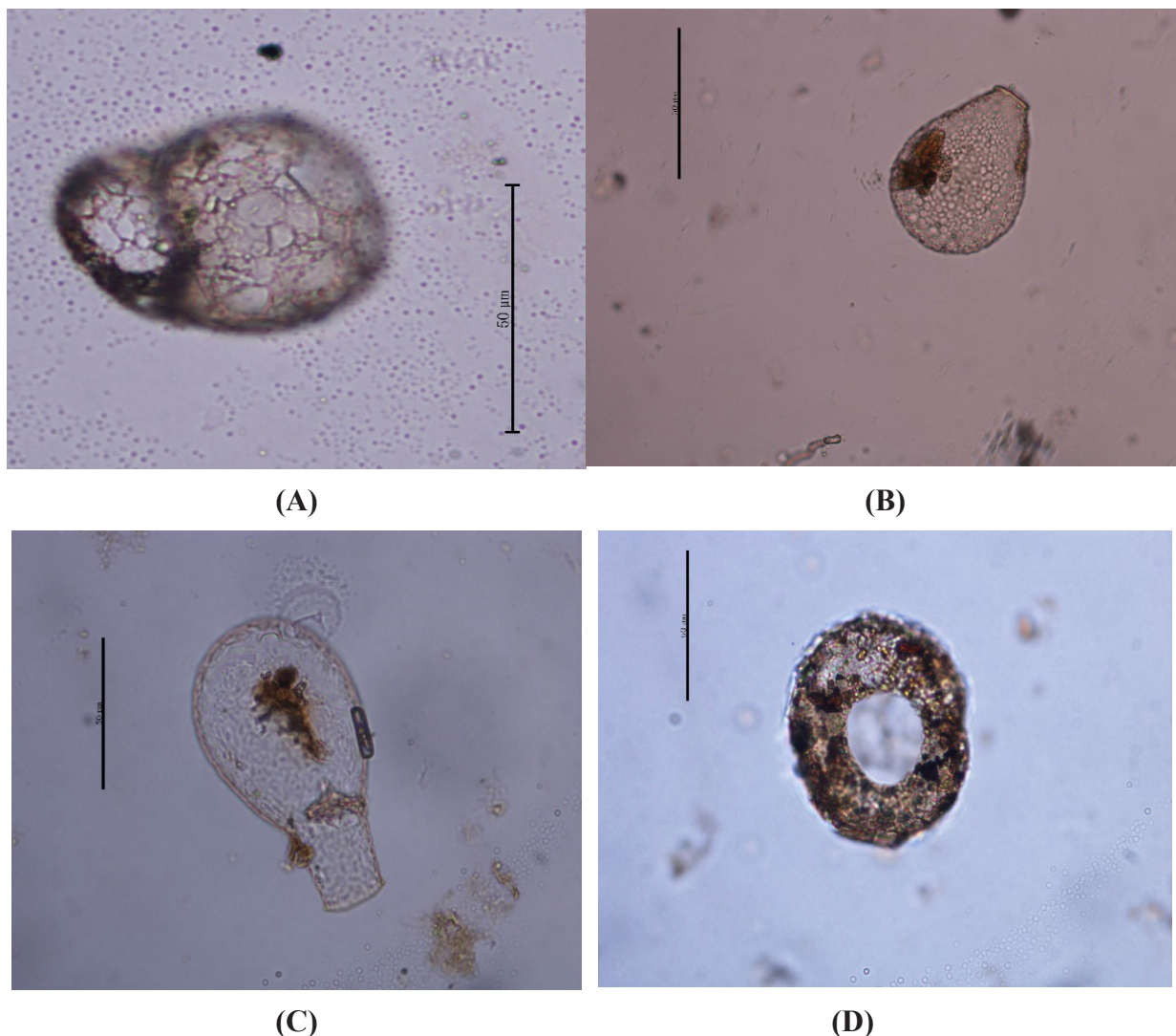
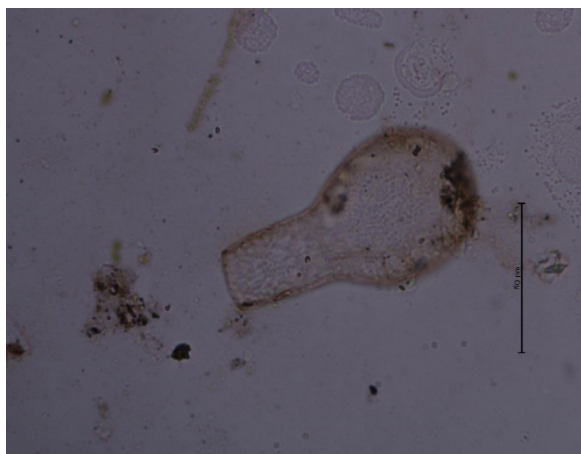


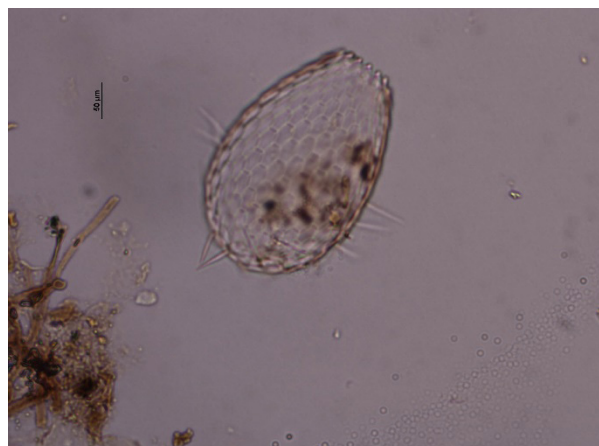
Plate 1. New records to India. (A) *Centropyxis loffleri* Laminger, 1971, (B) *Nebela parvula* Cash, 1908, (C) *Nebela spumosa* Awerintzew, 1906, (D) *Centropyxis kurakchayensis* Snegovaya et Alekperov, 2005.

(20 species) followed by the families Hyalospheniidae (15 species) and Euglyphidae (13 species). On a generic level the genera *Centropyxis* (20 spp.), *Euglypha* (13 spp.), *Diffugia* (8 spp.), *Cyclopyxis* and *Trinema* (7 spp. each) have the greatest species richness and the genera *Centropyxis*, *Euglypha* and *Diffugia* together constituted about 46% of all testate amoebae recorded from the study area. At a higher taxonomic level, the most numerous is in the order Arcellinida which includes 67 species of 15

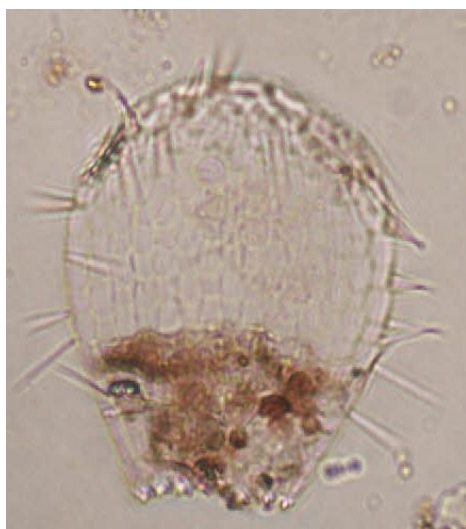
genera and 8 families followed by the order Euglyphida with 25 species, 5 genera and 3 families. A perusal of the literature revealed that only 9 species of testate amoebae have been reported from the Western Ghats of Kerala (Nair, 2001) and the present study added 81 more species and raises the total number to 90 even though the percentage contribution is very low from a highly diversified ecosystem. The actual diversity may be far above that recorded here and to enrich the diversity, more intensive studies should be made in a wide spectrum.



(A)



(B)



(C)



(D)

Plate 2. New records of India. (A) *Argynnia gertrudeana* Jung, 1942, (B) *Euglypha marginata* Van Oye, 1958, (C) *Euglypha strigosa heterospina* Wailes, 1912, (D) *Physochilla tenella* Penard, 1893.

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