

FAUNA OF MEGHALAYA

Part -10

PROTOZOA

Edited by :

The Director, Zoological Survey of India.
Calcutta.



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PROTOZOA

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Zoological Survey of India, Calcutta

INTRODUCTION

Perusal of literature reveals that there is no published report on any freeliving Protozoa of Meghalaya state till date although this group is available in almost every habitat where little moisture is found. It is, therefore, quite evident that all the species of freeliving protozoa dealt with in the present communication constitute new records for this state. The same is also true for symbiotic protozoa included in this paper since no symbiotic protozoa is reported so far from Meghalaya. However, there are few scattered reports on parasitic protozoa from this state. Cooper and Gulati (1926) recorded two unnamed species of coccidia, viz., *Eimeria* sp and *Isospora* sp from the faecal matter of cows at Shillong. Knowles, Senior White and Das Gupta (1930) produced a map on the distribution of malarial species in 'Indian Subregion' and showed occurrence of three species of malarial parasites, viz., *Plasmodium falciparum*, *P. malariae* and *P. vivax* in Shillong (see also Bhatia, 1938). Then, after a long gap Mandal (1966) described *Isospora rayi* from a garden lizard, *Ptyctolaemus* sp. collected in Shillong. Again after a decade, Mandal (1976) recorded seven more species of coccidia, viz., *Eimeria notopteri*, *Isospora corvæ*, *I. garrulusae*, *I. minuta*, *I. parusi*, *Wenyonella bahli* and *W. mackinmoni* from the faecal sample of different vertebrate hosts collected from Shillong. Since then no report on any protozoan species from Meghalaya is available.

The present communication includes 128 species of protozoa out of which 58 are freeliving, 58 parasitic and 12 symbiotic. Amongst these, two species of symbiotic protozoa are new to science and 22 species (12 freeliving and 10 symbiotic protozoa) are reported for the first time from India. Excepting eight named and two unnamed species of coccidia, and three named species of malarial parasites as mentioned earlier all the species were collected by three survey parties of the Zoological Survey of India in recent years. The first two surveys were undertaken during November-December, 1988 and the third one during March-April, 1991.

It is worth mentioning here that systematic account of Protozoa fauna of Meghalaya is dealt with under three broad categories, viz., freeliving, parasitic and symbiotic protozoa for the convenience of taxonomic treatment and for maintaining earlier convention of State Fauna Series published by the Zoological Survey of India.

SYSTEMATIC ACCOUNT

General morphology and terminology :

General morphology of protozoans are shown by diagrammatic illustrations (Pls. 1-8) and some widely used terminologies with brief explanations are listed below for the convenience of users.

Acephaline : A gregarine lacking an epimerite.

Adoral Zone of Membranellae : Three or more serially arranged membranellae along the left side of the oral area; found in oligohymenophoran and polyhymenophoran ciliates, and conspicuously in peritrich and many spirotrich species.

Anisogamy : Conjugation between two dissimilar gametes.

Apical complex : Ultra structural complex structure at the apex of merozoites.

Association : A group formed by attachment of two or more sporonts.

Biassociative : An association formed by the attachment of two sporonts.

Buccal cavity : Depression or pouch located usually at or near apical end of the body and/or on the ventral surface.

Buccal overture : Distal or outer aperture or opening of the buccal cavity; unrecongnisable when buccal cavity is averted or flattened out; easily visible in hymenostomes.

Caudal cilium : A distinctly longer cilium present near the distal end of the body.

Cephaline : A gregarine possessing an epimerite.

Cirrus : A thick conical locomotor organellae occurring in lines or in groups in definite patterns on the ventral surface of hypotrichs; classified and named by their location, such as, buccal, frontal, fronto-ventral, mid-ventral, anal, caudal and marginal.

Conoid : A truncated hollow cone of spirally fibrillar ultra structure, having 6-8 fibrils.

Contractile Vacuole Pore : Minute permanent opening (s) in the pellicle through which contents of contractile vacuole are to be expelled outside the body; it is characteristically stable in number and location.

Cyrtos or Cytopharyngeal basket : Tubular cytopharyngeal apparatus, the walls of which are arranged by longitudinally oriented nematodesmata derived from apically located kinetosomes and lined with extensions of post ciliary microtubules; typical in hypostomatous ciliates.

Cyst : Impervious membrane surrounding an organism or a pair of associated sporozoites at the beginning of reproduction.

Cytopharynx : Nonciliated tubular passage, long or short, leading from the cytostome proper into the inner cytoplasm of the unicellular animal.

Cytostome : An aperture permanently open (when present) through which food material of the organism passes into the inner cytoplasm *via* cytopharynx.

Deutomerite : The posterior portion of cephaline gregarine which is separated from protomerite by a septum.

Epimerite : Usually knob-like structure used for attachment with host cell by the young gregarine.

Gemete : Specialised cells tend to meet and fuse in conjugation.

Gametocyst : The cyst which surrounds two sporonts or gametocytes in associative stage.

Gametocyte : The mother cell that gives rise to number of gametes.

Gametogony : The process of production of gametocytes or gametes by a gamont.

Gamont : An individual that tends to form a gamete; also known as sporont.

Infraciliature : Whole of somatic and orally located kinetosomes together with associated subpellicularly located microfibrillar and microtubular structures; argentophilic in nature.

Infundibulum : Posterior, inner or lower part of buccal cavity usually funnel-shaped or long tubular; found particularly in peritrichous ciliates.

Isogamete : Gametes which are similar in shape and size.

Isogamy : Conjugation between isogametes or similar gametes.

Kinety : A single row of single or paired kinetosomes together with cilia and other associated cortical organelles and structures.

Lorica : Envelope or test secreted and/or assembled by many ciliates; commonly found in tintinnids, folliculinids and peritrichs.

Macrogamete : The larger non-motile gamete of an anisogamous type of reproduction.

Macrogametocyte : The mother cell of macrogamete.

Merozoite : A product of a sexual schizogony.

Microgamete : The smaller nonmotile gamete in anisogamous type of reproduction.

Microgametocyte : The mother cell of microgamete.

Micronemes : Small osmiophilic convoluted cord-like ultra structure at the anterior region of sporozoite/merozoite.

Micropore : An ultra structural organellae formed by the pellicle.

Microtubule : Ultra structural subpellicular fibrils originating at the polar ring and extending posteriorly.

Nematodesmata : Kinetosome associated birifringent bundle of paralleled microtubules; it strengthens walls of cytopharyngeal apparatus of gymnostomes and hypostomes.

Oocyst : A cyst containing conjugated gametes.

Ookinete : The motile zygote in Haemosporina.

Oral apparatus : General term to denote mouth *semu lato*.

Paroral membrane : Membrane lying along the right side or border of buccal cavity in oligo- and polyhymenophoran ciliates.

Peduncle : Stalk but, usually refers to long and distinctly visible stalks as found in peritrichs and suctorians.

Peristome : Entire oral area of those ciliates in which buccal ciliature encircles the major portion of the anterior end of the organism; found in peritrichs and spirotrichs.

Prebuccal area : Oral groove lined with somatic or slightly modified ciliature and leading to buccal cavity

Polar capsule : A sac like structure containing polar filament in the spore of Myxozoa and Microspora.

Polar filament : A thread like structure coiled inside the polar capsule.

Polar ring : An osmiophilic ultra structural thickening formed by the inner membrane of the pellicle.

Primitive : The first sporont in the association of a gregarine.

Protomerite : The portion preceding the septum of a cephaline gregarine.

Rhabdos : Tubular cytopharyngeal apparatus, the walls of which are strengthened on the out side by bundles of nematodesmata, often lined longitudinally by transverse microtubules— derived from circumoral kinetosome.

Rhotries : Ultra structural paired organellae having electron dense club-shaped structure located in the anterior region of sporozoite/merozoite.

Satellite : The sporont (s) attached behind the primitive.

Schizogony : A sexual agamic reproduction by equal, unequal or multiple division.

Schizont : The stage which is about to divide into a number of parts called merozoites.

Septate : In gregarines it indicates a type which is having septum between protomerite and deutomerite.

Spore : The body into which zygote develops after acquisition of a resistant outer coating.

Sporoduct : A tubular growth from the cyst of a gregarine through which spores are liberated.

Sporoblast : A cell which gives rise to spores.

Sporocyst : A cyst containing spores.

Sporogony : Development of spores from the sporont.

Sporont : *see* gamont.

Sporozoite : The individual with falciform bodies produced/released from a spore.

Syzygy : An association of two or more sporonts in a linear fashion.

Trichite : Hollow rod-like skeletal structure radially arranged beneath the pellicle; in older sense cytopharyngeal rod.

Trichocyst : Spindle-shaped non-toxic explosive organellae located in the sub-pellicle of some ciliate (*e.g. Paramecium*)

Trophozoite : The young feeding and growing stage.

Vestibulum : Depression located at either pole and leading directly to cytostome-cytopharyngeal complex covered with more or less complex somatic ciliature, exclusively found in the members of the subclass Vestibulifera.

Zygote : The cell formed by the fusion of two gametes.

Collection and preservation:

Freeliving protozoans were collected from freshwater ponds, puddles, streams and rivers and also from soil mosses, rock mosses and tree mosses. On the other hand parasitic and symbiotic protozoa were recovered from different host species as will be mentioned in the following taxonomic account. The present material has been collected from all the seven districts of Meghalaya, namely, West Garo Hills, East Garo Hills, South Garo Hills, West Khasi Hills, East Khasi Hills and Ri-Bhoi.

For the collection of freshwater protozoa water samples along with some algae, water weeds, bottom ooze and flocculent matter arising out of washing of water weeds and aquatic plants were collected and kept in wide mouthed sampling jars made up of glass. These jars were then brought to the laboratory and kept for few days, keeping their lids open for considerable increase in protozoa population occurring in those samples. The samples were then thoroughly examined under the light microscope from time to time. Freeliving ciliates were isolated by micropipette and

examined in living condition by keeping them in a natural medium. Sometimes Methocyl solution was used for slowing down the movement of fast moving ciliates for the study of their internal structures *in situ* under light microscope. Sometimes Lugol's solution was added as killing agent and for detecting peripheral organellae.

Schaudinn's fixative and Carnoy's fluid were used for making permanent slides of freeliving ciliates. The first one is effective for keeping the exact natural shape of the specimen while the second one is good for studying nuclear structure. Heidenhain's iron haematoxylin and Delafield's haematoxylin were used for staining the ciliates. In some cases dry silver impregnation method was employed to study their infra structures. These slides were mounted in DPX.

For making permanent slides of testacean rhizopods empty tests frequently found in the bottom ooze were isolated, air dried after two or three washings in absolute alcohol and mounted in DPX.

In order to collect moss inhabiting protozoa samples of soil mosses, rock mosses and tree mosses were brought to the laboratory. A portion of each sample was then kept in pretty dishes and sprinkled regularly with sufficient water. After a day or two aqueous drops drawn from the moss by micropipette were kept on glass slides and examined thoroughly. Any protozoa observed therein was fixed, stained and mounted in the same manner as stated earlier for water inhabiting protozoa.

For the collection of parasitic protozoa host samples collected from the fields were brought to the camp laboratory. These hosts were then dissected and their various organs and tissues, *viz.*, lumen of the digestive tract, body cavity, gill, gall bladder, lung, liver, spleen, blood, etc., were thoroughly examined for different groups of parasitic protozoa. Gut contents were examined after diluting them with physiological saline. Organ smears and blood smears were drawn on clean and grease-free slides, air-dried, fixed and/or stained mostly with Giemsa and Leishman's stains. The lumen dwelling forms as and when observed in physiological saline were usually fixed in Schaudinn's fixative and stained with Heidenhain's iron haematoxylin. Faecal samples were kept in 2.5 per cent potassium dichromate solution for subsequent sporulation of coccidial oocysts, if any. Dry silver impregnation techniques were employed in some cases for studying ciliary lines of some endocommensal ciliates.

In order to collect flagellate symbiotes of termites, the entire gut of the worker caste was removed and gut contents were emptied on clear slide containing a drop of 0.5 per cent saline. Sometimes 67 per cent Lock's solution was used in which these protozoans remain less deformed and considerably active in living condition for a longer period. For preparing permanent slides these flagellates were fixed in Schaudinn's fixative, stained with Heidenhain's iron haematoxylin or Delafield's haematoxylin and mounted in DPX. For more details Das *et al.* (1993) may be consulted.

FREELIVING PROTOZOA

SYSTEMATIC LIST

Phylum **SARCOMASTIGOPHORA**
Subphylum **SARCODINA**
Class **LOBOSEA**
Order **ARCELLINIDA**
Family **ARCELLIDAE**
Genus ***Arcella*** Ehrenberg

1. *Arcella discoides* Ehrenberg

Genus ***Lesquereusia*** Schlumberger

2. *Lesquereusia spiralis* (Ehrenberg)

Family **DIFFLUGIIDAE**

Genus ***Centropyxis*** Stein

3. *Centropyxis aculeata* (Ehrenberg)

4. *Centropyxis aerophila* Deflandre

5. *Centropyxis arcelloides* Penard

6. *Centropyxis cassis* (Wallich)

7. *Centropyxis constricta* (Ehrenberg)

8. *Centropyxis ecornis* (Ehrenberg)

9. *Centropyxis minuta* Deflandre

10. *Centropyxis oblonga* (Deflandre)

11. *Centropyxis platystoma* (Penard)

12. *Centropyxis spinosa* (Cash and Hopkinson)

Genus ***Difflugia*** Leclerc

13. *Difflugia acuminata* Ehrenberg

14. *Difflugia amphoralis* Hopkinson

15. *Difflugia avellana* Penard

16. *Difflugia globulosa* Dujardin

17. *Diffflugia lithophila* (Penard)
18. *Diffflugia lobostoma* Leidy
19. *Diffflugia oblonga* Ehrenberg
20. *Diffflugia pyriformis* Perty
21. *Diffflugia tuberculata* (Wallich)

Class FILOSEA

Order GROMIIDA

Family EUGLYPHIDAE

Genus *Euglypha* Dujardin

22. *Euglypha acanthophora* (Ehrenberg)
23. *Euglypha denticulata* Brown
24. *Euglypha laevis* (Ehrenberg)
25. *Euglypha rotunda* Wailes
26. *Euglypha scutigera* Penard
27. *Euglypha tuberculata* Dujardin

Genus *Nebela* Leidy

28. *Nebela vitrae* Penard

Genus *Trinema* Dujardin

29. *Trinema enchelys* (Ehrenberg)
30. *Trinema geleata* Penard
31. *Trinema lineare* Penard

Phylum CILIOPHORA

Class KINETOFRAGMINOPHOREA

Subclass GYMNOSTOMATIA

Order PROSTOMATIDA

Family PRORODONTIDAE

Genus *Prorodon* Ehrenberg

32. *Prorodon edentatus* Claparede & Lachmann

33. *Prorodon teres* Ehrenberg
Family COLEPIDAE
Genus *Coleps* Nitzsch
34. *Coleps hirtus* (Muller)
Family ENCHELYIDAE
Genus *Lagynophrya* Kahl
35. *Lagynophrya mutans* Kahl
subclass VESTIBULIFERA
Order COLPODIDA
Family COLPODIDAE
Genus *Colpoda* O.F. Muller
36. *Colpoda cucullus* Kahl
Order NASSULIDA
Family MICROTHORACIDAE
Genus *Drepanomonas* Fresenius
37. *Drepanomonas dentata* Fresenius
Genus *Microthorax* Engelmann
38. *Microthorax pusillus* Engelmann
Order CYRTOPHORIDA
Family CHILODONELLIDAE
Genus *Chilodonella* Strand
39. *Chilodonella cucullulus* (Muller)
Class OLIGOHYMENOPHOREA
SubClass HYMENOSTOMATIA
Order HYMENOSTOMATIDA
Family GLAUCOMIDAE
Genus *Monochilum* Schewiakoff

40. *Monochilum ovale* (Schewiakoff)
 Family OPHRYOGLENIDAE
 Genus *Ophryoglena* Ehrenberg
41. *Ophryoglena flava* (Ehrenberg)
 Family PARAMECIDAE
 Genus *Paramecium* Hill
42. *Paramecium caudatum* Ehrenberg
 Family FRONTONIIDAE
 Genus *Frontonia* Ehrenberg
43. *Frontonia leucas* (Ehrenberg)
 Order SCUTICOCILIATIDA
 Family LOXOCEPHALIDAE
 Genus *Loxocephalus* Eberhard
44. *Loxocephalus ellipticus* Kahl
 Family PLEURONEMATIDAE
 Genus *Pleuronema* Dujardin
45. *Pleuronema crassum* Dujardin
 SubClass PERITRICHIA
 Order PERITRICHIDA
 Family VORTICELLIDAE
 Genus *Vorticella* Linnaeus
46. *Vorticella campanula* Ehrenberg
 Class POLYHYMENOPHOREA
 SubClass SPIROTRICHIA
 Order HETEROTRICHIDA
 Family SPIROSTOMIDAE
 Genus *Blepharisma* Perty

47. *Blepharisma intermedium* Bhandary
Family METOPIDAE
Genus *Metopus* Claparede and Lachmann
48. *Metopus es* Muller
Family BURSARIIDAE
49. *Bursaria truncatella* Muller
Order ODONTOSTOMATIDA
Family EPALXELLIDAE
Genus *Saprodinium* Lauterborn
50. *Saprodinium putrinium* Lacky
Family HALTERIIDAE
Genus *Halteria* Dujardin
51. *Halteria grandinella* (O.F. Muller)
Family STROBILIDIIDAE
Genus *Strobilidium* Schewiakoff
52. *Strobilidium gyrans* (Stokes)
Order HYPOTRICHIDA
Family SPIROFILIDAE
Genus *Stichotricha* Perty
53. *Stichotricha socialis* Gruber
Family HOLOSTICHIDAE
Genus *Gonostomum* Sterki
54. *Gonostomum affine* (Stein)
Family OXYTRICHIDAE
Genus *Oxytricha* Bory
55. *Oxytricha bifaria* Stokes
56. *Oxytricha fallax* Stein
Family ASPIDISCIDAE
Genus *Aspidisca* Ehrenberg
57. *Aspidisca costata* (Dujardin)
Family EUPLOTTIDAE

58. *Euplotes patella* (Muller)

TAXONOMIC ACCOUNT

Phylum	SARCOMASTIGOPHORA
Subphylum	SARCODINA
Class	LOBOSEA
Order	ARCELLINIDA

Key to the families

- 1(2) Test simple and usually without any foreign bodyFamily Arcellidae
 2(1) Test with foreign bodiesFamily Difflugiidae

Family ARCELLIDAE

Key to the genera

- 1(2) Test semispiral in appearance, with curved or vermiform pellets (or with sand grains in single species)..... Genus *Lesquerensia*
 2(1) Test hemispherical, oval or circular with hexagonal markings and without any pellet or sand grain as stated aboveGenus *Arcella*

Genus *Arcella* Ehrenberg

1832. *Arcella* Ehrenberg, *Abh. Preuss. Akad. Wiss.*, Berlin, P.40.

Diagnosis : Test transparent, with hexagonal markings, hemispherical, oval or circular in shape, encrusted with chitinous particle; oral aperture circular, central and inverted like a funnel.

1. *Arcella discoides* Ehrenberg

1843. *Arcella discoides* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 139.

Material examined : 2 exs., Tura, West Garo Hills, 12.xi. 1988, coll D.N. Tiwari; 1 ex., Jowai, Jaintia Hills, 15.xi.1988, coll. D.N. Tiwari; 3 exs., Tura West Garo Hills, 19.iii.1991, coll. A.K. Das; 2 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A.K. Das; 1 ex., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; 2 exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das; 2 exs. Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Test spherical, planconvex in profile and circular in front view; height of the dome about one-third to one-fourth of the diameter of the test; test 50-120 µm in diameter.

Distribution : India : Meghalaya (West Garo, East Garo and South Garo Hills, East Khasi Hills and Jaintia Hills districts), West Bengal; in freshwater amongst bottom ooze.

Genus *Lesquereusia* Schlumberger

1845. *Lesquereusia* Schlumberger, *Ann. Sci. nat. zool.* (3) 3, p.255.

Diagnosis : Test compressed, semispiral in appearance, with interlacing curved or vermiform pellets; (test with sand grains in single species).

2. *Lesquereusia spiralis* (Ehrenberg)

1840. *Diffugia spiralis* Ehrenberg, *Mantab. Akad. Wiss.*, Berlin, p. 139.

Material examined : 3 exs., Rongram River, West Garo Hills, 23.iii.1991, Coll. A.K. Das; 2 exs., Bagmara, South Garo Hills, 24.iii.1991, Coll. A.K. Das.

Diagnosis : Test transparent, semispiral and composed of closely arranged vermiform pellets. 108-130 µm × 86-103 µm in dimension; neck below the constriction with a slight elevation from which outline continued in a straight line down to mouth; mouth circular, contracted, its margin plain and sharply defined.

Distribution : India: Meghalaya (West Garo Hills and South Garo Hills districts), Andhra Pradesh and West Bengal; in freshwater amongst bottom ooze.

Family DIFFLUGIIDAE

Key to the genera

- 1(2) Test composed of cemented quartz sand, diatoms and other foreign bodies, aperture terminal, pseudopodia cylindrical, simple or branching.....Genus *Diffugia*
- 2(1) Test usually with sand grains and sometimes with diatoms and occasionally with quartz crystals, pseudopodia digitate or sharply pointed.....Genus *Centropyxis*

Genus *Centropyxis* Stein

1859. *Centropyxis* Stein, *Abh. K. Bohm. Gesellsch. Wiss.*, 10, p.43.

1859. *Centropyxis* : Claparede and Lachmann. *Mem. de l' Inst. nat. genevois. Etudes Inf. et. Rhiz.* 2, p. 447

1929. *Centropyxis* : Deflandre. *Arch. Protistenk.*, 67, p. 322.

Diagnosis : As in the key to this genus.

Ten species of *Centropyxis* as follows have been collected from Meghalaya.

Key to the species

- 1(18) Test with dorso-ventral symmetry and swollen at posterior part, oral aperture not exactly centrally located.
- 2(7) Test beset with spine
- 3(6) Oral aperture usually circular, spines few resembling scrap of strap.
- 4(5) Test oblong-elliptical or oval, mouth always elliptical and proportionately much longer*C. oblonga*
- 5(4) Test more or less round, mouth varying in shape (sometimes triangular) and not so long as above.....*C. aculeata*
- 6(3) Oral aperture irregularly circular with invaginated borders, spines many and frequently curved.....*C. spinosa*
- 7(2) Test without spine
- 8(9) Test prolonged to the anterior end resembling a flat lens covering the mouth. a constriction present between oral and posterior part of the test.....*C. platystoma*
- 9(8) Test not prolonged as above, constriction between oral and posterior part of the test lacking
- 10(11) Test circular in ventral view.....*C. minuta*
- 11(10) Test more or less elliptical, oval or discoidal in ventral view
- 12(13) In ventral view flank of the posterior part of the shell strongly arched, mouth always invaginated quite strongly towards the posterior part.....*C. constricta*
- 13(12) In ventral view flank of the posterior part of the shell less arched, sometimes straight
- 14(15) Oral aperture circular or round, mature shell usually large, above 150 μm in length.....*C. ecornis*
- 15(14) Oral aperture semi circular, mature shell usually below 100 μm , rarely up to 120 μm
- 16(17) Test elliptical in ventral view, with widely rounded posterior part.....*C. cassis*
- 17(16) Test oval in ventral view. with spherical or little elliptical posterior part.....*C. aerophila*
- 18(1) Test regularly arched, oral aperture centrally located; test hemispherical, brown, chitinous, covered with small scale like structure.....*C. arcelloides*

3. *Centropyxis aculeata* (Ehrenberg)

1832. *Arcella aculeata* Ehrenberg, *Abh. Preuss. Akad. Wiss.*, Berlin. p.40.

1857. *Centropyxis aculeata* (Ehrenberg) : Stein, *S. Bohn. Ges. Wiss.*, Prague. 5(10) : pp. 41-43.

Material examined : 3 exs., Rongram River, West Garo Hills, 23.iii.1991, coll.A.K. Das; 1 ex., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; 4 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Test circular with fundus pressed to one side, 110-175 μm in diameter, mouth eccentric and circular; fundus of shell obtusely rounded and furnished with few (usually 4-6) divergent spines in a single and somewhat regular row, spines usually resembling scrap; shell usually with quartz crystals and some times with admixture of diatoms, fistules and particles.

Distribution : India: Meghalaya (West Garo Hills, South Garo Hills and East Khasi Hills districts), Andhra Pradesh, Rajasthan and West Bengal; in freshwater tanks amongst vegetation.

4. *Centropyxis aerophila* Deflandre

1929. *Centropyxis aerophila* Deflandre, *Arch. Protistenk.*, 67, p. 330.

Material examined : 1 ex., Nongpoh, Ri-Bhoi, 6.xi. 1988, coll. D.N. Tiwari; 1 ex., Thadleskein, Jaintia Hills, 10.i.1989, coll. D.N. Tiwari; 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; 1 ex., Rongrengiri, East Garo Hills, 27.iii.1991, coll. A.K.Das; 2 exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A.K. Das; 1 ex., Cherapunjee, East Khasi Hills, 3.iv.1991, coll. A.K. Das; 1 ex., Mawsmai, East Khasi Hills, 3.iv. 1991, coll. A.K. Das.

Diagnosis : Test small, 40-50 μm in width, 60-70 μm in length, fundus (dome) spheroidal with dorsal face strongly flattened towards mouth; test oval in ventral view with spherical or little elliptical posterior part whose flanks little arched, often almost straight; oral aperture semicircular; test chitinous bearing some foreign particles, viz., vegetable fragments and transparent crystals.

Distribution : India: Meghalaya (West Garo Hills, East Garo Hills, West Khasi Hills, East Khasi Hills, Jaintia Hills and Ri-Bhoi districts) and West Bengal; very common in moss.

5. *Centropyxis arcelloides* Penard

1902. *Centropyxis arcelloides* Penard, *Faune Rhiz. du bass. du Lemn.*, p. 309.

1929. *Centropyxis arcelloides* : Deflandre, *Arch. Protistenk.*, 67 p. 367.

Material examined : 3 exs., Mowsmai cave, East Khasi Hills, 3.iv.1991, coll. A.K. Das.

Diagnosis : Shell hemispherical, brown, chitinous, covered with small flat scale like structures; 95-100 μm in length; oral aperture centrally located occupying about half the width of the shell.

Distribution : India : Meghalaya (East Khasi Hills district), in moss.

Remarks : This species is reported for the first time from India. It has been collected from the rock moss of Mawsmoi cave near Cherapunjee (East Khasi Hills district). Meghalaya.

6. *Centropyxis cassis* (Wallich)

1864. *Diffflugia cassis* Wallich, *Ann. Mag. nat. Hist.*, (3) **13**, pp. 215–245.

1929. *Centropyxis cassis* (Wallich) Deflandre, *Arch. Protistenk.*, **67** p. 335.

Material examined : 2 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A.K. Das.

Diagnosis : In general appearance and dimensions test quite similar with that of *C. aerophila* but, test elliptical in ventral view with widely rounded posterior part, flank less arched, straight or parallel. oral aperture semi circular, test with small stones and quartz particles.

Distribution : India : Meghalaya (West Garo Hills district); Andhra, Orissa and West Bengal; in moss, soil and freshwater.

7. *Centropyxis constricta* (Ehrenberg)

1841. *Arcella constricta* Ehrenberg, *Abh. Akad. Wiss.*, Berlin.

1879. *Diffflugia constricta* Leidy, *Freshwater Rhizopod of North America*, pl. 18, fig. 29.30.

1902. *Diffflugia constricta partim* Penard, *Fauna Rhiz. du Bass. du leman*, P. 299.

1929. *Centropyxis constricta* : Deflandre, *Arch. Protistenk.*, **67**, p.340.

Material examined : 3 exs., Thadleskein, Jaintia Hills, 10.i.1989, coll. D.N. Tiwari.

Diagnosis : Test elliptical or oval in ventral view, 80-90 μm in diameter and 100-110 μm in height, flank of the posterior part of the shell strongly arched; oral aperture always invaginated quite strongly towards the posterior part.

Distribution : India : Meghalaya (Jaintia Hills district); from rock moss.

Remarks : This species is reported for the first time from India.

8. *Centropyxis ecornis* (Ehrenberg)

1843. *Arcella ecornis* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p.368.

1879. *Centropyxis ecornis* Leidy, *Freshwater Rhizopods of North America*, pl. 30, Figs. 20-34.

Material examined : 1 ex., Nongpoh, Ri-Bhoi district, 6.xi.1988, coll. D.N. Tiwari ; 1 ex., Nongstoin, West Khasi Hills, 9.xi.1988, coll. D.N. Tiwari; 2 exs., Jowai, Jaintia Hills, 15.xi.1988.

coll. D.N. Tiwari; 1 ex., Thadleskein, Jaintia Hills, 10.i.1989, coll. D.N. Tiwari; 1 ex., Bojengdoba, East Garo Hills, 21.iii.1991, coll. A.K. Das; 2 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A.K. Das; 2 exs., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; 2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv. 1991, coll. A. K. Das.

Diagnosis : Nature and texture of the test quite similiar with that of *C. aculeata* but, spine (one of the most important characteristic features) lacking, test 180-190 μm length; oral aperture circular or round.

Distribution : India ; Meghalaya (all the seven districts) and West Bengal, in freshwater amongst vegetation and bottom ooze.

9. *Centropyxis minuta* Deflandre

1929. *Centropyxis minuta* Deflandre. *Arch. Protistenk.*, 67. p. 366.

Material examined : 3 exs., Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A.K. Das; 4 exs., Mowmai cave, East Khasi Hills, 3.iv.1991, coll. A.K. Das.

Diagnosis : Test circular in ventral view and subspherical in lateral view; 40-50 μm in diameter, oral aperture circular.

Distribution : India : Meghalaya (East Khasi Hills district); Orissa and West Bengal; in moss.

10. *Centropyxis oblonga* (Deflandre)

1929. *Centropyxis aculeata* var. *oblonga* Deflandre: *Arch. Protistenk.*, 67; p. 349.

Material examined : 2 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A.K. Das,

Diagnosis : Test oblong-elliptical or oval (but never circular) in lateral view, 110—140 μm in length, fundus of the shell more elevated than that of *C. aculeata*; test furnished with variable number of divergent spines (usually 3-4) and mostly located at the posterior part ; oral aperture always elliptical and usually eccentric; shell with foreign material including few stones attached to the posterior part.

Distribution: Meghalaya (West Garo Hills district).

Remarks : Deflandre (1929) described this form as a new variety to the species, *Centropyxis aculeata* since it differs from *C. aculeata* in the shape of the test as well as oral aperture. This variety is now elevated to species rank since variety concept is no more valid under the prevalent International Code of Zoological Nomenclature.

This species is reported for the first time from India from freshwater bottom ooze of the Rongram River in West Garo Hills district of Meghalaya.

11. *Centropyxis platystoma* (Penard)

1890. *Diffugia platystoma* Penard, *Mem. Soc. Phys. et Hist. Nat. de Geneva*.

1929. *Centropyxis platystoma* Deflandre, *Arch. Protistenk.*, **67**, p. 338.

Material examined : 3 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; 1 ex., Ward lake, Shillong, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test prolonged to the anterior end, resembling a flat lens covering the mouth, in ventral view test elongated, elliptical, 70-85 μm in length; a constriction most often present between 'sleeve' of the shell and oral aperture; in lateral view posterior part of the shell strongly convex and anterior part more or less flat; oral aperture circular or subcircular; cuticle chitinous incorporating several silicious particles, quartz particles and small pebbles.

Distribution : India : Meghalaya (East Khasi Hills and West Garo Hills districts); in freshwater amongst bottom ooze.

Remarks : This species has been collected from the bottom ooze of Ward lake at Shillong and Rongram River in West Garo Hills district, Meghalaya. It constitutes new record from Indian sub-continent.

12. *Centropyxis spinosa* (Cash and Hopkinson)

1905. *Centropyxis aculeata* var. *spinosa* Cash and Hopkinson, *The British Freshwater Rhiz. and Heliozoa*, **1**, p. 135.

1929. *Centropyxis spinosa* (Cash and Hopkinson) Deflandre, *Arch. Protistenk.*, **67**, p. 353.

Material examined : 1 ex., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; 3 exs., Bagmara, South Garo Hills, 24.iii.1991, coll. A. K. Das; 1 ex., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Test circular and considerably flat, oral aperture eccentric and irregularly circular with invaginated borders, 110-130 μm in diameter, test provided with variable number of spines (usually 6-8), spines frequently curved, distributed irregularly on the dorsal side, test chitinous with few quartz crystals or diatom fistules.

Distribution: India : Meghalaya (West Garo Hills, South Garo Hills and East Khasi Hills districts) and West Bengal; in freshwater among vegetation and in bottom ooze.

Genus *Diffugia* Leclerc

1815. *Diffugia (partim)* Leclerc, *Mem. du Mus.*, **2**, p. 474.

1958. *Diffugia* Gauthier-Lievre and Thomas, *Arch. Protistenk.*, **103**, p. 241.

Diagnosis : As in the key to the genus.

In all, 9 species of *Diffugia* have been collected from Meghalaya and dealt with in the present communication.

Key to the species

- 1(12) Test without collar
- 2(3) Test terminated by spinous structure or 'horn', (pointed extension of the base usually straight) *D. acuminata*
- 3(2) Test not terminated by any spinous structure or 'horn'
- 4(5) Pseudostome normally quadrilobed in the form of a cross but very often trilobed.....
..... *D. lobostoma*
- 5(4) Pseudostome circular
- 6(9) Test compressed, oblong or ovoid elongate
- 7(8) Test characteristically oblong with smooth margin and big angular quartz crystals.....
..... *D. oblonga*
- 8(7) Test ovoid-elongate with fragments of silicious plates *D. avellana*
- 9(6) Test ovoid globular or pyriform and not compressed
- 10(11) Test typically pyriform with small angular quartz crystals *D. pyriformis*
- 11(10) Test ovoid globular with diversified material like clay, mineral platelets and vegetable fragments *D. globulosa*
- 12(1) Test with collar
- 13(14) Test bearing many disc shaped protruberances or particles :..... *D. tuberculata*
- 14(13) Test without bearing any protruberance or tubercle
- 15(16) Margin of collar around pseudostome recurved or rolled towards exterior, test ovoidal...
..... *D. amphoralis*
- 16(15) Margin of collar never recurved towards exterior or interior, test spherical to subglobose
..... *D. lithophila*

13. *Diffugia acuminata* Ehrenberg

1838. *Diffugia acuminata* Ehrenberg, *Die Infusionsthierchen als Vollkommene Organismen*, Leipzig, p. 131.

1958. *Diffugia acuminata* : Gauthier-Lievre and Thomas. *Arch. Protistenk.*, Jena, 103, p. 323.

Material examined : 1 ex., Nongpoh, Ri-Bhoi district, 6.xi.1988. coll. D. N. Tiwari: 3 exs..

Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 1 ex., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; 2 exs., Bagmara, South Garo Hills, 24.iii.1991, coll. A. K. Das.

Diagnosis : Test cylindrical, without any collar and with pointed 'horn'-like extension at the base; 150-280 μm \times 60-100 μm in dimensions, spine straight and differentiated from the base, quartz crystals of varying size embedded in the test; some crystals projecting out of the margin of the test giving an irregular appearance of test margin.

Distribution : India : Meghalaya (West Garo Hills, South Garo Hills and Ri-Bhoi districts), Andhra Pradesh and West Bengal; in bottom ooze of freshwater tanks.

14. *Diffugia amphoralis* Hopkinson

1958. *Diffugia amphoralis* Hopkinson, 1909 : Gauthier-Lievre and Thomas, *Arch. Protistenk.*, **103**, p. 300.

Material examined : 1 ex., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; 1 ex., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Test ovoidal, 150 μm \times 85 μm in dimensions, pseudostome wide, collar rolled towards exterior; base of the test not provided with any spine in local specimens.

Distribution : India : Meghalaya (West Garo Hills and East Khasi Hills districts) and West Bengal; in freshwater amongst vegetation and bottom ooze.

Remarks : Specimens collected from the Ward lake, Shillong are quite similar with *D. amphoralis* var. *globosa* described by Gauthier-Lievre and Thomas (1958) from Ivory coast, Africa in having ovoidal test and lacking spine or thorn. It is worth mentioning here that this species collected from West Bengal possessed 2-3 thorns on the base of the left resembling *D. amphoralis* var. *cornuta* (Das, Mandal and Sarkar, 1993).

15. *Diffugia avellana* Penard

1890. *Diffugia avellana* Penard, *Mem. de la Soc. de Phys. et d' Hist. Nat.*, Geneva, p. 144.

1958. *Diffugia avellana* : Gauthier-Lievre and Thomas, *Arch. Protistenk.*, Jena, 103, p. 287.

Material examined : 2 exs., Mawsmi cave, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test ovoid-elongate in frontal view and more or less pyriform in lateral view, base rounded and flanks converging imperceptively towards pseudostome; pseudostome oval and truncate; test made up of silicious particles.

Distribution : India : Meghalaya (East Khasi Hills district); in moss.

Remarks : This is a freshwater inhabiting species but Decloitre (1956) recorded it in Africa

from moss. The present material is also collected from rock moss in Mawsami cave, East Khasi Hills. This species is reported for the first time from India.

16. *Diffugia globulosa* Dujardin

1837. *Diffugia globulosa* Dujardin, *Ann. Sci. nat. Zool.*, (2) 8, p. 310-314.

1958. *Diffugia globulosa* : Gauthier-Lievre and Thomas, *Arch. Protistenk.*, Jená. 103, p. 310.

Material examined : 4 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das.

Diagnosis : Test slightly ovoidal and less elongated than *D. globularis*; 90 μm \times 73 μm in dimensions; pseudostome circular and its diameter about half of that of the test; various foreign material such as clay, mineral platelets, vegetable fragments, etc., embeded in brownish chitinous membrane.

Distribution : India : Meghalaya (West Garo Hills district), Andhra Pradesh, Rajasthan and West Bengal; in freshwater in bottom ooze.

17. *Diffugia lithophila* (Penard)

1902. *Diffugia hydrostatica* var. *lithophila* Penard, *Fauna rhizopodique du bassin du Lemán*, Geneve, p. 274.

1958. *Diffugia lithophila* Gauthier-Lievre and Thomas, *Arch. Protistenk.*, Jena, 103, p. 286.

Material examined : 2 exs., Nongpoh, Ri-Bhoi district, 6.xi.1988, coll. D. N. Tiwari; 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 1 ex., Rongram River, West Garo Hills, 19.iii.1991, coll. A. K. Das; 2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Test ovoid-globular or subglogular drawn out to the pseudostome in the form of short collar. 140-150 μm \times 110-115 μm in dimensions, pseudostome circular, test covered with well arranged stony particles.

Distribution : India : Meghalaya (West Garo Hills, East Khasi Hills and Ri-Bhoi districts) and West Bengal; in freshwater in bottom ooze.

18. *Diffugia lobostoma* (Leidy)

1879. *Diffugia lobostoma* Leidy, *Freshwater Rhizopods of North America*, p. 112.

1958. *Diffugia lobostoma* Gauthier-Lievre and Thomas, *Arch. Protistenk.*, Jena, 103, p. 368.

Material examined : 2 exs., Jowai, Jaintia Hills, 15.xi.1988, coll. D. N. Tiwari; 2 exs., Tura, West Garo Hills, 19.iii.1988, coll. A. K. Das; 2 exs., Rongram River, West Garo Hills, 23.iii.1991,

coll. A. K. Das; 1 ex., Bagmara, South Garo Hills, 24.iii.1991, coll. A. K. Das; 2 exs., Nongstoin, West Khasi Hills. 28.iii.1991, coll. A. K. Das; 1 ex., Ward lake, Shillong, East Khasi Hills. 2.iv.1991, coll. A. K. Das.

Diagnosis : Test ovoidal; pseudostome usually quadrilobed in the form of a cross but very often trilobed, not enclosed by collar; 65-120 μm \times 50-105 μm in dimensions, covered with angular quartz particles.

Distribution : India : Meghalaya (West Garo Hills, South Garo Hills, West Khasi Hills, East Khasi Hills and Jaintia Hills districts); Rajasthan and West Bengal; in freshwater amongst vegetation and in bottom ooze.

19. *Diffflugia oblonga* Ehrenberg

1838. *Diffflugia oblonga* Ehrenberg, *Die Infusionsthierchen als Vollkommene Organismen*. Leipzig, p. 131.

1958. *Diffflugia oblonga* : Gauthier-Lievre and Thomas, *Arch. Protistenk.*, Jena. **103**, p. 343.

Material examined : 2 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das.

Diagnosis : Test compressed, typically oblong with rounded base, smooth margin and big angular quartz particles; 310 μm \times 148 μm in dimensions; pseudostome circular.

Distribution : India : Meghalaya (West Garo Hills districts); Andhra Pradesh and West Bengal; in freshwater amongst vegetation and in bottom ooze.

20. *Diffflugia pyriformis* Perty

1848. *Diffflugia pyriformis* Perty in *Mith. nat. Ges.*, Bern. p. 168.

Material examined : 2 exs., Bagmara, South Garo Hills, 24.iii.1991, coll. A. K. Das; 2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Test pyriform or flask-shaped; pseudostome circular; mud particles encrusted on the chitinous membrane of the test, test 175-208 μm \times 96-160 μm in dimensions.

Distribution: India : Meghalaya (South Garo Hills and East Khasi Hills districts); Rajasthan and West Bengal; in the bottom ooze of freshwater bodies.

21. *Diffflugia tuberculata* (Wallich)

1864. *Diffflugia proteiformis* sub sp. *globularis* var. *tuberculata* Wallich, *Ann. Mag. nat. Hist.*, (3) **13**, p. 241.

1867. *Diffflugia tuberculata* Archer, *Quart. Journ. microsc. Sci.*, New Series. **7**, p. 173-174 & 177-179.

1958. *Diffugia tuberculata* : Gauthier-Lievre and Thomas, *Arch. Protistenk.*, Jena, **103**, p. 279.

Material examined : 2 exs., Rongram River, South Garo Hills, 23.iii.1991, coll. A. K. Das;
2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Test ovoidal with wide base; 105-126 μm \times 80-100 μm in dimensions; pseudostome hexagonal in outline with obtuse angles surrounded by a short collar, test yellowish or chocolate brown, covered with tubercles or disc-shaped protruberances and composed of small platelets perfectly uniting the tubercles.

Distribution: India : Meghalaya (West Garo Hills and East Khasi Hills districts) and West Bengal; in the bottom ooze of freshwater bodies.

Class	FILOSEA
Order	GROMIIDA
Family	EUGLYPHIDAE

Diagnosis : Test composed of silicious scales or plates cemented together; body hyaline, filiform pseudopodia often branching, sometimes anastomosing.

Key to the genera

- 1(2) Test chitinous, usually transparent, ovate, pyriform or elongate in broad view, composed of circular or oval platelets of uniform or various sizes Genus *Nebela*
- 2(1) Test hyaline, ovoid, composed of silicious scales
- 3(4) Test symmetrical, composed of silicious imbricated scales arranged in alternating longitudinal rows, aperture terminal, not invaginated Genus *Euglypha*
- 4(3) Test unsymmetrical, formed of circular silicious imbricated scales, aperture oblique and invaginated Genus *Trinema*

Genus *Euglypha* Dujardin

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

1962. *Euglypha* : Decloitre, *Arch. Protistenk.*, **106**, p. 51.

Diagnosis : Test hyaline, ovoid or elongated, circular or elliptical in transverse section; formed of circular, oval or scutiform silicious scales, arranged in alternating longitudinal rows regularly imbricated; aperture terminal, bordered by serrated or denticulated scales.

Key to the species

- 1(6) Pseudostome bordered with one or two rows of finely dentate scales
- 2(3) Base of the test with 3-8 scales prolonged into spines, body scales elliptical

- *E. acanthophora*
- 3(2) Test spineless, body scales oval or scutiform
- 4(5) Scales of the test oval, rarely circular, pseudostome usually bordered with one and occasionally with two rows of finely dentate scales *E. tuberculata*
- 5(4) Scales of the test scutiform, pseudostome bordered with two rows of finely dentate scales *E. scutigera*
- 6(1) Pseudostome not bordered with dentate scales
- 7(8) Scales bordering pseudostome terminated by a single semicircular projection ... *E. rotunda*
- 8(7) Scales bordering pseudostome without any semicircular projection
- 9(10) Scales bordering pseudostome unevenly denticulated and not shiny at their margin, scales of the test clearly visible *E. denticulata*
- 10(9) Scales bordering pseudostome pointed and always shiny at their margin, scales of the test not clearly visible *E. laevis*

22. *Euglypha acanthophora* (Ehrenberg)

1842. *Diffugia acanthophora* Ehrenberg, *Abh. Acad. Berlin*, p. 413.

1849. *Euglypha acanthophora* Perty in *Mitth. nat. Ges. Bern.*, p. 45.

Material examined : 3 exs., Nongpoh, Ri-Bhoi district, 6.xi.1988, coll. D. N. Tewari; 3 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das.

Diagnosis : Test ovoidal, 50-62 μm \times 26-30 μm in dimensions, pseudostome bordered with one or occasionally two rows of finely dentate scales; scales of the test elliptical or rarely circular; some scales at the posterior half and at the base of the fundus prolonged into spines.

Distribution: India : Meghalaya (West Garo Hills and Ri-Bhoi districts), Andhra Pradesh and West Bengal; in freshwater amongst vegetation and in bottom ooze, also in moss or sphagnum.

23. *Euglypha denticulata* Brown

1921. *Euglypha denticulata* Brown, *Scottish Naturalist*, p. 181.

Material examined : 2 exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A. K. Das; 2 exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A. K. Das; 3 exs., Mowsmai cave, East Khasi Hills, 3.iv.1991, coll. A. K. Das; 2 exs., Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test glabrous, oval; 30-40 μm \times 20-22 μm in dimensions; scales of the test clearly visible, pseudostome small, scales bordering pseudostome unevenly denticulated and not shiny at their margin.

Distribution: India : Meghalaya (East Garo Hills, East Khasi and West Khasi Hills districts) and West Bengal; in moss.

24. *Euglypha laevis* (Ehrenberg)

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

1849. *Euglypha laevis* Perty in *Mitth. nat. Ges. Bern.*, p. 163.

Material examined : 3 exs., Mawsmat cave, East Khasi Hills, 3.iv.1991, coll. A. K. Das; 1 ex., Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test oviform, glabrous, 22-50 μm \times 12-26 μm in dimensions, aperture elliptical to subcircular, scales bordering aperture (pseudostome) pointed terminally, shiny at their margin and having wider gap in between their free ends.

Distribution: India : Meghalaya (East Khasi Hills district), Andhra Pradesh and West Bengal; in ground moss.

25. *Euglypha rotunda* Wailes

1911. *Euglypha rotunda* Wailes, *Proc. roy. Irish Acad.*, **31**, p. 17.

Material examined : 1 ex., Thadleskein, Jaintia Hills, 10.i.1989, coll. A. K. Das; 1 ex., Mawmat cave, East Khasi Hills, 3.iv.1991, coll. A. K. Das; 1 ex., Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test oval, 25-40 μm in length, width of the test about half of its length; pseudostome bordering scales possessing a semicircular denticulate projection; imbrication of test scales displaying a hexagonal or rectangular pattern on the surface.

Distribution: India : Meghalaya (East Khasi Hills and Jaintia Hills districts) and West Bengal; in moss.

26. *Euglypha scutigera* Penard

1811. *Euglypha scutigera* Penard, *Proc. roy. Irish Acad.*, **31**, p. 41-42.

Material examined : 3 exs., Mawsmat cave, East Khasi Hills, 3.iv.1991, coll. A. K. Das; 2 exs., Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test oviform, without spine; 65-70 μm \times 35-37 μm in dimensions, scales of the test scutiform, disposed in alternate longitudinal rows; two rows of finely dentate scales present on the margin of the pseudostome, numbering 8-10 in each row.

Distribution: India : Meghalaya (East Khasi Hills districts) and West Bengal; in moss.

27. *Euglypha tuberculata* Dujardin

1841. *Euglypha tuberculata* Dujardin, *Zooph. Infus.*, 31, p. 251-252.

Material examined : 4 exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 2 exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; 2 exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A. K. Das.

Diagnosis : Test ovoidal to cylindrical; 56-70 μm \times 24-32 μm in dimensions; nature of pseudostomal and test scales resembling *E. acanthophora*; but these scales never prolonged into spine.

Distribution: India : Meghalaya (West Garo Hills and East Garo Hills districts) and in West Bengal; in freshwater amongst vegetation and in bottom ooze; also in moss and sphagnum.

Genus *Nebela* Leidy

1874. *Nebela* Leidy, *Proc. Acad. Philad.*, p. 156.

Diagnosis : Test usually transparent, more or less compressed, ovate, pyriform or elongate in broad view, composed of chitinous circular or oval platelets of uniform or variable size.

28. *Nebela vitrae* Penard

1899. *Nebela vitrae* Penard, *Rev. Suisse Zool.*, 7, p. 43.

Material examined : 3 exs., Mawsmi cave, East Khasi Hills, 3.iv.1991, coll. A. K. Das; 2 exs., Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test considerably transparent, ovoid in general without any neck, compressed laterally and covered with diaphanous angular scales adhering at their edges, overlapping rarely, margin of pseudostome crenulate.

Distribution: India : Meghalaya (East Khasi Hills districts); in rock moss.

Remarks : This species is reported from India for the first time from Mawsmi cave and Cherrapunjee Rest House compound in East Khasi Hills district, Meghalaya.

Genus *Trinema* Dujardin

1841. *Trinema* Dujardin, *Zooph. Infus.*, p. 249.

Diagnosis : Test small, hyaline, unsymmetrical, oviform or elongate, compressed anteriorly, covered with circular silicious plates; pseudostome circular, oblique and invaginated.

Key to the species

1(2) Test elongate, small, usually homogeneous in appearance *T. lineare*

- 2(1) Test ovoid, tapering both in broad and narrow views towards the aperture, covered with easily distinguishable circular plates.
- 3(4) Test oviform, anterior portion of the orifice furnished with a wide border, well defined lines present demarcating the joining of wide border with fundus *T. geleata*
- 4(3) Test ovoid and without any wide border or well defined lines as above *T. enchelys*

29. *Trinema enchelys* (Ehrenberg)

1838. *Diffugia enchelys* Ehrenberg, *Infusionsthierchen*. p. 132.

1878. *Trinema enchelys* Leidy, *Proc. Acad. Philad.*, p. 172.

Material examined : 5 exs., Thadleskein, Jaintia Hills, 10.i.1989, coll. D.N. Tiwari; sev. exs., Tura, West garo Hills, 19.iii.1991, coll. A.K. Das; 4 exs., Rongram River; West Garo Hills, 19.iii.1991, coll. A.K. Das; 4 exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das; sev. exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A.K. Das; sev. exs., Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das; sev. exs., Mawsmi cave; East Khasi Hills, 3.iv.1991, coll. A.K. Das; sev. exs. Cherrapunjee, East Khasi Hills, 3.iv.1991, coll. A. K. Das.

Diagnosis : Test hyaline, ovoid, compressed anteriorly, covered with silicious circular plates. 30–40 μm \times 12–20 μm in dimensions; aperture circular subterminal, oblique and invaginated.

Distribution : India : Meghalaya (West Garo Hills, East Garo Hills, East Khasi Hills and Jaintia Hills districts), Andhra Pradesh and West Bengal; in moss and aquatic vegetation.

30. *Trinema geleata* Penard

1890. *Trinema enchelys* var. *geleata* Penard, *Mem. Soc. Geneva*, 31 p. 186.

Material examined : 1 ex., Mawsmi cave, East Khasi Hills, 3.iv.1991, coll. A.K. Das.

Diagnosis : Test hyaline, oviform, compressed anteriorly, formed of circular imbricated silicious plates; test 35 μm \times 20 μm in dimension; aperture circular, subterminal, oblique and invaginated; anterior portion of the orifice furnished with a wide border.

Distribution : India : Meghalaya (East Khasi Hill district); in rock moss.

Remarks : This species is reported for the first time from India from Mawsmi cave in East Khasi Hills districts, Meghalaya.

31. *Trinema lineare* Penard

1890. *Trinema lineare* Penard, *Mem. Soc. Geneve*, 31, p. 187.

Material examined : 2 exs., Nongpoh, Ri-Bhoi district, 6. xi.1988, coll.D.N. Tiwari; 2 exs., Thadleskein, Jaintia Hills, 10.i.1989, coll. D.N. Tiwari ; sev. exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A.K. Das; 4 exs., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; sev. exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das; 2 exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A.K. Das; sev. exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das; sev. exs., Mawsmaj cave, East Khasi Hills, 3.iv.1991, coll. A.K. Das.

Diagnosis : Test small, hyaline, elongate, smooth, 20-38 μm \times 8-18 μm in dimensions, composed of small circular plates, aperture circular, oblique, invaginated.

Distribution : India : Meghalaya (all the seven districts) and West Bengal; in moss, sphagnum and aquatic vegetation.

Remarks : This species closely resembles *T. enchelys*. It is, however, distinguishable by its smooth outline and more elongate form.

Phylum	CILIOPHORA
Class	KINETOFRAGMINOPHOREA
Subclass	GYMNOSTOMATIA
Order	PROSTOMATIDA

Key to the families

- 1(2) Body oval, cytostome round or oval, sometimes in shallow atrium, oral basket made up of double trichites ending deep in cytoplasm.....Family Prorodontidae
- 2(1) Body elongated, egg-shaped with narrow drawn out and obliquely branched anterior end, cytostome usually slit-like, cytopharynx sometimes eversible, oral basket as above absentFamily Enchelyidae

Family	PRORODONTIDAE
Genus	<i>Prorodon</i> Ehrenberg

1833. *Prorodon* Ehrenberg, *Abhandl. d. Konigl. Akad. d. Wissench. zu Berlin, a. d. J. 1833* (1835), pp. 145-336.

1927. *Prorodon* Ehrenberg, emend. Kahl. *Arch. Protistenk.*, 60 p. 44.

Diagnosis : Uniform ciliation throughout the body; mouth at or closely adjacent to anterior pole; oral basket made up of double trichites, cytostome not surrounded by heavier cilia; macronucleus spherical, oval, sometimes band-like and curved, contractile vacuole terminal.

Key to the species

- 1(2) Pharyngeal tube with trichites and extending usually up to one fourth of the body
..... *P. teres*
- 2(1) Pharyngeal tube without trichite and extending up to the middle of the body.....
.....*P. edentatus*

32. *Prorodon edentatus* Claparede & Lachmann

1858. *Prorodon edentatus* Claparede & Lachmann, *Mem. Inst. Genevois*, Geneve, 6, p. 320.

1930. *Prorodon edentatus* : Kahl, *Urtiere order Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 18, p.73.

Material examined : 1. ex. , Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; 1 ex., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; 2 exs. Ward lake, Shillong, East Khasi Hills, 2.iv. 1991, coll. A.K. Das.

Diagnosis : Body ovoid or ellipsoidal, mouth terminal and eccentric; dimensions 78-90 μm \times 40-52 μm ; pharyngeal tube without trichites, extending diagonally up to the middle of the body; macronucleus single, oval and elongate; contractile vacuole single and located at posterior end.

Distribution : India : Meghalaya (West Garo Hills, South Garo Hills and East Khasi Hills districts) and West Bengal; in freshwater.

33. *Prorodon teres* Ehrenberg

1938. *Prorodon teres* Ehrenberg, *Die infusionsthierchen als Vollkommene Organismen*, Leipzig, p 316.

1930. *Prorodon teres* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 18, p. 80.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; 1 ex., Ward Lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Body ovoid, both anterior and posterior ends considerably round, dimensions 128-135 μm \times 60-70 μm , mouth polar, pharyngeal basket slightly conical with trichites, extending

about one-fourth of the body from anterior end; macronucleus spherical with single micronucleus; contractile vacuole single and terminal.

Distribution : India : Meghalaya (West Garo Hills and East Khasi Hills districts), Orissa and West Bengal.

Remarks : It is a freshwater species and has been collected from freshwater environs of West Bengal (Das *et. al.*, 1993) and Meghalaya (present collection). In Orissa, however, this species has been reported from the brackish water of the Chilka lagoon, having salinity 0.7- 3‰ (Das, *in press*).

Family COLEPIDAE

Genus *Coleps* Nitzsch

1817. *Coleps* Nitzsch, *Neue Schrift d. naturf. Ges. in Halle*, 3, p. 3..

Diagnosis : Body barrel-shaped, cuticular surface longitudinally and transversely furrowed forming regularly arranged quadrangular ectoplasmic plates; anterior end truncate, surrounded by teeth-like projections, posterior end rounded often with spinous projections; cytostome apical, surrounded with slightly longer cilia.

34. *Coleps hirtus* (Muller)

1786. *Cercaria hirta* O.F. Muller, *Hafniae et Lipsiae*, p. 128.

1817. *Coleps hirtus* Nitzsch, *Neue Schrift d. naturf. Ges. in Halle.*, 3, p.4.

Material examined : 4 exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; 2 exs., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; 1 ex., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das; sev. exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K.Das.

Diagnosis : Body barrel-shaped, body length about two times of body width; dimensions 75-88 μm \times 50 μm . ectoplasmic plates 18-20 in number; posterior extremity provided with 3 sinuous projections; macronucleus spherical, subcentral; contractile vacuole single, located at posterior end of the body.

Distribution : India : Meghalaya (West Garo Hills, East Garo Hills, South Garo Hills and East Khasi Hills districts), Jammu and Kashmir, Rajasthan and West Bengal; cosmopolitan in freshwater ponds.

Family ENCHELYIDAE

Genus *Lagynophrya* Kahl

1927. *Lagynophrya* Kahl. *Arch. Protistenk.*, 60, p. 91.

Diagnosis : Body elongate ovoid with asymmetrical shape, dorsal disc convex, ventral side more or less flattened; cytopharynx terminate anteriorly in a small cone-like process which may or may not distinct.

35. *Lagynophrya mutans* Kahl

1927. *Lagynophrya mutans* Kahl. *Arch. Protistenk.*, 60, p. 91.

Material examined : 4 exs.. Tura, West Garo Hills. 19.iii.1991, coll. A.K. Das.

Diagnosis : Body oval to cylindrical, contractile, striated: maximum length 80 µm when not contracted; cytoplasm colourless, oral cone hemispherical without any trichocyst; macronucleus oval and located at the posterior half of the body; contractile vacuole single and terminal.

Distribution : India : Meghalaya (West Garo Hills district); in freshwater among decaying leaves.

Remarks : This species is reported for the first time in India.

Sub class VESTIBULIFERIA

Order COLPODIDA

Family COLPODIDAE

Diagnosis : Body barrel shaped bearing armoured plates in longitudinal rows.

Genus *Colpoda* O.F. Muller

1773. *Colpoda* O.F. Muller. *Vermium terrest. et fluvialil. S. animal. infusor., etc., historia*, Havniae et Lipsiae. pt. 1 & 2. pp.56-57.

1971. *Colpoda* Gmelin. *Systema Naturae* (ed. 13). 1, p. 3894.

Diagnosis : Body kidney-shaped, laterally flattened, anterior end rounded, twisted from left to right and curved on ventral surface; cytostome present in the ventral depression, leading into peristomeal cavity and giving rise to a diagonal groove at dorsal side; a ciliated area present in the right edge of the cytostome.

36. *Colpoda cucullus* O.F.Muller

1773. *Colpoda cucullus* O.F. Muller. *Vermium terrest. fluvialil. S. animal infusor., etc., historia*. Havniae et Lipsiae. pt. 1 & 2. p. 58.

1838. *Colpoda cucullulus* Ehrenberg, *Die infusionsthierchen als Vollkommene Organismen*, Leipzig, pp. 347-348

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., Bojengdoba, East Garo Hills, 21.iii.1991, coll. A.K. Das; 7 exs., Rongrengiri, East Garo Hills, 27.iii.1991, coll. A.K. Das; 4 exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A.K. Das; sev. exs., Ransakbazar, East Garo Hills, 29.iii.1991, coll. A.K. Das; sev. exs., Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Body typically kidney-shaped with a well marked depression; length considerably varying ranging from 50-110 μm ; cytostome located almost at the middle of the body; frontal dentations 8-10 and meridians 29-34; macronucleus oval and located at the middle of the body; contractile vacuole single and posterior.

Distribution : India : Meghalaya (West Garo Hills, East Garo Hills, West Khasi Hills and East Khasi Hills districts), Andhra Pradesh, Assam, Jammu and Kashmir, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal.

Remarks : This is a very common soil inhabiting protozoa and has been found to occur in many ground moss samples collected by the present authors from West Bengal and Meghalaya.

Subclass	HYPOSTOMATIA
Order	NASSULIDA
Family	MICROTHORACIDAE

Diagnosis : Hypostomial fringe reduced drastically to a few short kinetal segments bearing pseudomembranelles' and sometimes set in a shallow atrium; body with firm pellicle and sparsely ciliated; cytopharynx simple or lacking.

Key to the genera

- 1(2) : Body more or less oval with delicate keeled armour, oral depression postero-ventral, with a stiff ectoplasmic lip on right side and a small tooth on left margin, cytopharynx lacking Genus *Microthorax*
- 2(1) Body semilunar or sickle-shaped with longitudinal furrow, oral field groove-like, located little above the middle of the body, cytopharynx tubular..... Genus *Drepanomonas*

Genus *Drepanomonas* Fresenius

1858. *Drepanomonas* Fresenius, *Abh. Senkenb. naturf. Ges.*, 2, p. 216.

Diagnosis : Already dealt with in the key to the genera of the family Microthoracidae.

37. *Drepanomonas dentata* Fresenius

1858. *Drepanomonas dentata* Fresenius, *Abh. Senkenb. naturf. Ges.*, 2, pp. 216-217.

1920. *Drepanomonas dentata* : Ghosh, *Report Sci. Convension Indian Ass. cult. Sci.* for 1918, p. 144.

Material examined : Scv. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das.

Diagnosis : Body semilunar, dimensions 26-34 μm \times 11.5- 16 μm , dorsal margin convex. ventral margin concave and both anterior and posterior ends sharply pointed; two longitudinal ciliated grooves present on the dorsal side; macronucleus spherical and situated little behind or above the peristome.

Distribution : India : Meghalaya (West Garo Hills district) and West Bengal.

Remarks : This is a freshwater inhabiting species; however, Ghosh (1920) reported it for the first time from India from 'vegetable infusion' in Calcutta, West Bengal. This is the second report of *D. dentata* from this country and the species is collected from freshwater stream at Tura.

Genus *Microthorax* Engelmann

1862. *Microthorax* Engelmann, *Zeitschr. f. Wiss. Zool.*, 11, p. 347.

Diagnosis : Already dealt with in the key to the genera of the Microthoracidae.

38. *Microthorax pusillus* Engelmann

1862. *Microthorax pusillus* Engelmann. *Zeitschr. f. Wiss. Zool.*, p. 347-393.

Material examined : 4 exs., Tura, West Garo Hills, 19.iii.1991; 2 exs., Bagmara, South Gaaro Hills, 24.iii.1991, coll. A.K. Das; 3 exs. Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Body small ovoid, 30- 35 μm in length, left border slightly sigmoid and right border more or less straight; oral depression on dorsal side; macronucleus spherical; contractile vacuoles two and located below the middle half of the body.

Distribution : India : Meghalaya (West Garo Hills, South Garo Hills and East Khasi Hills districts) and West Bengal; in freshwater:

Order CYRTOPHORIDA

Family CHILODONELLIDAE

Diagnosis : Body with pronounced anterior "beak" to the left, thigmotactic zone broad.

Genus *Chilodonella* Strand

1928. *Chilodonella* Strand. *Arch Naturgesch.*, **92**, p.31.

1931. *Chilodonella* Kahl. *Urtiere order Protozoa* (In *Dahl's Tierwelt Dtsch.*), Jena. pt.21, pp. 234-235.

Diagnosis : Ovoid, dorsal surface convex, ventral surface flat and with ciliary rows, a cross row of bristles on anteriorly flattened dorsal surface.

39. *Chilodonella cucullulus* (Muller)

1773. *Kolpoda cucullulus* Muller, *Verminum terrest. fluviatil. S. animal infusor., etc., historia.* Havniae et Lipsae, p. 158.

1833. *Chilodonella cullulus* Ehrenberg. *Abandl. d. Konigl. Akad. d. Wissensch. zu Berlin, a.d.J.* 1833 (1855). p. 169.

1931. *Chilodonella cucullulus* : Kahl., *Urtiere order Protozoa* (in *Dahl's Tierwelt Dtschi*). Jena. pt. 21. p. 235.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; 1 ex., Ward lake, Shillong, East Khasi Hills, 21.iii.1991, A.K. Das.

Diagnosis : Body dorsoventrally flattened, dimensions 90-104 μm \times 62-77 μm , cytopharynx straight, 19-20 ciliary rows; macronucleus oval, contractile vacuoles many and scattered.

Distribution : India : Meghalaya (West Garo Hills and East Khasi Hills districts), Orissa, Jammu and Kashmir, Maharastra, Rajasthan and West Bengal; in freshwater.

Class OLIGOHYMENOPHOREA

Subclass HYMENOSTOMATIA

Order HYMENOSTOMATIDA

Key to the families

- 1(2) Oral ciliature deep in buccal cavity, with "watch glass organellae", peristome running as a sickle-shaped ciliated cleft, perpendicular to the surface of the bodyFamily Ophryoglenidae
- 2(1) Oral ciliature without any "watch glass organellae", shape and orientation of peristome quite distinct from above.
- 3(4) Oral ciliature inconspicuous, preoral suture present but postoral suture lacking: [buccal cavity, membranellar bases with uniform width].....Family Glaucomidac

- 4(3) Oral ciliature deep in buccal cavity, both preoral and postoral sutures distinct
- 5(6) Prebuccal cavity or "vestibulum" conspicuous leading to equatorially located buccal cavity, two peniculi in buccal cavity, cytostome not expansible, contractile vacuoles two Family Parameciidae
- 6(5) Prebuccal area shallow or absent, three peniculi in buccal cavity, cytostome expansible, contractile vacuole single Family Frontonidae

Family GLAUCOMIDAE

Genus *Monochilum* Schewiakoff

1893. *Monochilum* Schewiakoff. *Mem. Acad. Sci. de. St. Petersb.* (7). 41, p.1-201.

Diagnosis : Ovoid to ellipsoid in shape; body with uniform and dense ciliation arranged in rows; cytostome oblong located at left of median line in about one-fourth the body length from anterior end; cytopharynx short, sometimes lacking, when present conical in shape with an undulating membrane.

40. *Monochilum ovale* (Schewiakoff)

1893. *Uronema ovale* Schewiakoff. *Mem. Acad. Sci. de. St. Petersb.* (7) 41. p. 1-201.

1931. *Monochilum ovale* Kahl. *Urtiere order Protozoa* (in : Dahl's *Tierwelt Dtsch.*). Jena. pt. 21. p. 340.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991 coll. A.K. Das.

Diagnosis : Body oval in shape, both anterior and posterior ends broadly rounded, dimensions 74 µm × 40 µm; cytostome short, oval, with undulating membrane on its left border and cilia on the right, cytopharynx lacking; macronucleus round in shape; contractile vacuole single and located on the dorsal side of the posterior fourth of the body.

Distribution : India : Meghalaya (West Garo Hills district) and Rajasthan; in freshwater.

Family OPHRYOGLENIDAE

Genus *Ophryogena* Ehrenberg

1831. *Ophryoglena* Ehrenberg. *Abhandl. d. Konigl. Akad. d. Wissench. zu Berlin, a. d. J. 1831* (1832). p. 117.

1979. *Ophryoglena* : Corliss. *The Ciliated Protozoa*, Pergamon Press. p. 259.

Diagnosis : Body ellipsoidal with both ends rounded or attenuated, preoral depression in the form of '6' due to an ectoplasmic membrane extending from the left edge.

41. *Ophryoglena flava* (Ehrenberg)

1833. *Bursaria flava* Ehrenberg, *Abhandl. d. Konigl. Akad. d. Wissensch. zu Berlin*, p. 233.

1887-89. *Ophryoglena flava* Butschli, *Protozoa (Bronn's Klassen und Ordnungen des Thier-Reichs)*, 3, p. 1703-4.

Material examined : 1 ex., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll.A.K.Das.

Diagnosis : Body ellipsoidal, 310 μm in length, cytostome on ventral side and situated at about one-third of the length of the body from anterior end; cytopharynx ear-shaped, longitudinally plicate, recurved and narrower at its posterior extremity; macronucleus elliptical; contractile vacuole two, one in the anterior and the other in the posterior half of the body, with long radiating canals.

Distribution : India : Meghalaya (East Khasi Hill district), Maharashtra, Rajasthan and West Bengal; in freshwater.

Family PARAMECIIDAE

Genus *Paramecium* Hill

1752. *Paraemecium* Hill, *History of Animals including the several classes of Animalcula visible only by the assistance of the Microscope*, Vol. 3. London.

1773. *Paramecium* Muller, O.F., *Vermium terrest. et fluviatil s. animal. infusor., etc., historia*, Havniae et Lipsiae, Parts I & II. p. 54.

1931. *Paramecium* Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 21, p. 289.

Diagnosis : Body cigar-shaped, peristome long, broad and slightly oblique, cytopharynx moderately long, with a row of very fine cilia attached to its dorsal wall.

42. *Paramecium caudatum* Ehrenberg

1833. *Paramecium caudatum* Ehrenberg, *Abhandl. d. Konigl. Akad. de Wissensch. Zu Berlin*, pp. 286, 323.

1931. *Paramecium caudatum* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 21, p. 291.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll.A.K. Das; sev. exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das; 6 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Body cigar-shaped, anterior end broader and rounded and posterior end gradually tapering; body-length around three times of the body width; dimensions 170-250 μm \times 55-85 μm , cytopharynx typically as for the genus, macronucleus egg-shaped, micronucleus single and compact lying close to macronucleus; contractile vacuoles two with radiating canals one lying within anterior one-third and the other within posterior one-third of the body.

Distribution : India : Meghalaya (West Garo Hills, East Garo Hills and East Khasi Hills districts), Jammu and Kashmir, Orissa, Rajasthan, Uttar Pradesh, and West Bengal; in freshwater and hay infusion.

Family FRONTONIIDAE

Genus *Frontonia* Ehrenberg

1838. *Qursaria* partim, Ehrenberg *Die infusionsthierchen als Vollkommene Organismen*, Leipzig., p. 325.

1838. *Frontonia* subgenus, Ehrenberg, *ibid*, p. 329.

1858. *Frontonia* Claparede and Lachmann, *Etudes sur les infusoires et les rhizopodes*, Geneve., pp. 259-60.

Diagnosis : Body ellipsoid, with both the ends rounded; cytostome lying in the anterior third of the ventral surface, large undulating membrane in the left oral margin; macronucleus oval or ellipsoidal, central and obliquely placed; contractile vacuole single, centrally located, with or without radiating canal.

43. *Frontonia leucas* (Ehrenberg)

1838. *Bursaria leucas* Ehrenberg, *Die infusionsthierchen als Vollkommene Organismen*, Leipzig., p. 329.

1858-61. *Frontonia leucas* Claparede and Lachmann, *Etudes sur les infusoires et les rhizopodes*, Geneve, pp. 259-60.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 1 ex., Bagmara, South Garo Hills, 24.iii.1991, coll. A.K. Das; 2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Body elongated or ovoid, rounded at both ends, dimensions 148-165 μm \times 72-85 μm ; cytostome carrying three rows of cilia, post oral groove extending to the posterior part of the body, macronucleus ellipsoid with several micronuclei, contractile vacuole single with long radiating canals and located at the middle of the body.

Distribution : India : Meghalaya (West Garo Hills, South Garo Hills and East Khasi Hills districts), Orissa, Jammu and Kashmir, Rajasthan, Maharastra and West Bengal.

Remarks : It is a freshwater species and collected from freshwater pool and streams of Meghalaya. It is worth mentioning here that *F. leucas* has also been reported from the brackish water of the Chilka lagoon, having salinity ranging from 1-11‰. (Das, *in press*).

ORDER SCUTICOCILIATIDA

Key to the families

- 1(2) Paroral membrane very prominent, sometimes present as stiff velum and distinctly curling about subequatorial cytostome, peristome extending along the surface of the body from anterior pole to oral apertureFamily Pleuronematidae
- 2(1) Paroral membrane as above lacking, buccal cavity small and anteroventral in positionFamily Loxocephalidae

Family LOXOCEPHALIDAE

Genus *Loxocephalus* Eberhard

1862. *Loxocephalus* Eberhard. *Osterprogramme der Realschule zu Koburg*, 1862.

1931. *Loxocephalus* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*) Jena, pt. 21, p. 341.

Diagnosis : Body ovoid to cylindrical, cytostome crescentric, located at a slightly flattened area near anterior end; with a zone of cilia around the body and with one or more long caudal cilia.

44. *Loxocephalus ellipticus* Kahl

1931. *Loxocephalus ellipticus* Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch*) Gena. pt. 21, p. 344.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991, coll A.K. Das.

Diagnosis : Body more or less cylindrical, anterior end slightly flattened and posterior end broadly round, dimensions 60 μm \times 22 μm caudal flagellum long and single; 8-9 ciliary rows on one side of the body; endoplasm with regularly arranged course, compact granules lying under the ciliary striations. macronucleus round located in the posterior half of the body; contractile vacuole single, lying near posterior fifth of the body.

Distribution : India : Meghalaya (West Garo Hills district.)

Remarks : This is the first report of this species since its description by Kahl (1931). This species inhabits freshwater and constitutes first record from India.

Family PLEURONEMATIDAE

Genus *Pleuronema* Dujardin

1841. *Pleuronema* Dujardin, *Histoire nat. des zoophytes infusoires*, p. 474.

Diagnosis : Body ovoid to ellipsoid; peristome extending from anterior end to two-third of the body; conspicuous membrane at both edges, a semicircular swelling to left near oral area.

45. *Pleuronema crassum* Dujardin

1841. *Pleuronema crassa* Dujardin. *Histoire nat. des Zoophytes Infusoires*, p. 474-475.

1931. *Pleuronema crassum* : Kahl. *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 21, p. 387.

Material examined : 4 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body irregularly ovoid, dimensions 28 µm × 12 µm; peristome prominent, undulating membrane very distinct and narrow anteriorly and rapidly widening posteriorly; macronucleus round with adjacent micronucleus, located at the anterior half of the body; contractile vacuole single and postero-dorsal.

Distribution: India : Meghalaya(East Khasi Hills district) and West Bengal; in freshwater.

Subclass	PERITRICHIA
Order	PERITRICHIDA
Family	VORTICELLIDAE

Diagnosis : With contractile stalk, colonial (except in two genera); in colonial forms zooids not independently contractile (except in one species).

Genus *Vorticella* Linnaeus

1767. *Vorticella* Linnaeus. *Systema Naturae*, 1 (12th ed.). p. 1317.

1838. *Vorticella* Ehrenberg. *Die infusionsthierchen als Vollkommene Organismen*, Leipzig, p. 269.

Diagnosis : Shape inverted bell form, solitary, may be in clusters but not in colonies; attached posteriorly to any substratum by a simple, undivided, elongated, thread-like pedicle, with contractile axial filament, macronucleus more or less elongated, band-shaped, with a micronucleus, lying close to it.

46. *Vorticella campanula* Ehrenberg

1831. *Vorticella campanula* Ehrenberg. *Abhandl. d. Konigl. Akad. d. Wissensch. zu Berlin. a. d. J.* 1831 (1832), p. 92.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; sev. exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; sev. exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body hemispherical or campanulate in normal condition, vestibule very large with an outer pharyngeal membrane, pedicle thick, cuticular surface smooth and highly elastic, endoplasm filled with refractile reserve granules; macronucleus

Distribution : India : Meghalaya (West Garo Hills and East Khasi Hills districts), in freshwater; first report from India.

Class POLYHYMENOPHOREA

Subclass SPIROTRICHIA

Order HETEROTRICHIDA

Key to the families

- 1(2) Anterior part of the body uniquely twisted to left and posterior part sometimes tailed and/or bearing tuft of longer cilia Family Metopidae
- 2(1) Anterior part of the body not twisted as above
- 3(4) Body large, elongate and cylindrical or pyriform, highly contractile, peristomial field long and narrow Family Spirostomidae
- 4(3) Body large, broad, with rounded posterior end, not highly contractile, peristomial field funnel-like and prominent Family Bursariidae

Family SPIROSTOMIDAE

Genus *Blepharisma* Perty

1852. *Blepharisma* Perty, *Zur Kenntniss Kleinster Lebensformen*, p. 137.

1932. *Blepharisma* : Kahl, *Urtiere oder Protozoa* (in Dalh's *Tierwelt Dtsch.*), Jena, pt. 25, p. 442.

Diagnosis : Body usually pyriform or ellipsoidal, somewhat narrowed anteriorly, peristome twisted to right at posterior end and connected with oral funnel without membrane, cytostome at posterior end of peristome, cytopharynx usually short, contractile vacuole terminal and without any straight canal.

47. *Blepharisma intermedium* Bhandary

1962. *Blepharisma intermedium* Bhandary, *J. Protozool.*, **9**, p. 437.

Material examined : 5 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body flattened, ellipsoidal, cytoplasm pink coloured; 110-140 μm long.

undulating membrane not very prominent extending about one-third the length of the body; macronucleus cylindrically elongated, number of nuclei 6 to 30.

Distribution : India : Meghalaya (East Khasi Hills district), Karnataka and West Bengal; in freshwater.

Family METOPIDAE

Genus *Metopus* Claparede and Lachmann

1858. *Metopus* Claparede and Lachman. *Mem. Inst. Nat. Genevois*, 5. p. 1.

1932. *Metopus* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena. pt. 25. p. 405.

Diagnosis : Body elongated, asymmetrical due to left side anterior torsion; band-like subanterior peristome never spiralling; cytostome subanterior or subequatorial, anterior body part shorter than or equal to posterior body part.

48. *Metopus es* Muller

1786. *Metopus es* Muller, O. F., *Animalcula infusoria fluviatilia et marina, etc., historia*, Havniae et Lipsiae, p. 126.

1932. *Metopus es* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena pt. 25. 416.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 1 ex., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body characteristically sigmoid (S-like), comparatively large and slender, dimensions 108–140 μm \times 50–62 μm ; cytoplasm colourless, pellicular striations prominent; macronucleus single and sausage-shaped; contractile vacuole single, terminal and without any raising edge.

Distribution : India : Meghalaya (West Garo Hills and East Khasi Hills districts); Andhra Pradesh, Orissa, Rajasthan and West Bengal; in freshwater.

Family BURSARIIDAE

Genus *Bursaria* Muller

1773. *Bursaria* Muller, O. F., *Vermium terrest. et fluviatil. S. animal. infusor., etc., historia*, Havniae et Lipsiae, p. 62.

1932. *Bursaria* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena. pt. 25. p. 476.

Diagnosis : Body very large, ovoid, anterior end truncate, posterior end broadly rounded, peristome deep and wide, extending about the middle of the body, cytostome bent to the left; macronucleus hand shaped without micronucleus.

49. *Bursaria truncatella* Muller

1773. *Bursaria truncatella* Muller, O. F., *Vermium terrest. et fluviatil. S. animal. infusor., etc., historia*, Havniae et Lipsiae, p. 62.

1932. *Bursaria truncatella* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 476.

Material examined : 3 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body ovate, purse-shaped, dimensions 548 μm \times 350 μm , dorsal surface convex, ventral surface flat; peristome and nucleus as in the genus; contractile vacuoles many and distributed all over the body.

Distribution: India : Meghalaya (East Khasi Hills district) and West Bengal; in freshwater.

Remarks : This is the second report of this species from India; the first report was made by Das, Mandal and Sarkar (1993) from West Bengal.

Order ODONTOSTOMATIDA

Family EPALXELLIDAE

Diagnosis : "Chunky" forms, generally with short posterior spines; cirri lacking, somatic ciliature relatively dense; some species with well developed spine overhanging, hidden buccal cavity.

Genus *Saprodinium* Lauterborn

1908. *Saprodinium* Lauterborn, *Zeitschr. wiss. Zool.*, **90**, p. 1.

1932. *Saprodinium* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 525.

Diagnosis : Body rounded triangular, anterior end pointed towards ventral surface, posterior end irregularly truncate; right carapace with one dorsal and one ventral ciliary rows in posterior region, usually four (two to three) median teeth; some anal teeth (left and right) with spine.

50. *Saprodinium putrinium* Lackey

1925. *Saprodinium putrinium* Lackey, *New jersey Agr. Exp. Stat. Bull.*, 417.

1932. *Saprodinium putrinium* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 526.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das.

Diagnosis : Body laterally compressed, dorsal side more convex and shape rounded triangular; dimensions 40-43 μm \times 35 μm ; posterior end irregularly truncate with 5-6 anal teeth; anal teeth without any spine; macronuclei round and two in number; contractile vacuole single and located at the ventral side of the posterior end of the body.

Distribution : India : Meghalaya (West Garo Hills district).

Remarks : This species has been collected from sewage water running across the hillocks at Tura and constitutes first record from Indian subcontinent.

Order OLIGOTIRCHIDA

Key to the families

- 1(2) Cirlet of apical mambranelles "open" Family Halteriidae
 2(1) Peristomial field entirely apical with cirlet of apical mambranelles "closed".....
 Family Strobilidiidae

Family HALTERIIDAE

Genus *Halteria* Dujardin1841. *Halteria* Dujardin, *Histoire nat. Zoophytes infusoires*, Paris, p. 414.1932. *Halteria* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*). Jena, pt. 25, p. 504.

Diagnosis : More or less globose and constant in form, oral aperture terminal, eccentric, associated with a wreath of large cilia; a zone of long stiff springing bristles developed around the equatorial region of the body.

51. *Halteria grandinella* (O. F. Muller)1773. *Trichoda grandinella* O. F. Muller, *Verminum terrest. et fluviatil S. animal infusor., etc., historia*. Havniae et Lipsiae, p. 77.1932. *Halteria grandinella* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 505.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; sev. exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A. K. Das; sev. exs., Nongstoin, West Khasi Hills, 28.iii.1991.

Diagnosis : Body subglobose, dimensions 32-40 μm \times 28-30 μm ; about seven bristle-bearing grooves, fifteen frontal and seven adoral membranellae; springing bristles very long and fine, forming a central girdle; macronucleus oval to kidney-shaped; contractile vacuole single and located at the anterior half of the body.

Distribution : India : Meghalaya (West Garo Hills, East Garo Hills and West Khasi Hills districts) and West Bengal; common in stagnant water of ponds.

Family STROBILIDIIDAE

Genus *Strobilidium* Schewiakoff1893. *Strobilidium* Schewiakoff, *Mem. Acad. Sci. de St. Petersb.* (7) 41, p. 1-201.1932. *Strobilidium* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*). Jena, pt. 25, p. 508.

Diagnosis : Turnip-shaped, oral aperture apical and without cytopharynx, macronucleus horse-shoe shaped and located at the anterior end.

52. *Strobilidium gyrans* (Stokes)

1887. *Strobilidium gyrans* Stokes, *J. roy. micros. Soc.*, 7, p. 35-40.

1893. *Strobilidium adhaerens* Schewiakoff, *Mem. Acad. Sci. de St. Petersb.*, (7)41, p. 1-201.

1932. *Strobilidium gyrans* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 510.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; sev. exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A. K. Das; sev. exs., Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body turnip-shaped or pyriform, posterior end truncate or with knob-like projection, 50-60 μm in length, anterior end of the body provided with a crown of cilia, macronucleus horseshoe shaped, contractile vacuole single and located below the middle of the body.

Distribution: India : Meghalaya(West Garo Hills, East Khasi Hills and West Khasi Hills districts), Rajasthan and West Bengal; in freshwater.

Order HYPOTRICHIDA

Key to the families

- 1(4) Ventral cirri generally small and inconspicuous and typically arranged in 3-12 longitudinal rows, marginals common
- 2(3) Ventral cirri arranged in helically spiralled rows, right and left marginal cirri not present Family Spirofilidae
- 3(2) Ventral cirri arranged in straight rows, right and left marginal cirri present Family Holostichidae
- 4(1) Ventral cirri typically heavy and conspicuous and arranged in specific localised groups, marginal cirri often absent or else reduced
- 5(6) Distinctive rows of right and left marginal cirri present; (adoral zone of membranellae restricted to anterior third or quarter of the elongated body)Family Oxytrichidae
- 6(5) Marginal cirri absent or greatly reduced.
- 7(8) Oral ciliature prominent, usually extending more than half the length of body, transverse and frontoventral cirri tremendously developed, heavy and very conspicuous, dorsal surface not ribbed, ridged or humped Family Euplotidae
- 8(7) Oral ciliature poorly developed, oral membranellae located centrally and inconspicuously on the ventral surface of the body, dorsal surface often distinctly ribbed, ridged or humped Family Aspidiscidae

Family SPIROFILIDAE
Genus *Stichotricha* Perty

1852. *Stichotricha* Perty, *Zur Kenntniss Kleinster Lebensformen nach Bau, Funktionen, Systematic. mit Specialverzeichniss der in der Schweiz beobachteten*, 1952, Jent & Reinert, Bern, p. 228.

1979. *Stichotricha* : Corliss, *The Ciliated Protozoa*, 2nd Ed., Pergamon Press. p. 308.

Diagnosis : Body slender, peristome bearing part beak-like/narrowed, peristome extending over one-fourth of the body-length.

53. *Stichotricha socialis* Gruber

1880. *Stichotricha socialis* Gruber, *Zeitschr. f. Wiss. Zool.*, 33.

1932. *Stichotricha socialis* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 557.

Material examined : 2 exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A. K. Das; 1 ex., Ward lake, Shilliong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body slender, ovoid, anterior end gradually attenuated and posterior end rounded; 108-127 μm in length; peristome extending more than half of the body; four spiral rows of ventral cirri present, living in gelatinous colonial tubes.

Distribution : India : Meghalaya (East Garo Hills and East Khasi Hills districts) and West Bengal; in freshwater.

Family HOLOSTICHIDAE
Genus *Gonostomum* Sterki

1878. *Gonostomum* Sterki, *Z. Wiss. Zool.*, 31, p. 57.

1932. *Gonostomum* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 598.

Diagnosis : Body form variable, elongated to elongate-oval; eight or more frontals; one to two oblique ventral rows of short cirri; four or five anals. two rows of marginal cirri present.

Remarks : Corliss (1969) placed this genus under the family Holostichidae and suborder Stichotrichina and opines that "the family seems over large" and some genera should be removed from the family. He also thinks (*op. cit.*) that the genus *Gonostomum* belongs to the suborder Sporadotrichina and perhaps family Oxytrichidae.

Since ventral cirri are conspicuous and arranged in specific localised group in the genus *Gonostomum* the present authors agree with the opinion of Corliss. (*op. cit.*). However, for proper systematic rearrangement of this genus more critical analysis and comparison with other related genera are needed.

54. *Gonostomum affine* (Stein)

1859. *Oxytricha affinis* Stein, *Der Organismus der Infusionsthier nach eigenen Forschungen in systematischer Reihenfolge bearbeitet* – I. Leipzig., p. 186-187.

1880-82. *Plagiotricha (Gonostomum) affinis* Kent. *A Manual of the Infusoria*. London. p. 772.

1887-89. *Gonostomum affine* Butschli, *Protozoa*, Vol. 3. Leipzig., pl. 71, fig. 8.

1929. *Gonostome andoi* Shibuya, *Proc. Imp. Acad. Tokyo*, 5, p. 155.

Material examined : 3 exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das.

Diagnosis : Body elongate-oval, both anterior and posterior ends rounded; length 94-108 μm , peristome reaching up to the middle of the body sometimes making a sharp bent near its hind end; frontal cirri eight, ventral cirri five or six arranged in an oblique row, marginal cirri uninterrupted at posterior end, anal cirri four; macronucleus bipartite and distributed in two elongated ovoid masses in either half of the body; contractile vacuole single, located near the left margin, about the middle of the body.

Distribution : India : Meghalaya(West Garo Hills District); Delhi, Jammu and Kashmir, Karnataka, Maharastra, Punjab, Tamil Nadu and Uttar Pradesh.

Remarks : This species is reported as common from soil in India (see Bhatia, 1936). However, the present material has been collected from freshwater in Tura.

Family OXYTRICHIDAE

Genus *Oxytricha* Bory

1926. *Oxytricha* Bory, *Essai d'une Classification des Animaux Microscopiques*. Paris, p. 104.

1932. *Oxytricha* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 599.

Diagnosis : Body ellipsoid and flexible, frontal cirri eight, both ventral and anal cirri five, short or no caudal cirri, marginal cirri may or may not be continuous along posterior border; macronucleus bipartite, rarely single or in four parts.

Key to the species

- 1(2) Anterior half of the body broader than posterior half, posterior end pointed, body length around 250 μm *O. bifaria*
- 2(1) Posterior half of the body broader than anterior half, posterior region broadly rounded, body-length around 150 μm *O. fallax*

55. *Oxytricha bifaria* Stokes

1887. *Oxytricha bifaria* Stokes, *Ann. Mag. Nat. Hist.* (5) 20 pp. 104-114.

1932. *Oxytricha bifaria* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 602.

Material examined : 2 exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 3 exs., Nongstoin, West Khasi Hills, 28.iii.1991, coll. A. K. Das.

Diagnosis : Body ellipsoid, right side convex, left side flattened, anterior half broader than posterior half, posterior end of the body pointed while anterior end broadly rounded; dimensions 235 μm – 254 μm \times 80-90 μm ; arrangement of cirri as in the genus; macronucleus bipartite, contractile vacuole single and located near the middle of the body.

Distribution .: India : Meghalaya (West Garo Hills and West Khasi Hills districts); in freshwater.

Remarks : This species is reported for the first time from India.

56. *Oxytricha fallax* Stein

1859. *Oxytricha fallax* Stein, *Der Organismus Infusionsthier*, Leipzig, 1, p. 189.

1932. *Oxytricha fallax* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 602.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Ellipsoidal, both left and right sides convex; posterior half broader than anterior, posterior region broadly rounded, dimensions 148-155 μm \times 60-70 μm ; arrangement of cirri as in the genus; macronucleus usually in two parts, contractile vacuole single and located at the anterior half of the body.

Distribution : India : Meghalaya (West Garo Hills district), Rajasthan and West Bengal; in freshwater.

Family ASPIDISCIDAE

Genus *Aspidisca* Ehrenberg

1830. *Aspidisca* Ehrenberg, *Abhandl. d. Konigl. Akad. d. Wissensch. zu Berlin, a. d. J. 1830* (1832), p. 42.

1932. *Aspidisca* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 6-13.

Diagnosis : Small, ovoid or shield-shaped, dorsal surface conspicuously ridged. cirri strong and long; adoral zone reduced or rudimentary; frontoventral cirri seven. anal cirri five to twelve; macronucleus curved or horse-shoe shaped.

57. *Aspidisca costata* (Dujardin)

1841. *Cocquidia costata* Dujardin, *Histoire nat des Zoophytes Infusoires*, p. 446.

1858-61. *Aspidisca costata* Claparede and Lachmann, *Etudes sur les infusoires et les rhizopodes*, Geneve, p. 190.

Material examined : Sev. exs., Rongram River, West Garo Hills, 23.iii.1991, coll. A. K. Das; sev. exs., Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body more or less ovate, dimensions 30-40 μm \times 25 μm ; rounded at both ends; dorsal surface convex with five to six distinct longitudinal ridges; peristome starting from the anterior end of the body and extending up to anal cirri; seven fronto-ventral and five anal cirri present; macronucleus curved; contractile vacuole single and located at posterior half.

Distribution : India : Meghalaya (West Garo Hills and East Khasi Hills districts), Uttar Pradesh and West Bengal; in freshwater.

Family EUPLOTIDAE

Genus *Euplotes* Ehrenberg

1830. *Euplotes* Ehrenberg, *Abhandl. d. Konigl. Akad. d. Wissensch. zu Berlin, a. d. J.* 1830 (1832), p. 42.

1932. *Euplotes* : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 628.

Diagnosis : Body ovoid, peristome well developed and broadly triangular; ventral surface flattened, dorsal surface convex, longitudinally ridged; fronto-ventral cirri more than nine; anal cirri well developed and five in number, caudal cirri four and scattered.

58. *Euplotes patella* (Muller)

1773. *Trichoda patella* Muller, O. F., *Verminum terrest. et. fluviatil S. animal. infusor., etc., historia*, Havniac et Lipsae.

1960. *Euplotes patella* : Tuffrau, *Hydrobiologia*, 15, p. 40.

Material examined : 1 ex., Tura, West Garo Hills, 19.iii.1991, coll. A. K. Das; 1 ex., William Nagar, East Garo Hills, 26.iii.1991, coll. A. K. Das; 2 exs., Ward lake, Shillong, East Khasi Hills, 2.iv.1991, coll. A. K. Das.

Diagnosis : Body oval to elliptical, truncate anteriorly, dimensions 85-92 μm \times 68-77 μm ; anterior collar less prominent; peristomal lip large and hyaline; nine latero-ventral, nine fronto-ventral, five transverse and four caudal cirri present; macronucleus resembling inverted C .

Distribution : India : Meghalaya (West Garo Hills, East Garo Hills and East Khasi Hills districts), Orissa, Rajasthan and West Bengal; in freshwater.

PARASITIC PROTOZOA

2 SYSTEMATIC LIST

Phylum	SARCOMASTIGOPHORA
Class	ZOOMASTIGOPHOREA
Order	KINETOPLASTIDA
Family	BODONIDAE
Genus	<i>Bodomonas</i> Davis

1. *B. rebae* Tripathi

Catla Catla

Cirrhina mrigala

Family TRYPANOSOMATIDAE

Genus *Trypanosoma* Gruby

Parasites of fishes

2. *T. batrachi* Quadri *Clarius batrachus*

3. *T. granulosum* Leveran and Mesnil Eel

Parasites of amphibians

4. *T. inopinatum* Sergent and Sergent *Rana tigerina*

5. *T. rotatorium* (Meyer) *Bufo melanostictus*

Parasite of bird

6. *T. avium* Danilewsky *Dicrurus adsimilis*

Dendrocita vagabunda

Parasite of mammal

7. *T. lewsi* (Kent) *Rattus rattus*

Order RETORTOMONADIDA

Family CHILOMASTIGIDAE

Genus *Chilomastix* Alexeieff

8. *C. caprae* Fonseca *Capra hircus*

Order TRICHOMONADIDA

Family TRICHOMONADIDAE

Genus *Trichomonas* Donne

9. *T. ruminantium* Braune *Capra hircus*

Class OPALINATEA

Order OPALINIDA

Family OPALINIDAE

Genus *Cepedia* Metcalf

10. *C. longa* (Bezenberger) *Bufo melanostictus*

Genus *Opalina* Purkinje and Valentin

11. *O. lata* Bezenberger *Rana cyanophlyctis*

12. *O. plicata* Ghosh *Bufo melanostictus*

Parasites of birds

- | | |
|--------------------------------------------|---------------------------|
| 23. <i>C. acervulina</i> Tyzzer | <i>Gallus</i> sp. |
| 24. <i>E. columbae</i> Mitra and Das Gupta | <i>Columba intermedia</i> |
| 25. <i>E. labbeana</i> (Labbe) | -do- |
| 26. <i>E. maxima</i> Tyzzer | <i>Gallus</i> sp. |
| 27. <i>E. necatrix</i> Johnson | <i>Gallus</i> sp. |

Parasites of mammals

- | | |
|---------------------------------------------|---------------------|
| 28. <i>E. ahsata</i> Honess | <i>Capra hircus</i> |
| 29. <i>E. arloingi</i> (Marotel) | -do- |
| 30. <i>E. faurei</i> (Moussu and Marotel) | -do- |
| 31. <i>E. intricata</i> Spiegel | -do- |
| 32. <i>E. neodeblicki</i> Vetterling | <i>Sus scrofa</i> |
| 33. <i>E. parva</i> Koltan, Mocsy and Vajda | <i>Capra hircus</i> |
| 34. <i>E. spinosa</i> Henry | <i>Sus scrofa</i> |
| 35. <i>Eimeria</i> sp. | Domestic cow |

Genus *Isospora* Schneider

- | | |
|-----------------------------------------|---------------------|
| 36. <i>I. wenyoni</i> Ray and Das Gupta | <i>Rana tigrina</i> |
|-----------------------------------------|---------------------|

Parasites of reptiles

- | | |
|------------------------------------------|-----------------------------------------------|
| 37. <i>I. minuta</i> Mitra and Das Gupta | <i>Naja naja</i>
<i>Ophiophagus hannah</i> |
| 38. <i>I. rayi</i> Mandal | <i>Ptyctolaemus</i> sp
(Garden lizard) |

Parasities of birds

- | | |
|--------------------------------------------|-------------------------------------------------------|
| 39. <i>I. corvae</i> Ray <i>et al.</i> | <i>Corvus macrorhynchus</i>
<i>intermedia</i> |
| 40. <i>I. garrulusae</i> Ray <i>et al.</i> | <i>Garrulus glandarius</i>
<i>bipularis</i> |
| 41. <i>I. lacazei</i> (Labbe) | <i>Passer domesticus</i>
<i>Pycnonotus jocosus</i> |

42. *I. parusi* Ray *et al.* *Parus dichrurus*
Parasites of mammals
43. *Isospora* sp. Domestic cow
Genus **Wenyonella** Hoare
44. *W. bahli* Misra *Coturnix communis*
45. *W. mackinnoi* Misra *Motacilla alba*
Family PLASMODIIDAE
Genus **Plasmodium** Marchiava and Celli
46. *P. falciparum* (Welch) *Homo sapiens*
47. *P. malariae* Laveran *Homo sapiens*
48. *P. vivax* (Grassi and Feletti) *Homo sapiens*
Family HAEMOPROTEIDAE
Genus **Haemoproteus** Kruse
49. *H. columbae* Kruse *Columba livia*
50. *H. dicruri* de Mello *Dicrurus adsimilis*
51. *H. oryzivora* Anschütz *Copsychus saularis*
52. *H. zosteropsis* Chakravarty *Zosterops palpebrosa*
Order PIROPLASMIDA
Family BABESIIDAE
Genus **Babesia** Starcovici
53. *B. motasi* Wenyon *Ovis* sp.
Phylum CILIOPHORA
Class KINETOFRAGMINOPHOREA
Order TRICHOSTOMATIDA
Family BALANTIDIIDAE
Genus **Balantidium** Claparede and Lachmann
54. *B. helenae* Bezenberger *Rana cyanophlyctis*
Rana tigrina
55. *B. rotundum* Bezenberger *Rana tigrina*

Class POLYHYMENOPHOREA
 Order HETEROTRICHIDA
 Family NYCTOTHERIDAE
 Genus *Nyctotherus* Leidy

56. *N. ovalis* Leidy *Periplaneta americana*

Genus *Nyctotheroids* Grasse

57. *N. cordiformis* (Ehrenberg) *Bufo melanostictus*

Family SICUOPHORIDAE

Genus *Sicuophora* de Puytorac and Grain

58. *S. macropharyngeus* (Bezenberger) *Rana tigrina*

TAXONOMIC ACCOUNT

Phylum SARCOMASTIGOPHORA
 Class ZOOMASTIGOPHOREA
 Order KINETOPLASTIDA

Key to the families

- 1(2) **Body ovoid or elongate with two heterodynamic flagella, of which one directed anteriorly and, the other directed posteriorly and trailing, adbasal kinetoplast arranged in several discrete bodies or dispersed throughout mitochondrion.....Family Bodonidae**
- 2(1) **Body characteristically leaf-like with a single flagellum attached to the body by undulating membrane, kinetoplast relatively small and compact.....Family Trypanosomatidae**

Family BODONIDAE

Genus *Bodomonas* Davis

1947. *Bodomonas* Davis, *Fishery Bull. Fish and Wildlife Service*, 51 (41), pp. 1-29.

Diagnosis : Body elongate with a small depression at anterior end; flagella two in number: anterior flagellum small, posterior flagellum long and trailing.

1. *Bodomonas rebae* Tripathi

1954. *Bodomonas rebae* Tripathi, *Rec. Indian Mus.*, **52**, p. 221.

Material examined : 5 exs., Shillong market, East Khasi Hills, 18.xi. 1988, coll.A.K. Mandal; 3 exs., Tura, West Garo Hills, 25.xi. 1988, coll. A.K. Mandal.

Diagnosis : Body elongate with broad and flattened anterior end and tapering posterior end; cytoplasm granular, contractile vacuole round; cytopharynx present as a small depression at the anterior end; nucleus spherical; flagella two in number, anterior one small and the posterior one extending beyond the posterior end of the body.

Host : *Cirrhina mrigala* and *Catla catla* ; site of infection : skin.

Distribution : India : Meghalaya (East Khasi Hills and West Garo Hills district) and West Bengal.

Family TRYPANOSOMATIDAE

Genus *Trypanosoma* Gurby

1843. *Trypanosoma* Gurby, *C. R. Acad. Sci.*, **17**, p. 1134.

Diagnosis : Body highly flattened, leaf-like, pointed at flagellar end and bluntly rounded or pointed at the opposite end; flagellum arising from a blepharoblast running towards opposite end and making the outer boundary of the undulating membrane. polymorphism common, parasitic in the circulatory system of vertebrates.

Remarks : Six species of *Trypanosoma* have been collected from the state, of which 2 are recovered from fishes, 2 from amphibians and one each from birds and mammals respectively. Host-wise key to these species is given below since these are host specific at least in their hosts class level.

Key to the species of Trypanosoma of fishes

- 1(2) Trypomastigote form monomorphic, nucleus located towards anterior half of the body having chromatin granules concentrated at the centre, length of cell body 60-80 μm *T. granulorum*
- 2(1) Trypomastigote form dimorphic, nucleus located towards posterior half of the body and always encircled with a clear halo, cell body in large form measuring 25-30 μm*T. batrachi*

2. *Trypanosoma batrachi* Quadri

1962. *Trypanosoma batrachi* Quadri, *Parasitology*, **52**, p. 225.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18.xi.1988, coll.A.K. Mandal; sev. exs., Tura market, West Garo Hills, 27.xi.1988, coll. A.K. Mandal.

Diagnosis : Trypomastigote form dimorphic, cytoplasm granular, volutin granules present sometimes as compact mass, nucleus situated towards posterior end and always encircled with a clear halo; cell body in large form measuring 22-30 μm with long flagellum, 8-15 μm in length.

Host : *Clarius batrachus*; site of infection : blood.

Distribution : India : Meghalaya (East Khasi Hills and West Garo Hills districts), Andhra Pradesh and West Bengal.

3. *Trypanosoma granulosum* Levern and Mesnil

1902. *Trypanosoma granulosum* Levern and Mesnil, *Arch. Protistenk.*, 1, p. 475.

Material examined : Sev. exs., William Nagar, East Garo Hills, 2.xii.1988, coll. A.K. Mandal.

Diagnosis : Trypomastigote form monomorphic, attenuated at both ends; cytoplasm highly granular towards anterior half of the body where bean shaped nucleus also located. chromatin granules concentrated at central portion of nucleus; undulating membrane distinct; length of the cell body 20-35 μm .

Host : Eel; site of infection : blood.

Distribution : India : Meghalaya (East Garo Hills district) and West Bengal.

Key to the species of Trypanosoma of amphibians

- 1(2) Trypomastigote form monomorphic, cytoplasm granular and vacuolated at the anterior half of the body, striated myonemes as in following species lacking.....
*T. inopinatum*
- 2(1) Trypomastigote form pleomorphic, cytoplasm densely granular in the posterior two-third of the body, 2-3 striated myonemes present along longitudinal axis.....*T. rotatorium*.

4. *Trypanosoma inopinatum* Sergent and Sergent

1904. *Trypanosoma inopinatum* Sergent and Sergent, *C. r. Seanc. soc. Biol.*, 56, p. 128.

Material examined : 4 exs., Thadleskein, Jaintia Hills, 21.xi.1988, coll. A.K. Mandal.

Diagnosis : Trypomastigote form monomorphic, elongate, tapering at both ends; cytoplasm granular and vacuolated at anterior half of the body; nucleus elliptical, situated near the centre of the body, flagellum when present very short; length of the cell body 30-35 μm .

Host : *Rana tigerina*; site of infection : blood.

Distribution : India : Meghalaya (Jaintia Hills district) and West Bengal.

5. *Trypanosoma rotatorium* (Mayer)

1843. *Amoeba rotatorium* Mayer, *Des haematozoaires* (Ph.D. Thesis).

1901. *Trypanosoma rotatorium* Leveran and Mesnil, *C. r. Soc. Biol*, **53**, p. 678.

Material examined : 3 exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., Shillong, East Khasi Hills, 2.iv.1991, coll. A.K. Das.

Diagnosis : Trypomastigote form pleomorphic, forms termed as Type I, Type II and Type III; cytoplasm densely granular in the posterior two-third of the body, having 2-3 striated myonemes along longitudinal axis; length of the cell body 30-35 μm .

Host : *Bufo melanostictus*, *Rana tigerina*; site of infection : blood.

Distribution : India : Meghalaya (West Khasi Hills and East Khasi Hills districts), Andaman islands, Goa, Orissa, Tripura and West Bengal.

Trypanosoma from bird

A single species of *Trypanosoma* as follows has been collected from birds of Meghalaya.

6. *Trypanosoma avium* Danilewsky

1885. *Trypanosoma avium* Danilewsky, *Biol. Centralbl.*, **5**, p. 529.

Material examined : Sev exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. Mandal; sev. exs. William Nagar, East Garo Hills, 2.xii.1988, coll. A.K. Mandal.

Diagnosis : Highly pleomorphic, sometimes attaining a great size, length varying from 26-60 μm or even more; kinetoplast elliptical, stained deep red and situated a long distance away from the posterior end; nucleus oval, located almost at the middle of the body; free flagellum short.

Host : *Dicrurus adsimilis*, *Dendrocita vagabunda*; site of infection: blood.

Distribution : Meghalaya (East Khasi Hills and East Garo Hills districts), Delhi, Jammu and Kashmir and West Bengal.

Remarks : It is a cosmopolitan species with worldwide distribution.

Trypanosoma from mammal

A single species viz., *Trypanosoma lewisi* was recovered from mammalian host, that too, from rodents from this state as follows.

7. *Trypanosoma lewisi* (Kent)

1880. *Herpetomonas lewisi* Kent, *A Manual of the Infusoria*, London.

1901. *Trypanosoma lewisi* Leveran and Mesnil. *Ann. Inst. Pasteur*, 15, p. 673.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. Mandal.

Diagnosis : Trypomastigote form monomorphic, cell body measuring 21-36.5 μm ; nucleus oval, situated at the anterior half of the body; free flagellum measuring 7.2-7.8 μm .

Host : *Rattus rattus* ; site of infection: blood.

Distribution : India : Meghalaya (East Khasi Hills district), West Bengal and sporadically reported from other states.

Order RETORTOMONADIDA

Family CHILOMASTIGIDAE

Diagnosis : Flagellates having four flagella of which three anteriorly and one posteriorly directed, the last one undulating in the cytostomal cleft.

Genus *Chilomastix* Alexeieff

1910. *Chilomastix* Alexeieff, *Arch. zool. exp.*, 6, N & R, p. 1.

1926. *Chilomastix* : Wenyon, *Protozoology*, 1, Bailliere, Tindal and Cox, p.621.

Diagnosis : Body pyriform, with a large cytostomal cleft at anterior end; three longer flagella anteriorly directed, fourth flagellum short and undulating within the cleft.

8. *Chilomastix caprae* Fonseca

1915. *Chilomastix caprae* Fonseca. *Mem. Inst. Oswald. Cruz.*, 8, p. 5.

Material examined : Sev. exs., Tura market, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., William Nagar market, East Garo Hills, 26.iii.1991, coll. A.K. Das.

Diagnosis : Body small, pear-shaped, 9-10 μm \times 4-6 μm in dimensions; flagella four in number and their disposition same as in the genus.

Host : *Capra hircus*; site of infection : rumen.

Distribution : India : Meghalaya (West Garo Hills and East Garo Hills districts) and West Bengal.

Order TRICHOMONADIDA

Family TRICHOMONADIDAE

Diagnosis : Anterior flagella variable in number, undulating membrane bordered by a flagellum, a definite cytostome present, axostyle often conspicuous and protruding from the posterior end of the body, a filamentous costa arising from the blepharoplast.

Genus *Trichomonas* Donne

1837. *Trichomonas* Donne, *Recherches microscopiques* etc., Paris.

1926. *Trichomonas* : Wenyon, *Protozoology*, 1, Bailliere, Tindell and Cox, p. 648.

Diagnosis : More or less pyriform, anterior flagella free and four in number, fifth flagellum posteriorly directed along the outer margin of the undulating membrane, axostyle protruding out of the posterior end of the body ; costa lying at the base of the membrane.

9. *Trichomonas ruminantium* Braune

1913. *Trichomonas ruminantium* Braune, *Arch. Protistenk.*, 32, p. 111.

Material examined : Sev. exs., Tura market, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., William Nagar market, East Garo Hills. 26.iii.1991, coll. A.K. Das.

Diagnosis : Body roughly pyriform, dimensions 8-17 μm \times 5-15 μm , axostyle rigid and protruding out of the posterior end of the body.

Host : *Capra hircus*; site of infection : rumen.

Distribution : Meghalaya (West Garo Hills and East Garo Hills districts) and West Bengal.

Class OPALINATEA

Order OPALINIDA

Family OPALINIDAE

Diagnosis : Numerous cilia in oblique longitudinal rows over the entire body surface; cytostome absent, nucleus of one kind ranging from one to many.

Key to the genera

- 1(2) **Body highly flattened, multinucleate, ellipsoidal in cross section**Genus *Opalina*.
- 2(1) **Body cylindrical or pyriform, multinucleate, circular in cross section**Genus *Cepedia*.

Genus *Cepedia* Metcalf

1920. *Cepedia* Metcalf. *Science*, **52**, p. 135.

Diagnosis : As in the key above.

10. *Cepedia longa* (Bezzemberger)

1904. *Opalina longa* Bezzemberger. *Arch. Protistenk.*, **3**, p. 138.

1923. *Cepedia longa* Metcalf. *Bull. U.S. Mus.*, **120**, p. 168.

Material examined : 8 exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. Mandal; sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das.

Diagnosis : Body greatly elongated, rounded in front and tapering posteriorly to a point, length 200-600 µm; endoplasm with thick central zone of compact alveolai and loose peripheral zone; nuclei many, ellipsoidal or spherical.

Host : *Bufo melanostictus*; site of infection: rectum.

Distribution : India : Meghalaya (East Khasi Hills, West Garo Hills and East Garo Hills districts) and West Bengal.

Genus *Opalina* Purkinje and Valentin

1835. *Opalina* Purkinje and Valentin. *De Phaenomeno generali et fundamentali, etc.*, Bratislavac, p.43

1923. *Opalina* : Metcalf. *Bull. U.S. Mus.*, **120**, p. 175.

Diagnosis : As in the key above.

Key to the species

- 1(4) **Body more or less rounded**
- 2(3) **Body oval, anterior half more or less triangular, dorsal surface without any ridge**.....
.....*O. lata*
- 3(2) **Body broadly or elongately ovate (slightly longer than broad), tapering and rounded anteriorly, dorsal surface with two or four ridges**.....*O.plicata*
- 4(1) **Body oblanccolate**

- 5(6) Body about twice as long as broad.....*O. triangularis*
 6(5) Body about three to five times as broad.....*O. scalpriformis*.

11. *Opalina lata* Bezenberger

1904. *Opalina lata* Bezenberger, *Arch. Protistenk* **3**, pp. 166-167.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. Mandal; sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das.

Diagnosis : Body oval, anterior half more or less triangular, 250-300 μm \times 185-230 μm in dimensions, greatest width near the middle of the body; nuclei numerous.

Host : *Rana cyanophlyctis* ; site of infection : intestine and rectum.

Distribution : India : Meghalaya (East Khasi Hills and West Garo Hills districts) and Goa.

12. *Opalina plicata* Ghosh

1919. *Opalina plicata* Ghosh, *Proc. Indian Assoc. cult. Sci.*, **4**, p. 102.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. Mandal; sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das.

Diagnosis : Body broadly or elongately ovate, tapering and rounded anteriorly, wide and rounded posteriorly, dorsal surface with two or four ridges.

Host : *Bufo melanostictus* ; site of infection : intestine and rectum.

Distribution : India : Meghalaya (East Khasi Hills, East Garo Hills and West Garo Hills districts) and West Bengal.

13. *Opalina scalpriformis* Ghosh

1919. *Opalina scalpriformis* Ghosh, *Proc. Indian Assoc. cult. Sci.*, **4**, p. 103.

Material examined : Sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das; sev. exs., William Nagar, East Garo Hills, 26.iii.1991, coll. A.K. Das.

Diagnosis : Body elongated, cylindrical, rounded anteriorly and narrower posteriorly; anterior part of the body with several longitudinal folds or ridges, dimensions 175-200 μm \times 60-80 μm , nuclei numerous..

Host : *Bufo melanostictus* ; site of infection : intestine and rectum.

Distribution : India : Meghalaya (West Garo Hills and East Garo Hills districts), Goa, Uttar Pradesh and West Bengal.

14. *Opalina triangularis* Ghosh

1919. *Opalina triangularis* Ghosh, *Proc. Indian Assoc. cult. Sci.*, 4, p. 104.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. Mandal; sev. exs., Tura, West Garo Hills, 19.iii.1991, coll. A.K. Das.

Diagnosis : Body lanceolate, more or less rounded and wider anteriorly and tapering posteriorly; one side nearly straight or concave another side strongly convex, dimensions 85-250 μm \times 40-135 μm , nuclei many.

Host : *Bufo melanostictus* ; site of infection : intestine and rectum.

Distribution : India : Meghalaya (East Khasi Hills and West Garo Hills districts), Goa and West Bengal.

Phylum	APICOMPLEXA
Class	SPOROZOEA
Order	EUGREGARINIDA

Key to the families

- 1(2) Trophozoites without any marked differentiation at the anterior end, sporocysts biconical with similar nonappendiculate polesFamily Monocystidae
- 2(1) Trophozoites with an anterior sucker-like epimeritic organ, sporocysts navicular with similar nonappendiculate and truncate poles..... Family Stomatophoridae

Family	MONOCYSTIDAE
Genus	<i>Monocystis</i> stein

1848. *Monocystis* Stein, *Arch. Anat. Phys. Wiss. Med.*, pp. 183-223.

Diagnosis : Trophozoites ovoid, solitary, often provided with an inconspicuous micron at the anterior pole; sporocysts as for the family.

15. *Monocystis bengalensis* Ghosh

1919. *Mynocystis bengalensis* Ghosh, *J. roy. microsc. Soc.*, p. 423.

Material examined : Sev. exs., Thadleskein, Jaintia Hills, 21.Xii.1988, coll A.K. Mandal.

Diagnosis : Mature trophozoites elongated and club-shaped, dimensions 40-80 μm \times 12-30 μm , ectoplasm very thin and endoplasm highly granular, myonemes indistinct; nucleus rounded with a large irregular karyosome; gametocysts irregularly hemispherical, 70-80 μm in diameter; gametocytes rounded or oval.

Host : *Metaphire posthuma* (Annelida : Oligochaeta) ; site of infection : seminal vesicle.

Distribution : India : Meghalaya (Jaintia Hills district) and West Bengal.

Family STOMATOPHORIDAE

Genus *Stomatophora* Drzeweeki

1907. *Stomatophora* Drzeweeki, *Arch. Protistenk.*, **10**, p. 216.

Diagnosis : Trophozoites ovoid, or spherical, anterior end provided with a sucker-like epimerite, sucker petaloid, with radiating sides, oocysts biconical, with flattened button at each end, attached to each other end to end in a long chains inside gametocysts.

16. *Stomatophora diadema* Hesse

1909. *Stomatophora diadema* Hesse, *Arch. zool. exp. gen.* (5) **3** pp. 187-189.

Material examined : 2 exs., Shillong, East Khasi Hills, 16.xi.1988, coll A..K. Mandal.

Diagnosis : Trophozoite spherical, compressed, disc-like, 105 μm in diameter, marked by furrows and irregular lobes; sucker a shallow cup-like depression in the centre of the body, with a central conical projection; nucleus rounded or oval, eccentric, with a large karyosome, gametocysts spherical, 125-170 μm in diameter; sporocysts navicular with truncated ends.

Host : *Metaphire posthuma* (Annelida : Oligochaeta) ; site of infection : seminal vesicle.

Distribution : India : Meghalaya (East Khasi Hills district) and West Bengal.

Order EUCOCCIDA

Key to the families

- 1(2) Macrogamete and microgamont usually associated in syzygy during development, microgamont producing 1-4 microgametes, (zygote active, life cycle involving two hosts, one vertebrate and other invertebrates (leech).....Family Haemogregarinidae
- 2(1) Macrogamete and microgamont developing independently, syzygy absent, microgamont producing many microgametes
- 3(4) Sporozoite typically enclosed in sporocyst within oocyst, zygote non motile, (homoxenous, merogony and gamogony within hosts, sporogony typically outside, sporozoites never in blood cell).....Family Eimeriidae

- 4(3) Sporozoite naked, with three membrane wall, zygote motile (ookinete)
- 5(6) Parasite having sexual phase in mosquito and asexual cycle in tissue and blood cells of vertebrate host, distinguished by erythrocytic schizogony.....Family Plasmodiidae
- 6(5) Parasite having sexual phase in insects other than mosquito and asexual cycle in tissue cells of vertebrate host, erythrocytic schizogony lacking, (pigmented gametocytes in erythrocytes of vertebrate hosts).....Family Haemoproteidae.

Family HAEMOGREGARINIDAE

Genus *Haemogregarina* Danilewski

1885. *Haemogregarina* Danilewski, *Arch. micr. Anat.*, 24, pp. 588-598.

Diagnosis : Oocysts with 8 or more naked sporozoites, infection of vertebrate host by bite of invertebrate, schizogony occurring in erythrocytes of vertebrates.

Key to the species

- 1(2) Both polar capsule and polar cap present, mature macrogametocyte sausage-shaped *H. nucleobiscens*
- 2(1) Polar capsules present but polar cap lacking, gametocyte typically elongate and straight, anterior end more or less rounded and posterior end pointed.....*H. berestneffi*

17. *Haemogregarina berestneffi* Castellani and Willey

1905. *Haemogregarina berestneffi* Castellani and Willey, *Q.J. Microsc. Sci.*, 49, p. 383.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi.1988, coll.A.K. Mandal.

Diagnosis : Gametocyte typically elongate and straight, anterior end more or less rounded and narrower while posterior end pointed; cytoplasm homogeneous, little granular at anterior end, nucleus rounded, oval or irregular in shape, situated centrally or little below towards posterior end.

Host : *Rana cyanophlyctis*, *Rana tigerina*; site of infection : blood.

Distribution : India : Meghalaya (East Khasi Hills district), Maharashtra, Tamil Nadu and West Bengal.

18. *Haemogregarina nucleobiscens* Shortt

1917. *Haemogregarina nucleobiscens* Shortt, *Indian J. Med. Res.*, 4, p. 402.

Material examined : Sev. exs., Tura, West Garo Hills, 25.xi.1988, coll. A.K. Mandal.

Diagnosis : Gametocyte sausage-shaped, slightly curved and lying usually with concave border applied to the nucleus of the host cell, nucleus rounded, oval, band-shaped, triangular or even irregular in outline, situated centrally containing a close network of granules and without any karyosome.

Host : *Bufo melnostictus* ; site of infection : blood.

Distribution : India : Meghalaya (West Garo Hills district), Delhi, Punjab and West Bengal..

Family EIMERIIDAE

Key to the genera

- 1(4) Each oocyst with two sporocysts.
- 2(3) Each sporocyst with four sporozoites.....Genus *Isospora*
- 3(2) Each sporocyst with eight sporozoites.....Genus *Dorisa*
- 4(1) Each oocyst with four sporocysts
- 5(6) Each sporocyst with two sporozoites.....Genus *Eimeria*.
- 6(5) Each sporocyst with four sporozoitesGenus *Wenyonella*

Genus *Dorisa* Levine

1980. *Dorisa* Levine, *J. Parasitol.*, **66**, p. 11

Diagnosis : Each oocyst with two sporocysts and each sporocyst with 8 sporozoites, occurring in vertebrate hosts.

19. *Dorisa vagabundae* (Mandal and Chakravarty)

1967. *Dorisiella vagabundae* Mandal and Chakravarty, *Proc. zool. Soc., Calcutta*, **16**, p. 147.

Material examined : Sev. exs., Jowai, Jaintia Hills, 19.xi.1988, coll. A.K. Mandal.

Diagnosis : Oocyst oval, double walled; outer wall thinner, micropyle seen in earlier stage; oocyst residium present; fully developed oocyst with pointed anterior and rounded posterior ends and with a less prominent steida body; sporozoite club-shaped, nucleus situated at rounded posterior end.

Host : *Dendrocitta vagabunda*; site of infection : intestine.

Distribution : India : Meghalaya (Jaintia Hills district) and West Bengal.

Genus *Eimeria* Schneider

1875. *Eimeria* Schneider, *Arch. zool. Exp. Gen.*, 4, p.493.

Diagnosis : Each oocyst with four sporocysts, each sporocyst with two sporozoites; merogony intracellular, sporogony extracellular, occurring in vertebrates, only a few in invertebrates.

Eimeria from fish host20. *Eimeria notopteri* Chakravarty and Kar

1944. *Eimeria notopteri* Chakravarty and Kar, *Curr. Sci.*, 13, p.51.

Diagnosis : Oocyst irregular in shape, double walled; micropyle and oocystic residuum absent; sporocyst oval with both ends bluntly pointed; sporocystic residuum absent; sporozoite elongated with one pointed and other rounded ends.

Host : Feather back, *Notopterus notopterus* and Chital, *Notopterus chitala*; site of infection: intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and West Bengal.

Remarks : Mandal (1976) recorded this species from both the hosts mentioned above, collected from Shillong market.

Eimeria from amphibian hosts

Key to the species

- 1(2) Oocyst spherical, measuring 9-11 μm in dimensions.....*E. laminata*
 2(1) Oocyst oval or subspherical, 15-20 μm x 15-18 μm in dimensions*E. cyanophlyctis*

21. *Eimeria cyanophlyctis* Chakravarty and Kar

1944. *Eimeiria cyanophlyctis* Chakravarty and Kar, *Proc. Indian Sci.congr.*, p. 104.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi.1988, coll. A.K. mandal.

Diagnosis : Mature oocyst oval, single walled, 15-20 μm x 15-18 μm in dimensions; micropyle absent, oocystic residum in the form of an irregular mass; sporocyst spindle-shaped, single layered, sporocystic residum scattered; sporozoite elongated with pointed anterior end.

Host : *Rana cyanophlyctis*; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and West Bengal.

22. *Eimeria laminata* Ray

1935. *Eimeria laminata* Ray, *Parasitology*, 27 p. 369.

Material examined : Sev. exs., William Nagar, East Garo Hill, 2. xii. 1988, coll. A.K. Mandal.

Diagnosis : Oocyst spherical, measuring 8.5-11 μm in diameter, oocyst wall double layered, outer one thicker than the inner one, oocystic residuum present ; sporocyst spindle-shaped, pointed at both ends and without any knob ; sporocystic residuum present ; sporozoite elongated and pointed at anterior end.

Host : *Bufo melanostictus* ; site of infection : intestine.

Distribution : India : Meghalaya (East Garo Hills district) and West Bengal.

*Eimeria from avian hosts**Key to the species*

- 1 (4) Oocyst with micropyle and without any oocystic residuum
- 2 (3) Oocyst egg-shaped or oval, smooth walled with uniformly thick double wall except at anterior end, mostly parasitic in domestic fowl *E. acervulina*
- 3 (2) Oocysts in two forms, oval or spherical, double walled, the outer one thinner, mostly parasitic in domestic pigeon *E. labbeana*
- 4 (1) Oocyst without any micropyle, oocystic residuum may or may not be present
- 5 (6) Sporulated oocyst ovoid or ellipsoidal with mean length more than 30 μm , a prominent 'steida' body present *E. maxima*
- 6 (5) Sporulated oocyst sub-spherical or broad-ovoid with mean length around 20 μm , 'steida' body not present
- 7 (8) Oocyst subspherical with oocystic residuum, parasitic in domestic pigeon *E. columbae*
- 8 (7) Oocyst broad-ovoid with one end less pointed, oocystic residuum absent, parasitic in domestic fowl *E. necatrix*

23. *Eimeria acervulina* Tyzzer

1929. *Eimeria acervulina* Tyzzer, *Am. J. Hyg.*, 10 ; 269.

Material examined : Sev. exs., Umsning, Ri-Bhoi district, 23. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst egg-shaped or oval, smooth walled with uniformly thick double wall except at anterior end where wall slightly thin, 18-20 μm \times 14-16 μm in dimensions ; micropyle present at the narrower end ; oocystic residuum absent.

Host : Domestic fowl, *Gallus* sp., site of infection : intestine.

Distribution : India : Meghalaya (Ri-Bhoi district), Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh.

24. *Eimeria columbae* Mitra and Das Gupta

1937. *Eimeria columbae* Mitra and Das Gupta, *Proc. Indian Sci. Congr.*, p. 291.

Material examined : Sev. exs., Tura, West Garo Hills, 25. xi. 1988, coll. A.K. Mandal ; sev. exs., William Nagar, East Garo Hills, 2. xii. 1988, coll. A.K. Mandal.

Diagnosis : Oocyst subspherical, double walled, outer one being thinner and membranous, oocyst measuring 15-17 μm \times 13-15 μm in dimension ; micropyle absent and oocystic residuum present.

Host : Domestic Pigeon, *Columba intermedia* ; site of infection : intestine.

Distribution : India : Meghalaya (West Garo Hills and East Garo Hills districts), Orissa and West Bengal.

25. *Eimeria labbeana* (Labbe)

1896. *Coccidium pfeifferi* Labbe, *Archs. zool. Exp. Gen.*, 4, p. 517.

1928. *Eimeria labbeana* Pinto, *C. r. Seanc. Soc. Biol.*, 98, p. 1571.

Material examined : Sev. exs., William Nagar, East Garo Hills district, 2. xii. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst in two forms, oval or spherical, double walled, of which outer one thinner, micropyle present and oocystic residuum absent ; sporocyst oval and sporozoite elongated in shape, sporocystic residuum appearing as a compact mass.

Host : Domestic Pigeon, *Columba intermedia* ; site of infection : intestine.

Distribution : India : Meghalaya (East Garo Hills district) and West Bengal.

26. *Eimeria maxima* Tyzzer

1929. *Eimeria maxima* Tyzzer, *Amm. J. Hyg.*, 10, p. 269.

Material examined : Sev. exs., Jowai, Jaintia Hills, 19. xi. 1988, coll. A. K. Mandal ; sev. exs., Umsning, Ri-Bhoi district, 23. xi. 1988, coll. A. K. Mandal.

Diagnosis : Sporulated oocysts ovoid or ellipsoidal, double walled, of which outer one thinner, 27-34 μm \times 16-28 μm in dimensions, oocystic residuum absent, a prominent 'steida' body present ; sporocyst ovoid, sporozoite elongated and provided with a large refractile globule on the broader end and small globule towards narrower end.

Host : Domestic fowl, *Gallus* sp; site of infection : intestine.

Distribution : India : Meghalaya (Jaintia Hills and Ri-Bhoi districts), Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh.

27. *Eimeria necatrix* Johnson

1930. *Eimeria necatrix* Johnson, *Ore. Agric. Expt. St.*, p. 119.

Material examined : Sev. exs., Thadleskein, Jaintia Hills, 21. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst broad-ovoid with one end less pointed, oocyst wall smooth and double contoured, 16-23 μm \times 14-16 μm in dimensions, micropyle absent, oocystic residuum present.

Host : Domestic fowl, *Gallus* sp. ; site of infection : intestine.

Distribution : India : Meghalaya (Jaintia Hills district), Tamil Nadu and Uttar Pradesh.

Eimeria from mammalian hosts

Key to the species

- 1 (2) Oocysts ellipsoidal, entire surface of oocystic wall covered by about 1 μm high spine *E. spinosa*
- 2 (1) Oocysts subspherical or ovoid to ellipsoidal, oocystic wall without any spine
- 3 (10) Micropyle present
- 4 (9) Micropyle with a polar cap present
- 5 (8) Polar cap crescent-shaped
- 6 (7) Oocyst ellipsoidal to ovoid, micropyle large and appearing as a wide gap below the crescent shaped polar cap, sporocyst pyramidal in shape *E. intricata*
- 7 (6) Oocyst typically ellipsoidal, crescent shaped polar cap lying above the micropyle without showing any gap, sporocyst elongate ovoid *E. arloingi*
- 8 (5) Micropylar cap not crescent shaped *E. ahsata*
- 9 (4) Prominant micropyle present at the narrower end of oocyst but with no cap over it *E. faurei*
- 10 (3) Micropyle absent
- 11 (12) Oocyst ellipsoidal, occasionally ovoid, larger, 17-26 μm \times 14-29 μm in dimensions, sporocyst broadly ovoid, parasitic in domestic pig *E. neodebliecki*
- 12 (11) Oocyst ellipsoid, ovoidal or subspherical, smaller, 14-19 μm \times 12-15 μm in dimensions, mostly parasitic in sheep and goat *E. parva*

28. *Eimeria ahsata* Honess

1942. *Eimeria ahsata* Honess, *Univ. Wyo. Agric. Exp. Stn.*, **249**, p. 3.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst ellipsoidal to ovoid, 40-45 μm \times 22-29 μm in dimensions, oocystic residuum absent, micropyle with micropylar cap present ; sporocyst elongate ovoid, 'steida' body absent, sporozoite banana-shaped.

Host : Domestic Goat, *Capra hircus* ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Orissa, Uttar Pradesh and West Bengal.

29. *Eimeria arloingi* (Marotel)

1905. *Coccidium arloingi* Marotel, *Rec. Med. Vet.*, **33**, p. 243.

1909. *Eimeria arloingi* Martin, *Rev. Vet.* (Toulouse), **34**, p. 201.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst typically ellipsoidal, a prominent crescent shaped polar cap lying just above the micropyle ; oocystic residuum absent ; sporocyst elongate ovoid ; 'steida' body absent or vestigial ; sporozoite elongated lying lengthwise, head to tail, within the sporocyst.

Host : Domestic Goat, *Capra hircus*, site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh and West Bengal.

30. *Eimeria faurei* (Moussu and Marotel)

1901. *Coccidium* sp. Moussu and Marotel, *C. r. Seanc. Soc. Biol.*, Paris, **53**, p. 1087.

1902. *Coccidium faurei* Moussu and Marotel, *Arch. Parasit.*, **6**, p. 82.

1909. *Eimeria faurei* Martin, *Rev. Vet.*, Toulouse, **34**, p. 201.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst egg-shaped, 24-38 μm \times 19-23 μm in dimensions, micropyle present at the narrower end but no micropylar cap present ; oocystic residuum absent ; sporocyst ellipsoidal and sporozoite elongate.

Host : Domestic Goat, *Capra hircus* ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Haryana, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh and West Bengal.

31. *Eimeria intricata* (Spiegel)

1925. *Eimeria intricata* Spiegel, *Z. Infektkankh. u. Hygiene de Hasstiere*, **28**, p. 42.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst ellipsoidal to ovoid, excystic wall of oocyst very thick, micropyle large and appearing as a wide gap below crescent shaped polar cap ; sporocyst pyramidal and sporozoite elongate.

Host : Domestic Goat, *Capra hircus*, site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Bihar, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh and West Bengal.

32. *Eimeria neodebliecki* Vetterling

1965. *Eimeria neodebliecki* Vitterling, *J. Parasit*, **5**, p. 897.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst usually ellipsoidal, occasionally ovoid, 17-26 μm \times 14-19 μm in dimensions ; micropyle and oocystic residuum absent, sporocyst broadly ovoid, 'steida body' present ; sporozoite banana-shaped.

Host : Domestic Pig, *Sus scrofa*; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Madhya Pradesh and Uttar Pradesh.

33. *Eimeria parva* Koltan, Mocsy and Vajda

1929. *Eimeria parva* Koltan, Mocsy and Vajda, *Allatorv Lapok*, **52**, p. 304.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst ellipsoid, ovoidal or subspherical, 14-19 μm \times 12-15 μm in dimensions; oocystic wall displaying a distinct double-layered contour due to presence of two darker refractile lines ; micropyle and polar cap absent ; sporocyst ellipsoidal, steida body present.

Host : Domestic Goat, *Capra hircus* ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Bihar, Haryana, Madhya Pradesh, Maharashtra, Orissa, Punjab and Uttar Pradesh.

34. *Eimeria spinosa* Henry

1931. *Eimeria spinosa* Henry, *Univ. Calif. Publs. Zool.*, **36**, p. 115.

Material examined : Sev. exs., Shillong market, East Khasi Hills, 18. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst ellipsoidal, 16-22 μm \times 13-16 μm in dimensions, oocystic wall brown and entirely covered with 1 μm high spines, oocyst dark coloured, steida body present.

Host : Domestic Pig, *Sus scrofa*; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district), Haryana, Madhya Pradesh, Orissa and West Bengal.

35. *Eimeria* sp.

Host : Domestic cow; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district).

Remarks : Gulati (1926) reported the occurrence of an undetermined species of *Eimeria* in the faeces of cows in Shillong.

Genus *Isospora* Schneider

1881. *Isospora* Schneider, *Arch. Zool. Exp. Gen.*, **9**, p. 387.

Diagnosis : Each oocyst with two sporocysts and each sporocyst with four sporozoites, usually parasitic in vertebrates.

Four species of *Isospora* including one undetermined species, one each from amphibian, reptilian, avian and mammalian hosts have been collected/reported from this state. These are discussed below host wise.

Isospora from amphibian host

36. *Isospora wenyoni* Ray and Das Gupta

1935. *Isospora wenyoni* Ray and Das Gupta, *Arch. Protistenk.*, **86**, p. 219.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst subcylindrical, double layered, 15-20 μm \times 13-15 μm in dimensions, micropyle absent, oocystic residuum present, sporocyst oval at immature stage and becoming naviculoid at mature stage.

Host : *Rana tigerina*; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and West Bengal.

Isospora from reptilian host

Key to the species

- 1 (2) Oocyst cylindrical, 14.5—16.5 μm \times 6.8—8.5 μm , single walled, sporocyst spherical, sporozoite elongated *I. minuta*
- 2 (1) Oocyst spherical, 25.5—27.4 μm in diameter, double walled, sporocyst naviculoid, sporozoite bean-shaped *I. rayi*

37. *Isospora minuta* Mitra and Das Gupta

1937. *Isospora minuta* Mitra and Das Gupta, *Proc. Indian Sci. Congr.*, p. 291.

Diagnosis : Oocyst cylindrical, 14.5—16.5 μm \times 6.8—8.5 μm in dimension; oocyst single walled; micropyle and oocystic residuum not seen; sporocyst spherical; sporozoites elongated, tapering at both ends; sporocystic residuum present as compact mass.

Host : *Naja naja* and *Ophiophagus hannah*; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and West Bengal.

Remarks : Mandal (1976) recorded this species from Shillong.

38. *Isospora rayi* Mandal

1966. *Isospora rayi* Mandal, *Sci. and Cult.*, 32, p. 507.

Diagnosis : Oocyst spherical, 25.5—27.4 μm in diameter. oocyst wall double layered, outer wall thin and membranous and inner wall thick, micropyle and oocystic residuum absent; sporocyst naviculoid, tapering at both ends, blackish sporocystic residuum visible as shiny globular material, scattering irregularly inside the sporocyst; sporozoite bean-shaped.

Host : Garden lizard, *Ptyctolaemus* sp.; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district).

Remarks : Mandal (1966) described this species from the faecal sample of the Garden Lizard as mentioned above collected in Shillong, Meghalaya.

*Isospora from avian hosts**Key to the species*

- 1 (6) Oocyst double walled, both wall equally thick, sporocyst pyriform, sporozoite elongated
- 2 (3) Micropyle absent, oocystic residuum present, sporocyst pyriform with a knob at tapering anterior end *I. corvae*
- 3 (2) Both micropyle and oocystic residuum present, sporocyst pyriform with a steids body at its anterior end
- 4 (5) Steida body of sporocyst in the form of a plug, oocyst grayish white with yellowish tinge, parasitic in Browncrested Tit *I. parusi*
- 5 (4) Steida body of sporocyst not in the form of plug, oocyst grayish, parasitic in Himalayan Jay *I. garrulusae*
- 6 (1) Oocyst double walled, inner wall thicker than the outer one, sporocyst ovoid to pyriform, sporozoite bean shaped *I. lacazei*

39. *Isospora corvae* Ray, Shivnani, Oommen and Bhaskaran

1952. *Isospora corvae* Ray, Shivnani, Oommen and Bhaskaran, *Proc. zool. Soc., Calcutta*, 5, p. 141.

Diagnosis : Oocyst subspherical, double walled, grayish pink in colour; micropyle absent, oocystic residuum present ; sporocyst pyriform with a knob at the tapering anterior end, posterior end being rounded ; sporocystic residuum present as a compact mass; sporozoite elongated with pointed anterior end.

Host : Jungle Crow, *Corvus macrorhynchus intermedius*; site of infection : Intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and Uttar Pradesh.

Remarks : Mandal (1976) reported this species from Shillong.

40. *Isospora garrulusae* Ray, Shivnani, Oommen and Bhaskaran

1952. *Isospora garrulusae* Ray, Shivnani, Oommen and Bhaskaran, *Proc. zool. Soc., Calcutta*, 5, p. 141.

Diagnosis : Oocyst oval to subspherical, double walled, grayish in colour ; micropyle and oocystic residuum present : sporocyst pear shaped with pointed anterior and rounded posterior ends ; sporocystic residuum present as a compact mass ; sporozoite elongated with pointed anterior and rounded posterior ends.

Host : Himalayan Jay, *Garrulus glandarieus bispecularis* ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and Uttar Pradesh.

Remarks : Mandal (1976) reported this species from Shillong.

41. *Isospora lacazei* (Labbe)

1983. *Diplospora lacazii* Labbe, *C.r. Acad. Sci.*, Paris, 117, p. 407.

1899. *Isospora lacazei* Labbe, *Tierreich Eine Zusammenstellung und Kennzeichnung der Rezenten Tierformen*, 5., Friedlander & Sons, Berlin.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16. xi. 1988, coll. A. K. Mandal.

Diagnosis : Oocyst spherical or subspherical, 24-32 μm \times 20-30 μm in dimensions, oocyst wall double-layered of which inner one thicker ; micropyle and oocyst residuum absent ; sporocyst ovoid to pyriform with button-shaped plug at the narrow anterior end ; sporozoite bean-shaped.

Host : *Passer domesticus* and *Pycnonotus jocosus* ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and West Bengal.

42. *Isospora parusi* Ray, Shivnani, Oommen and Bhaskaran

1952. *Isospora parusae* Ray, Shivnani, Oommen and Bhaskaran, *Proc. zool. Soc., Calcutta*, 5, p. 141.

1976. *Isospora parusi* emend Mandal, *Rec. zool. Surv. India*, 70, p. 63.

Diagnosis : Oocyst oval to subspherical, double walled, grayish-white with yellowish tinge; micropyle present, oocystic residuum in the form of one or two granules ; sporocyst pyriform, tapering at anterior end with a steida body in the form of a plug ; sporocystic residuum present in the form of globular mass ; sporozoites elongated with tapering anterior end.

Host : Browncrested Tit, *Parus dichrurus* (Hodgson) ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and Uttar Pradesh.

Remarks : Mandal (1976) reported this species from Shillong.

Isospora from mammal

43. *Isospora* sp.

Host : Domestic cow ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district).

Remarks : Cooper and Gulati (1926) reported this undetermined species of *Isospora* from the faecal sample of domestic cow in Shillong.

Genus *Wenyonella* Hoare

1933. *Wenyonella* Hoare, Parasitology, 25, p. 359.

Diagnosis : Each oocyst with four sporocysts and each sporocyst with four sporozoites.

Two species of *Wenyonella* have been reported so far from Meghalaya and both of them were recovered from avian hosts.

Key to the species

- 1 (2) Oocyst subspherical or ovoid, double layered, both layer equally thick, sporozoite ovoid, parasitic in Common Quail *W. bahli*
- 2 (1) Oocyst spherical or ovoid, double layered, inner layer thin and outer layer comparatively thick, sporozoite club-shaped, parasitic in Wagtail *W. mackinnoni*

44. *Wenyonella bahli* Misra

1944. *Wenyonella bahli* Misra, Proc. natn. Inst. Sci. India, 10, p. 203.

Diagnosis : Oocyst subspherical or ovoid, double layered, both layers equally thick ; micropyle and oocystic residuum absent ; sporocyst egg-shaped without any knob ; sporocystic residuum absent ; sporozoite ovoid.

Distribution : India : Meghalaya (East Khasi Hills district) and Uttar Pradesh.

Remarks : Mandal (1976) reported this species from Shillong.

Host : Common Quail, *Coturnix communis* ; site of infection : intestine.

45. *Wenyonella mackinnoni* Misra

1947. *Wenyonella mackinnoni* Misra, Proc. Indian Acad. Sci., 25 (B), p. 75.

Diagnosis : Oocyst spherical or ovoid, double layered, outer layer thin and colourless and inner layer comparatively thick and brownish ; micropyle and oocystic residuum absent ; sporozoite club-shaped.

Host : Wagtail, *Motacilla alba* ; site of infection : intestine.

Distribution : India : Meghalaya (East Khasi Hills district) and Uttar Pradesh.

Remarks : Mandal (1976) recorded this species from Shillong.

Family PLASMODIIDAE

Genus *Plasmodium* Marchiafava and Celli

1885. *Plasmodium* Marchiafava and Celli, Rif. Med., Naples, No. 214, p. 737.

Diagnosis : Trophozoites ring-shaped, amoeboid in erythrocytes, schizonts (merogony) in

erythrocytes and also in various other tissues depending on the species ; hemozoin pigment visible with the light microscope usually formed, vectors mosquitoes or phlebotomine flies, parasitic in mammals, birds and reptiles.

Three species of *Plasmodium* as discussed below are known to occur in this state as mentioned in the introductory part of the present communication.

Key to the species

- 1 (2) Full grown schizonts rounded, nearly filling erythrocytes, merozoites typically arranged in circle, schizogony in 72 hours *P. malariae*
- 2 (1) Full grown schizonts irregular in form, filling half to two-third the erythrocyte and irregularly arranged, schizogony in about 48 hours
- 3 (4) Gametocytes crescent shaped, infected erythrocytes normal or atrophied *P. falciparum*
- 4 (3) Gametocytes rounded or oval, infected erythrocytes hypertrophied *P. vivax*

46. *Plasmodium falciparum* (Welch)

1897. *Haematozoon falciparum* Welch, *Syst. Pract. Med.*, 1, p. 17.

1966. *Plasmodium falciparum* (Welch) : Garnham, *Malarial Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 357.

Diagnosis : 'Ring' form relatively small, often two or more in each infecting red cell, with double dots of chromatin, some apparently on edge (acoele forms), usually with crescentic gametocytes, macrogametocyte 12-14 μm long ; trophozoite compact, rarely seen in peripheral blood; mature schizont irregular in form, 8-32 merozoites irregularly arranged filling half to two-third the erythrocyte, with early clumping of coarse dark pigments ; rarely occur in peripheral circulation ; host erythrocyte not hypertrophied but accompanied by reddish clefts known as Maurer's cleft.

Host : Man, *Homo sapiens* ; site of infection : blood, liver, kidney, spleen, bone-marrow, brain, etc.

Distribution : India : Meghalaya (East Gargo Hills district) ; in almost all parts of India (Knowles, Senior White and Das Gupta, 1930 ; Bhatia, 1938).

Remarks : This species of *Plasmodium* causes Malignant tertian malaria and appears significantly fatal to human race over most parts of Africa and elsewhere in the tropics (Garnham, 1966).

47. *Plasmodium malariae* (Grassi and Felletti)

1892. *Haemamoeba malariae* Grassi and Felletti, *Atti Acad. Zioenia Sci. nat. Catania*, Memoir, 5, p. 10.

1900. *Plasmodium malariae* Luhe, *Zbl. Bakt.*, 27, p. 460.

Diagnosis : 'Ring' form about one-third diameter of erythrocyte, one in each infecting red cell ; trophozoite compact, often band-like, schizont rounded, 7 µm in diameter, nearly filling the erythrocyte, 6-12 merozoites typically aranged in circle, schizogony in 72 hours ; gametocyte round or ovoid, 9 µm in diameter with brown black pigments ; host erythrocyte not hypertrophied.

Host : Man, *Homo sapiens*, Chimpanzee in West Africa (Garnham, 1966) ; site of infection: blood, liver, kidney, etc.

Distribution : India : Meghalaya (East Garo Hills district), almost all over India (Knowles, Senior White and Das Gupta, 1930 ; Bhatia, 1938).

Remarks : This species causes Quartan malaria in man. It is less common than *P. vivax* and not very pathogenic although its chronic infection may lead to a lethal kidney condition.

48. Plasmodium vivax (Grassi and Feletti)

1892. *Haemamoeba vivax* Grassi and Feletti, *Atti Acad. Zioenia Sci. nat. Catania*, Memoir, 5, p. 10.

1900. *Plasmodium vivax* Luhe, *Zbl. Bakt.*, 27, p. 460.

Diagnosis : Relatively large 'ring' forms, about one-third diameter of erythrocyte, round or oval, usually one in each infecting red cell ; a round chromatin dot in thin part of ring ; trophozoite amoeboid ; schizout irregular, filling half to two-third the erythrocyte ; schizogony usually at interval of 48 hours ; 12-24 merozoites in irregular grape-like cluster, with small pigment granules usually collected in a single mass ; gametocyte large, round or ovoid, 10 µm in diameter ; host erythrocyte hypertrophied, stippled with red dots known as Schiffner's dots, all erythrocytic stages occurring in peripheral blood.

Host : Man, *Homo sapiens* ; site of infection : blood, liver, kidney etc.

Distribution : India : Meghalaya (East Garo Hills district), almost in all parts of India (Knowles, Senior White and Das Gupta, 1930 ; Bhatia, 1938).

Remarks : This is the most wide spread human malarial parasites and causes Benign tertian malaria in man.

Family HAEMOPROTEIDAE

Genus *Haemoproteus* Kruse

1980. *Haemoproteus* Kruse, *Arch. Pathol. Anat.*, 120, p. 541.

Diagnosis : Trophozoite in erythrocytes ; merogony (schizogony) in endothelial cells of blood vessels, especially in lungs and in erythrocytes, hemozoin pigments visible with light microscope formed ; vectors hippoboscid flies (*Culicoides* or *Chrysops*), parasitic in birds, reptiles and amphibia.

Key to the species

- 1 (2) Parasite causing marked displacement of host cell nucleus, (mean number of pigment granules 17, macrogametocytes 14.4 µm × 3.6 µm in dimensions and 53.5 µm² in area) *H. oryzivora*

- 2 (1) Parasite not causing marked displacement of host cell nucleus
- 3 (4) Mean number of pigment granules more than twenty, (mean number of such granules 33, parasitic in Columbae)*H. columbae*
- 4 (3) Mean number of pigment granules fifteen
- 5 (6) Parasitic in Dicruridae, macrogametocyte $12.6 \mu\text{m} \times 2.5 \mu\text{m}$ in dimensions and $36 \mu\text{m}^2$ in area *H. dicruri*
- 6 (5) Parasitic in Zosteropidae, macrogametocyte $15.8 \mu\text{m} \times 3 \mu\text{m}$ in dimensions and $50.5 \mu\text{m}^2$ in area *H. zosteropis*

49. *Haemoproteus columbae* Kruse

1890. *Haemoproteus columbae* Kruse, *Arch. Pathol. Anat.*, **120**, p. 359.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16.xi. 1988, coll. A. K. Mandal; sev. exs., William Nagar, East Garo Hills, 2.xii. 1988, coll. A. K. Mandal.

Diagnosis : Macrogametocyte halteridial, inner and polar margin amoeboid, outer margin entire, occupying about 60 per cent of the host cell – parasitic complex; pigment yellowish-black, discrete, round, scattered, 30 granules per parasite in average; nucleus round-oval, median to submedian, host cell relatively unchanged, host cell nucleus atrophied 25.8 per cent in area.

Host : *Columba livia*; site of infection : blood.

Distribution : India : Meghalaya (East Khasi Hills and East Garo Hills districts), Delhi, Maharashtra and West Bengal.

50. *Haemoproteus dicruri* de Mello

1935. *Haemoproteus dicruri* de Mello, *Proc. Indian Acad. Sci.*, **2B**, p. 469.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16. xi. 1988, coll. A. K. Mandal.

Diagnosis : Macrogametocyte halteridial, margins entire, occupying about 60 per cent of the host cell – parasite complex, nucleus submedian, round oval; pigments yellowish brown, 15 granules in average; host cell hypertrophied by 19.2 per cent in area, host cell nucleus atrophied 3.4 per cent in area.

Host : *Dicrurus adsimilis*; site of infection : blood.

Distribution : India : Meghalaya (East Khasi Hills district), Goa, Jammu and Kashmir, Orissa and West Bengal.

51. *Haemoproteus oryzivorae* Anschutz

1909. *Haemoproteus oryzivorae* Anschutz, *Zentralbl. Bakteriolog. Parasitenkd. Infektionskr. Hyg. I.* Orig.: 51 ; p. 654.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16. xi. 1988, coll. A. K. Mandal.

Diagnosis : Macrogametocyte halteridial, rarely broadly sausage-shaped, margins entire occupying about 70 per cent of the host cell-parasite complex; nucleus round, ovoid or broadly triangular, median to subterminal, usually located at the outer margin of the parasite, occupying about 9 per cent of the area of the macrogametocyte; pigment granules small, ovoid, yellow to dark-yellow brown, scattered, 12 granules in average; host cell hypertrophied in area by 34.6 per cent and host cell nucleus atrophied 10.4 per cent in area and markedly displaced to periphery.

Host : *Copsychus saularis*; site of infection : blood.

Distribution : India : Meghalaya (East Khasi Hills district), Andhra Pradesh, Goa, Orissa and West Bengal.

52. *Haemoproteus zosteropsis* Chakravarty and Kar

1909. *Haemoproteus zosteropsis* Chakravarty and Kar, *Proc. Indian Acad. Sci.*, 22B, p. 63.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16. xi. 1988, coll. A. K. Mandal.

Diagnosis : Macrogametocyte halteridial, margins entire, occupying 66 per cent of the host cell-parasite complex, nucleus ovoid, median to submedian, pigments usually scattered, occasionally clumping in various parts of the cytoplasm, 15 granules in average; host cell hypertrophied by 12 per cent in area and host cell nucleus slightly atrophied (2 per cent) in area.

Host : *Zosterops palpebrosa*; site of infection : blood.

Distribution : India : Meghalaya (East Khasi Hills district), and West Bengal.

Order PIROPLASMIDA

Family BABESIIDAE

Diagnosis : Pyriform, round or oval, arranged in pairs, schizogony occurring in erythrocytes of vertebrates; ticks acting as vector.

Genus : *Babesia* Starcovici

1893. *Babesia* Starcovici, *Zentralbl. Bakteriolog. Parasitenkd. Infektionstr. Abt.*, 1, p. 14.

Diagnosis : Apical complex reduced to a polar ring, rhoptries and subpellicular microtubules; filaments not present on parasitized erythrocytes.

53. *Babesia motasi* Wenyon

1926. *Babesia motasi* Wenyon, *Protozoology*, 2 Bailliere, Tindal and Cox, London, p. 1006.

Material examined : Sev. exs., Shillong, East Khasi Hills, 16. xi. 1988, coll. A. K. Mandal.

Diagnosis : Parasites mostly pyriform, occasionally round or irregular, $2.5 \mu\text{m} \times 1.2\text{-}3 \mu\text{m}$, occurring singly or in pairs and the pairs always lying at an acute angle at their narrower ends; chromatin often appeared as double; host cell hypertrophied.

Host : Sheep, *Ovis* sp.; *site of infection* : blood.

Distribution : India : Meghalaya (East Khasi Hills district), and West Bengal.

Phylum	CILIOPHORA
Class	KINETOFRAGMINOPHOREA
Order	TRICHOSTOMATIDA
Family	BALANTIDAE

Diagnosis : Vestibulum anteriorly located, cytostome located at the base of vestibulum; somatic ciliation uniform, parasite in invertebrate and vertebrate hosts.

Genus *Balantidium* Claparede and Lachmann

1858. *Balantidium* Claparede and Lachmann, *Etudes sur les infusoires et des rhizopodes*, Geneve, p. 247

Diagnosis : Body oval, ellipsoid to subcylindrical, uniformly ciliated; peristome starting at or near anterior end, cytopharynx not well developed, contractile vacuole and cytopyge terminal.

Key to the species

- 1 (2) Body elongated, egg-shaped, peristome not reaching the middle of the body, macronucleus kidney shaped *B. helenae*
- 2 (1) Body round or broadly oval, peristome slit-like and reaching below the middle of the body, macronucleus elongated *B. rotundum*

54. *Balantidium helenae* Bezenberger

1904. *Balantidium helenae* Bezenberger, *Arch. Protistenk.*, 3 ; p. 151.

Material examined : 2 exs., William Nagar, East Garo Hills, 26.iii. 1991, coll. A. K. Das.

Diagnosis : Body ovoid, anterior end narrower than the posterior, $110\text{-}145 \mu\text{m} \times 46\text{-}54 \mu\text{m}$; peristome not reaching up to the middle of the body, macronucleus kidney shaped, micronucleus rounded, lying at the notch of macronucleus, contractile vacuole usually single.

Host : *Rana cyanophlyctis*, *Rana tigerina*; site of infection : intestine and rectum.

Distribution : India : Meghalaya (East Garo Hills district) and West Bengal.

55. *Balantidium rotundum* Bezenberger

1904. *Balantidium rotundum* Bezenberger, *Arch. Protistenk.*, 3 ; p. 153.

Material examined : 3 exs., William Nagar, East Garo Hills, 26.iii. 1991, coll. A. K. Das.

Diagnosis : Body round or completely egg-shaped, strongly compressed dorsoventrally, with a marked bulging on the ventral surface, 60 µm × 45 µm; peristome slit-like, anteriorly located, extending along the right margin, a little in front of the middle, micronucleus oval or slightly kidney-shaped, macronucleus distinct and located at the notch lying on the middle or at one end of macronucleus; contractile vacuole single.

Host : *Rana tigerina*; site of infection : intestine.

Distribution : India : Meghalaya (East Garo Hills district) and West Bengal.

Class POLYHYMENOPHOREA

Order HETEROTRICHIDA

Key to the families

- 1 (2) Body ovoid to slightly reniform, plump, sucker on ventral side lacking..... Family Nyctotheridae
- 2 (1) Body plump-ovoid to ellipsoidal, occasionally tailed, sucker typically present on concave side of the body Family Sicutophoridae

Family NYCTOTHERIDAE

Key to the genera

- 1 (2) Body generally less flat, micronucleus most often located above macronucleus, commensal of both invertebrates and vertebrates Genus *Nyctotherus*
- 2 (1) Body ovoid, pyriform or reniform, left margin convex, right margin more or less flat, micronucleus always below macronucleus, commensal of anurans Genus *Nyctotheroides*

Genus *Nyctotherus* Leidy

1849. *Nyctotherus* Leidy, *Proc. Acad. Nat. Sci.*, Philadelphia, 4, p. 233.

Diagnosis : As in the key to the genera.

56. *Nyctotherus ovalis* Leidy

1949. *Nyctotherus ovalis* Leidy, *Proc. Acad. Nat. Sci.*, Philadelphia, 4 ; p. 233

Material examined : 3 exs., Tura, West Garo Hills, 19.iii. 1991, coll. A. K. Das; 2 exs., William Nagar, East Garo Hills, 26.iii. 1991, coll. A. K. Das.

Diagnosis : Body broadly oval, 100-270 μm in length, divisible into two parts by caryophore diaphragm, out of which anterior part smaller and transparent and, posterior part larger and alveolar; infranuclear portion possessing large alveole and numerous inclusions; macronucleus egg-shaped, curved; cytopharynx slightly bent and reaching up to the middle; contractile vacuole single and subterminal.

Host : *Periplaneta americana*; site of infection : mid gut and hind gut.

Distribution : India : Meghalaya (West Garo Hills and East Garo Hills districts), Punjab, Goa and West Bengal.

Genus *Nyctotheroides* Grasse

1928. *Nyctotheroides* Grasse, *Ann. Protistol.*, **1**, p. 55-68.

Diagnosis : As in the key to the genera.

57. *Nyctotheroides cordiformis* (Ehrenberg)

1838. *Bursaria cordiformis* Ehrenberg, *Die Infusionsthierchen als Vollkommene Organismen*, Leipzig, p. 328.

1867. *Nyctotherus cordiformis* Stein, *Der Organismus der Infusionsthier nach eigenen Forschungen in Systematischer Reihenfolge Bearbeitet*. II. p. 338-344.

1928. *Nyctotheroides cordiformis* Grasse, *Ann. Parasitol.*, **1**, p. 55-68.

Material examined : 1 exs., Tura, West Garo Hills, 19.iii. 1991, coll. A. K. Das; 2 exs., William Nagar, East Garo Hills, 26.iii. 1991, coll. A. K. Das.

Diagnosis : Body reniform, somewhat pointed anteriorly, 95-200 μm in length; cytopharynx broadly curved, reaching beyond the middle of the body; macronucleus kidney-shaped, micronucleus located below macronucleus and centrally attached to it.

Host : *Bufo melanostictus*; site of infection : intestine and cloaca.

Distribution : India : Meghalaya (West Garo and East Garo Hills districts) Goa, Karnatak, Rajasthan and West Bengal.

Family SICUOPHORIDAE.

Genus *Sicuophora* de Puytorac and Grain

1969. *Sicuophora* de Puytorac and Grain, *Protistologica*, **4**, 1968 p.405-414.

Diagnosis : Body ovoid, highly complex along inferior surface, provided with polysaccharide skeletal armature, commensal in annurans.

58. *Sicuophora macropharyngea* (Bezenberger)

1904. *Nyctotherus macropharyngeus* Bezenberger, *Arch. Protistenk.*, **3**, p. 138.

1973. *Sicuophora macropharyngea* Albert, *J. Protozool.*, **20**, pp. 51-57.

Material examined : 2 exs., William Nagar, East Garo Hills, 26. iii. 1991, coll. A. K. Das.

Diagnosis : Body oval, posterior part of the body distinctly thicker than the anterior part ; 120-130 μm in length, at anterior end a thinner portion appearing to project like a frill, cytopharynx large, funnel shaped, posterior portion of which forming a coil in two to two and a half spiral turns ; macronucleus of diverse shape (pentagonal, oval or cone-shaped), micronucleus single and placed over macronucleus ; macronucleus two to three, located near posterior end.

Host : *Rana tigerina* ; site of infection : cloaca.

Distribution : India : Meghalaya (East Garo Hills district), Maharashtra, Karnataka, Rajasthan and West Bengal.

SYMBIOTIC PROTOZOA

SYSTEMATIC LIST

Phylum	SARCOMASTIGOPHORA
Subphylum	MASTIGOPHORA
Class	ZOOMASTIGOPHOREA
Order	OXYMONADIDA
Family	PYRSONYMPHIDAE
Genus	<i>Dinenympha</i> Leidy
1. <i>D. axilis</i> Koidzumi	<i>Reticulitermes assamensis</i>
2. <i>D. leidy</i> Koidzumi	<i>R. assamensis</i>
3. <i>D. nobilis</i> Koidzumi	<i>R. assamensis</i>
4. <i>D. parva</i> Koidzumi	<i>R. assamensis</i>
5. <i>D. rugosa</i> Koidzumi	<i>R. assamensis</i>

Genus *Pyronympha* Leidy

6. <i>P. grandis</i> Koidzumi	<i>R. assamensis</i>
7. <i>P. modesta</i> Koidzumi	<i>R. assamensis</i>

Order	HYPERMASTIGIDA
Family	SPIROTRICHONYMPHIDAE

Genus *Holomastigotes* Grassi

- 8.
- H. indica*
- sp. nov.
- R. assamensis*

Genus *Spirotrichonympha* Grassi and Foa

- 9.
- S. porteri*
- (Koidzumi)
- R. assamensis*

FAMILY TERANYMPHIDAE

Genus *Teranympha* Koidzumi

- 10.
- T. mirabilis*
- Koidzumi
- R. assamensis*

FAMILY TRICHONYMPHIDAE

Genus *Trichonympha* Leidy

- 11.
- T. agilis*
- Leidy
- R. assamensis*

- 12.
- T. meghalayensis*
- sp. nov.
- R. assamensis*

TAXONOMIC ACCOUNT

Phylum SARCOMASTIGOPHORA

Class ZOOMASTIGOPHOREA

Order OXYMONADIDA

Family PYRSONYMPHIDAE

Diagnosis : Large or small forms ; axostyle of variable thickness running longitudinally down the body ; four to eight flagellar cords starting from the anterior tip of the body running spirally backward and becoming free flagella at posterior end.

Key to the species

- 1 (2) Body slender, club-shaped or lanceolate, sometimes spirally twisted, end of axostyle fixed at posterior tip of the body or indistinct except at anterior end Genus *Dinenympha*
- 2 (1) Body pyriform, club-shaped, spindle-shaped or screw-like, spirally twisted, axostyle hanging in the endoplasm and its posterior end is free from the body wall Genus *Pyrsonympha*

Genus *Dinenympha* Leidy1877. *Dinenympha* Leidy, *Proc. Acad. Nat. Sci. Phila.*, **29**, p. 149.*Diagnosis* : As in the key to the genus.*Key to the species*

- 1 (6) Body surface almost smooth
- 2 (3) Body long and slender, tapering gradually at extremities, axostyle thick but becoming slightly thinner towards posterior end *D. exilis*

- 3 (2) **Body slender or club-shaped, anterior portion of the body bend back, axostyle indistinct**
- 4 (5) **Body club-shaped, gradually thickened towards posterior end, anterior portion usually turned back assuming commonly the shape of a hook *D. nobilis***
- 5 (4) **Body slender, anterior portion usually bend back and rest of the portion of the body appearing almost straight *D. parva***
- 6 (1) **Body surface ridged**
- 7 (8) **Body slender, flat and ribbon-like, tapering more abruptly at posterior end, course of flagellar cords markedly wavy, free ends of flagellar cords not very long *D. rugosa***
- 8 (7) **Body lanceolate and fairly thick at posterior portion, course of flagellar cords straight, free ends of flagellar cords conspicuously long, almost half the length of the body *D. leidy***

1. *Dinenympha exilis* Koidzumi

1921. *Dinenympha exilis* Koidzumi, *Parasitology*, **13**, p. 291.

Material examined : Sev. exs., Dawki, Jaintia Hills, 18. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body large, slender and gradually tapering at extremities, 50-110 $\mu\text{m} \times 4-10 \mu\text{m}$ in dimensions ; number of complete spiral turns two or two and a half ; body surface almost smooth ; axostyle distinct and thick, but becoming thinner towards posterior end of the body ; nucleus oval, situated at anterior extremity.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (Jaintia Hills district) ; first record from India.

2. *Dinenympha leidy* Koidzumi

1921. *Dinenympha leidy* Koidzumi, *Parasitology*, **13**, p. 292.

Material examined : 4 exs., Tura, West Garo Hills, 22. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body lanceolate and fairly thick at posterior portion, dimensions 22-65 $\mu\text{m} \times 8-18 \mu\text{m}$; body surface distinctly ridged ; these ridges arranged regularly ; axostyle indistinct ; free ends of flagellar cords conspicuously long, almost half the length of the body.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (West Garo Hills district) ; first record from India.

3. *Dinenympha nobilis* Koidzumi

1921. *Dinenympha leidy* Koidzumi, *Parasitology*, **13**, p. 292.

Material examined : 6 exs., Dawki, Jaintia Hills, 18. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body club-shaped, gradually thickened towards posterior end, dimensions 30-50 $\mu\text{m} \times 5-15 \mu\text{m}$; anterior portion of the body usually turned back assuming commonly the shape of a hook ; axostyle indistinct ; body surface smooth ; nucleus round, located towards anterior end.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (Jaintia Hills district) ; first report from India.

4. *Dinenympha parva* Koidzumi

1921. *Dinenympha parva* Koidzumi, *Parasitology*, **13**, p. 294.

Material examined : Sev. exs., Balat, West Khasi Hills, 11. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body slender, anterior portion curved or bend back, rest of the body appearing almost straight, dimensions 18-44 $\mu\text{m} \times 4-6 \mu\text{m}$; body surface almost smooth ; axostyle slender and indistinct ; nucleus spherical and located at anterior extremity.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (West Khasi Hills district) ; first record from India.

5. *Dinenympha rugosa* Koidzumi

1921. *Dinenympha rugosa* Koidzumi, *Parasitology*, **13**, p. 292.

Material examined : 4 exs., Nongpoh, Ri-Bhoi district, 6. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body long, slender but flat and ribbon like, tapering more abruptly at posterior end ; dimensions 40-100 $\mu\text{m} \times 5-10 \mu\text{m}$; body surface distinctly ridged ; course of flagellar cords markedly wavy ; nucleus round and located at anterior end of the body.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (Ri-Bhoi district) ; first record from India.

Remarks : In *D. rugosa* flagellar cords are markedly wavy in their course where as in its other congeners these cords run straight towards posterior end of the body.

Genus *Prysonympha* Leidy

1877. *Prysonympha* Leidy, *Proc. Acad. Nat. Sci. Phila.*, **29**, p. 148.

Diagnosis : As in the key to this genus.

Key to the species

- 1 (2) Body pear-shaped, often conspicuously twisted resembling a screw, axostyle slender
 *P. modesta*

2 (1) Body club-shaped, not twisted as above, axostyle comparatively thick *P. grandis*

6. *Pyrsonympha grandis* Koidzumi

1921. *Pyrsonympha grandis* Koidzumi, *Parasitology*, 13 : p. 281.

Material examined : 3 exs., Balat, West Khasi Hills, 11. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body club-shaped, slightly curved with pointed anterior and round posterior ends ; dimensions 67.2-83.2 μm \times 19-22 μm ; axostyle thick, well developed and hanging free in the endoplasm ; nucleus ovoidal and situated at anterior end of the body.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (West Khasi Hills district); new record from India.

7. *Pyrsonympha modesta* Koidzumi

1921. *Pyrsonympha modesta* Koidzumi, *Parasitology*, 13, p. 289.

Material examined : 4 exs., Cherrapunjee, East Khasi Hills, 8. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body pear shaped with slightly pointed anterior and oval posterior ends ; body often conspicuously twisted resembling a screw ; dimensions 40.7-59.3 μm \times 24-37 μm ; axostyle more slender than that of the preceding species and always single, hanging freely in the endoplasm ; nucleus round and located at anterior end of the body.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (East Khasi Hills district) ; new record from India.

Order HYPERMASTIGIDA

Key to the families

- 1 (2) Body regularly ridged transversely, giving its segmented appearance, each ridge provided with single row of flagella Family Teranymphidae
- 2 (1) Body not ridged as above
- 3 (4) Spiral flagellar bands arising from a common point near anterior end of the body, axostyles may be separate or joining to form closely adhering bundleFamily Spirotrichonymphidae
- 4 (3) Spiral flagellar bands as above lacking, axostyles absent, posterior portion of the body not flagellated Family Trichonymphidae

Family SPIROTRICHONYMPHIDAE

Key to the genera

- 1 (2) Body spindle shaped, nucleus located very close to rostrum, being embedded in a mass of dense cytoplasm, which is not conical Genus *Holomastigotes*
- 2 (1) Body elongate, pyriform, nucleus considerably away from rostrum and appearing to be suspended in a mass of dense conical shaped cytoplasm whose base indistinct Genus *Spirotrichonympha*

Genus *Holomastigotes* Grassi

Diagnosis : Body spindle shaped, a few spiral flagellar bands arising from a common point near anterior end of the body and reaching up to posterior end ; flagella arising from the bands lining up closely in rows and forming fasciculi after reaching the surface of the body ; nucleus located very close to the rostrum, embedding in a mass of dense protoplasm.

Remarks : Koidzumi (1921) noted the characteristic features of the genus *Holomastigotes* Grassi as follows : body spindle shaped, its surface spirally ridged and flagella arising in the groove behind the ridge. He (*op. cit.*) placed this genus under the family Holomastigotidae. This classification was followed by many subsequent Protozoologists including Kudo (1966). While dealing with the taxonomic features of *Holomastigotes* he (*op. cit.*), however, did not mention the occurrence of any spiral ridge on its body surface. This genus is at present treated as *incertae sedis* (Yamin, 1979) may be due to its ambiguously stated taxonomic features.

From the careful and critical examination of the present species of *Holomastigotes* it is quite evident that this genus belongs to the family Spirotrichonymphidae. Because, it possesses few spiral bands (4 pairs or 8) arising from a common point near anterior end of the body and nucleus anchored to rostrum by a nuclear sleeve. (*see* Cleveland and Dey, 1958). It needs mention here that the present material of *Holomastigotes* does not possess any spiral ridge on the body surface and flagella arise from flagellar bands which encircle the body spirally from anterior to posterior end.

8. *Holomastigotes indica* sp. nov.

(Pl. 8, fig. 2)

Diagnosis : Body more or less spindle shaped with rounded posterior end, measuring 43.2—65.5 (51.7) μm in body length and 12.8-25.6 (20.4) μm in maximum width ; anterior end with well marked rostrum ; flagellar bands 8 in number, arising from a common point near anterior end of the body ; these bands spiralling slightly in rostrum but markedly in body portion reaching up to the posterior end of the body ; flagella arising from bands lining up closely in rows, reaching the surface of the body and forming fasciculi ; nucleus oval, 3.6-9.6 (7.7) μm in length and 3.0-6.2 (5.8) μm in width, situated very close to the rostrum and embedded in a mass of dense protoplasm ; endoplasm containing small fragments of ingested wooden particles.

Type material : *Holotype* : 1 ex., on slide (Reg. No. Pt. 3027), Nongpoh, Ri-Bhoi district, Meghalaya, India, 6. xi. 1988, coll. D. N. Tiwari.

Paratypes : 5 exs. on one slide (Reg. No. Pt. 3028) ; other data as for the holotype.

Type host : *Reticulitermes assamensis* ; location : gut.

Remarks : Five species of *Holomastigotes*, namely, *H. crassum*, *H. elongatum*, *H. hoffmani*, *H. magnum* and *H. rosei* as well as one undetermined species of this genus have been described so far from the globe. All these species excepting *H. elongatum* were recovered from the gut of termites belonging to the genus *Anacanthotermes*. On the other hand, *H. elongatum* was first described from the termite, *Hodotermes* by Grassi (1982) and subsequently from two termite genera, *Anacanthotermes* and *Reticulitermes* by Grassi (1917) and Koidzumi (1921) respectively.

The present species of *Holomastigotes* distinctly differs from all the earlier described congeners in body shape and dimensions and in having prominent rostrum. However, *H. magnum* resembles the present species to some extent in body shape only. But, its posterior portion of the body is drawn out and rostral part is quite different from the present species. Moreover, *H. magnum* has been recorded from 4 species of *Anacanthotermes* belonging to the family Hodotermitidae while the present one has been found in the gut of an endemic Indian species of termite, *Reticulitermes assamensis* belonging to the family Reticulitermitidae.

It is worth mentioning that *H. elongatum*, the only species of *Holomastigotes* recovered so far from the termite genus, *Reticulitermes* differs considerably from *H. indica* sp. nov., in having fusiform or lanceolate body (vs. spindle shaped body with rounded posterior end in the present species), smaller dimensions, i.e., 15-45 μm \times 10-15 μm (vs. 43.2-65.5 μm \times 12.8-25.6 μm in the present species) and distinct ridges found on the body surface (vs. body surface without any ridge in the present species)

Genus *Spirotrichonympha* Grassi and Foa

1911. *Spirotrichonympha* Grassi and Foa. *Rend. R. Acad. Lincei* (5), 20 : 727.

Dignosis : Body elongate, pyriform, flagella deeply embedded in cytoplasm in anterior region arising from flagellar bands, mass of dense cytoplasm conical and its base indistinct.

9. *Spirotrichonympha porteri* (Koidzumi)

1917. *Spirotrichonympha porteri* Koidzumi, *Ann. Rep. Inst. Sci. Govt. Formosa*, 6 : 93.

1921. *Microspirotrichonympha porteri* Koidzumi, *Parasitology*, 13 : 268.

Material examined : 10 exs., Dawki, West Khasi Hills, 18. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Anterior end of the body cone-shaped and posterior end round with finger-like prolongation ; dimensions 14.4-35.2 (23.4) μm \times 11.2-27.2 (17) μm ; number of spiral flagellar band 6-8. hinder portion of the body free from any flagella ; nucleus oval, situated at about anterior third of the body ; nucleus not suspended freely but connected with anterior tip of body by means of rostral tube of uniform thickness.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (West Khasi Hills district) ; new record from India.

Remarks : From *Reticulitermes* Koidzumi (1921) recorded some specimens of *S. porteri* having rounded body and without any finger-like projection at posterior end. Such forms are not observed in the present material.

Family TERANYMPHIDAE

Genus *Teranympha* Koidzumi

1917. *Teranympha* Koidzumi ; *Ann. Rep. Inst. Sci. Govt. Formosa*, 6 : 93.

Diagnosis : Large, elongate, body ridged regularly and transversely, presenting a metameric appearance, each ridge provided with a single row of flagella ; nucleus single, vesicular, enclosed in nuclear sac, fixed to the body wall and base of head, lying on the first apparent segment of the body.

10. *Teranympha mirabilis* Koidzumi

1917. *Teranympha mirabilis* Koidzumi, *Ann. Rep. Inst. Sci. Formosa*, 6: 93.

Material examined : 6 exs., Cherrapunjee, East Khasi Hills, 8. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body wider at anterior and gradually tapering towards posterior end, dimensions 150-233 μm \times 21.6-70 μm , body ridged regularly and transversely, number of ridges varying from 18-30 and sometimes even more ; shape and location of nucleus as in the genus.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (East Khasi Hills district) ; new record from India.

Family TRICHONYMPHIDAE

Genus *Trichonympha* Leidy

1877. *Trichonympha* Leidy, *Proc. Acad. Nat. Sci. Phil.*, 29 : 147.

Diagnosis : Relatively large, body subdivided into three regions—rostrum, flagella bearing region behind rostrum and nonflagellated posterior region—flagella arising at the posterior limit of flagellated region longest, extending beyond the posterior end of the body ; parabasal apparatus composed of numerous cords in endoplasm of posterior region.

Key to the species.

- 1 (2) Body more or less oval or spindle shaped with widest portion from anterior to middle of the body *T. agilis*
- 2 (1) Body with truncated posterior end, widest portion being in the posterior part of the body, usually possessing a notch near anterior one-third of the body *T. meghalayensis*

11. *Trichonympha agilis* Leidy

1877. *Trichonympha agilis* Leidy, *Proc. Acad. Nat. Sci. Phil.*, 29 : 147.

Material examined : 2 exs., Balat, West Khasi Hills, 11. xi. 1988, coll. D. N. Tiwari.

Diagnosis : Body more or less spindle-shaped or oval, measuring 40-110 (75) μm in length and 20-46 (31) μm in width ; flagellated region occupying about one-third the length of the body, parabasal apparatus basket like comprising numerous slender separate cords, these cords usually meeting just behind the nucleus and occasionally beyond the nucleus ; nucleus spheroidal or ellipsoidal, situated near or just beyond the posterior end of the flagellated zone of the body.

Host : *Reticulitermes assamensis* ; location : gut.

Distribution : India : Meghalaya (West Khasi Hills district) ; new record from India.

12. *Trichonympha meghalayensis* sp. nov.

(Pl. 9)

Diagnosis : Body more or less elongated with truncated posterior end, usually possessing a notch just behind the flagellated zone of the body ; measuring 81-148.7 (133.8) μm in length and 29.6-59.2 (45.2) μm in width, maximum width being near the posterior end of the body ; body divisible into three distinct zones, viz., rostrum, flagellated zone and non flagellated zone; flagella on the rostrum of uniform length excepting just posterior to the cap where few shorter flagella present ; posterior to the rostrum flagella increase in length and those arising at the posterior limit of the flagellated region longest, extending beyond the posterior end of the body ; flagellated zone occupying less than one-third the length of the body ; parabasal apparatus distinct, forming a bowl-shaped structure within which nucleus located ; parabasal cords separate and numerous, extending up to or above nucleus ; nucleus ovoidal, measuring 8.1-14.8 (12.6) μm in length and 7.2-12.9 (9.2) μm in width, situated near the posterior end of the flagellated zone ; endoplasm containing small fragments of ingested wooden particles.

Type material : *Holotype* : 1 ex., on slide (Reg. No. Pt. 2129), William Nagar, East Garo Hills district, Meghalaya, India, 28. xi. 1988, coll. D. N. Tiwari.

Paratypes : 6 exs., on one slide (Reg. No. Pt. 2130), other data as for the holotype.

Type host : *Reticulitermes assamensis* ; location : gut.

Remarks : The present species in having characteristic features, namely, (i) elongated body usually with a notch just behind the flagellated zone of the body and (ii) bowl-shaped parabasal apparatus holding the nucleus achieves a separate identity from all other described species of *Trichonympha*. However, it resembles *T. agilis* to some extent in the structure of parabasal apparatus and in having numerous separate parabasal cords reaching upto the nucleus. But, *T. meghalayensis* sp. nov. differs from *T. agilis* by its characteristic shape and larger dimensions (133.8 μm \times 45.2 μm in average vs 82.3 μm \times 34.2 μm in average in *T. agilis*) and in flagellated to non-flagellated zone ratio (average 0.32 : 1 vs 0.64 : 1 in *T. agilis*).

Mention is to be made here that *T. agilis* has been recovered from the gut of all the species of *Reticulitermes* studied so far for their symbiotes including the present termite species, *R. assamensis*. The average dimension of *T. agilis* collected from Meghalaya is $75 \mu\text{m} \times 31 \mu\text{m}$ as mentioned earlier.

GENERAL REMARKS ON DISTRIBUTION

The district-wise distribution of each protozoan species reported from Meghalaya has already been stated during its respective taxonomic treatment. In Table 1 and Map 2 number of species of freeliving, parasitic and symbiotic protozoa recorded so far from each of seven districts of this state is presented for quick perusal.

Table-1. District-wise distribution of Protozoan species in Meghalaya.

Name of district	No. of species of Protozoa			
	Freeliving	Parasitic	Symbiotic	Total
West Garo Hills	42	14	1	57
East Garo Hills	13	15	2	30
South Garo Hills	13	—	—	13
East Khasi Hills	41	40	1	82
West Khasi Hills	7	—	4	11
Jaintia Hills	8	5	2	15
Ri-Bhoi	6	3	2	11

From the table it is quite evident that maximum number of protozoan species is reported from East Khasi Hills district followed by West Garo Hills and East Garo Hills districts. After analysing the distribution list of all the species given in the taxonomic account it is revealed that only two species, viz., *Centropyxis ecornis* and *Trinema lineare* have been collected from all the districts of this state. Interestingly, both are freeliving rhizopods. The first one was collected from freshwater while the second one from ground and rock moss. The list of cosmopolitan species of Meghalaya will be certainly long if more intensive survey of Protozoa in this state is done in future.

The symbiotic Protozoa has been recovered from a single termite host species, namely, *Reticulitermes assamensis*. Incidentally, this host species has never been studied for their symbiotes earlier. In all 12 species of flagellates were collected from its gut, out of which two species are new to science and the remaining ten constitute new records from Indian subcontinent.

Another aspect needs mention here. Two species of parasitic Protozoa, viz., *Lankesteria mackiei* and *Plasmodium semnopithecii* were reported from erstwhile Assam (see Bhatia, 1938),

the exact collecting localities of which are not indicated. The first one was recovered from the pupa and adult of the sand fly *Phlebotomus argentipes* and the second one from the blood of *Semnopithecus entellus* in 'Assam' and *Presbytes pileatus* in the Zoological Garden, London but brought from 'Assam' (Bhatia, *op. cit.*). These two species are excluded from the present taxonomic list and taxonomic treatment of parasitic protozoa of Meghalaya for obvious reason.

SUMMARY

A consolidated taxonomic account of all the freeliving, parasitic and symbiotic Protozoa reported and collected so far from Meghalaya has been presented. This includes 128 species belonging to 3 phyla, 9 classes, 21 orders, 46 families and 57 genera. Among these 58 species are freeliving, 58 Parasitic and 12 symbiotic.

Two species of symbiotic protozoa, *viz.*, *Holomastigotes indica* sp. nov. and *Trichonympha meghalayensis* sp. nov. are new to science, 22 species (12 freeliving and 10 symbiotic) constitute new records from India and 91 species (46 freeliving and 45 parasitic) are reported for the first time from Meghalaya.

The termite host species, *Reticulitermes assamensis* is studied for the first time in the globe for their symbiotic protozoa.

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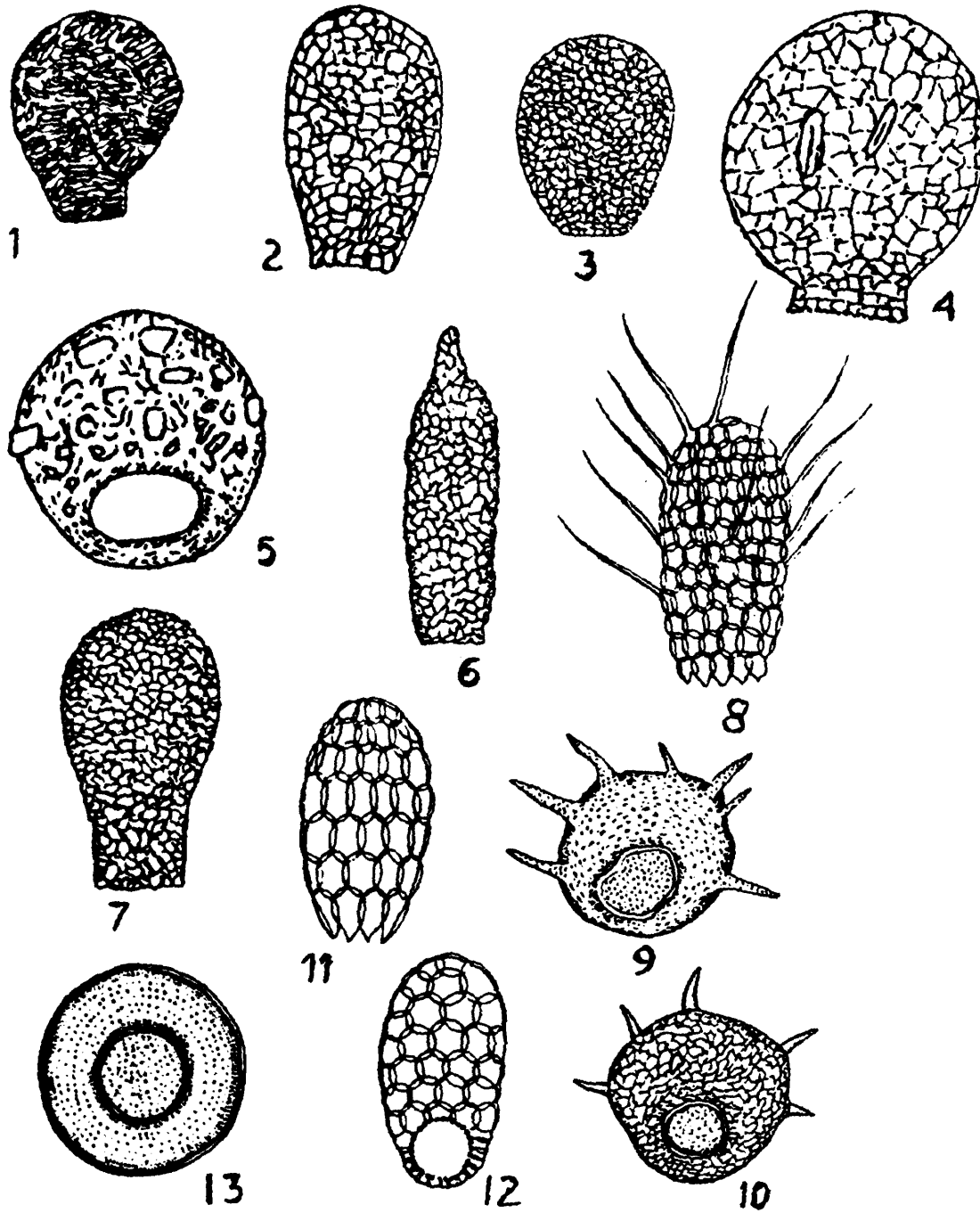


Plate 1

Figs. 1—13 Showing structure and sculpture of tests of different rhizopods

- Fig. 1. *Lesquereusia spiralis* (Ehrenberg); Fig. 2. *Diffflugia avellana* Penard; Fig. 3. *Diffflugia lobostoma* Leidy; Fig. 4. *Diffflugia lithophila* (Penard); Fig. 5. *Diffflugia globulosa* Dujardin; Fig. 6. *Diffflugia acuminata* Ehrenberg; Fig. 7. *Diffflugia pyriformis* Perty; Fig. 8. *Euglypha acanthophora* (Ehrenberg); Fig. 9. *Centropyxis spinosa* (Cash and Hopkinson); Fig. 10. *Centropyxis aculeata* (Ehrenberg); Fig. 11. *Euglypha tuberculata* Dujardin; Fig. 12. *Trinema enchelys* (Ehrenberg); Fig. 13. *Arcella discoides* Ehrenberg

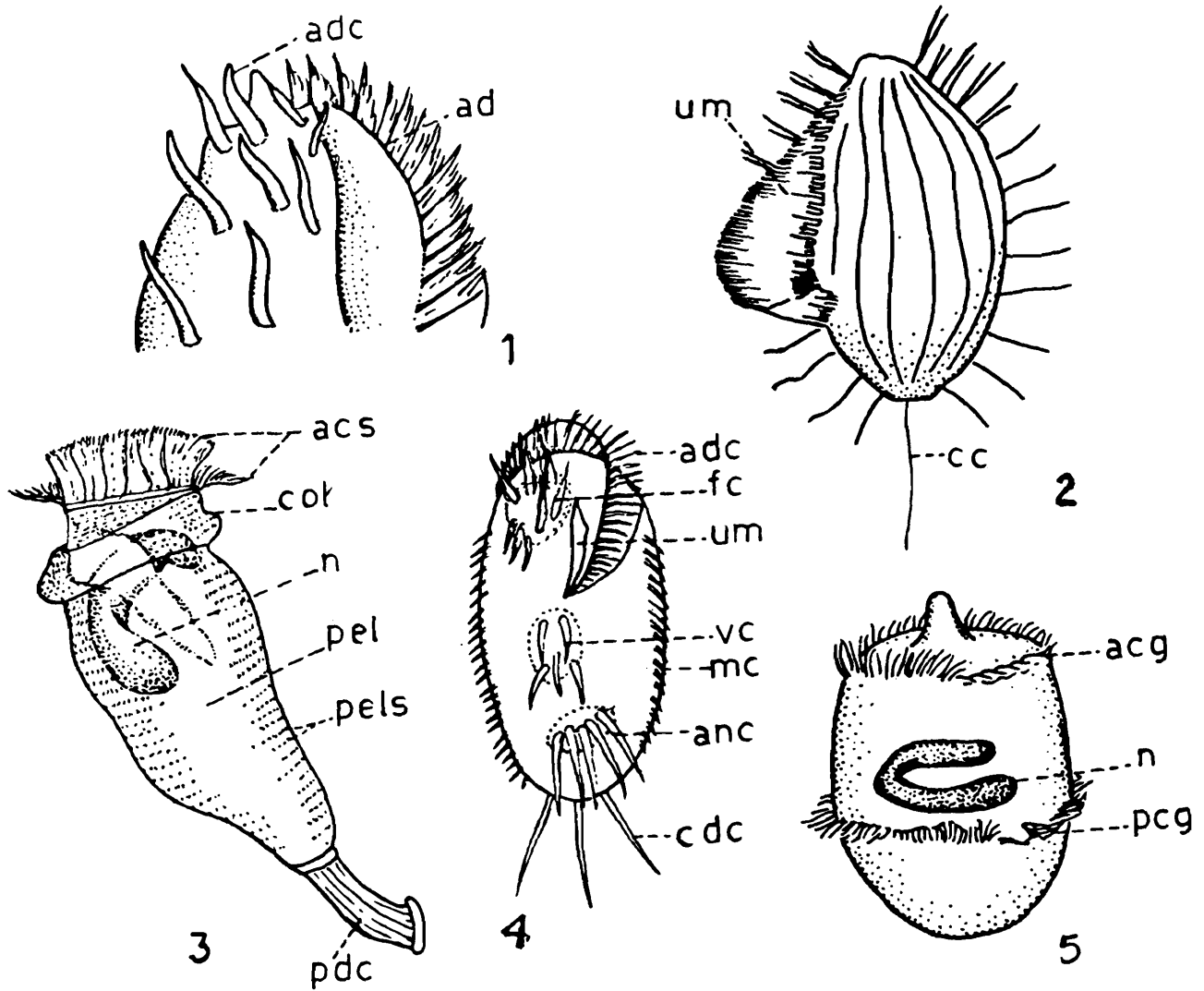


Plate 2

Figs. 1—5 Showing external ciliary structures of Ciliophora

Figs.1,4. *Euplotes* sp. (hypotrich ciliate); Fig. 2. *Cyclidium* sp. (scuticociliate); Fig. 3. *Epistylis* sp. (peritrich ciliate); Fig. 5. *Didinium* sp. (gymnostome)

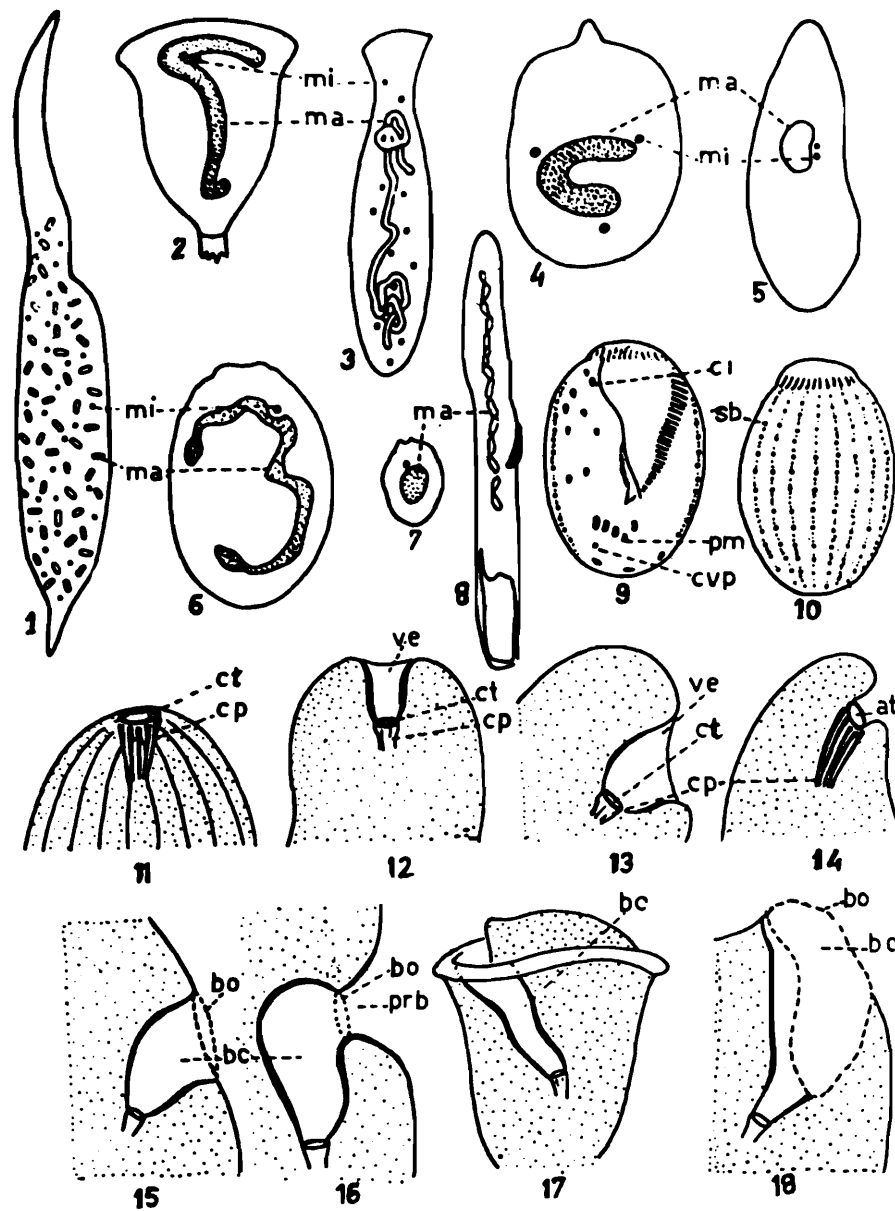


Plate 3

Figs. 1—8. Showing diversified shape of nucleus in freeliving ciliates

1. *Dileptus* sp. ; 2. *Vorticella* sp. ; 3. *Spathidium* sp. ; 4. *Didinium* sp. ; 5. *Paramecium* sp.; 6. *Euplotes* sp. ; 7. *Urotricha* sp. ; 8. *Spirostomum* sp.

Figs. 9—10. Showing infraciliature in *Euplotes* sp. (a hypotrich ciliate) by silver impregnation method after Chatton-Lwoff. 9. Ventral view ; 10. Dorsal view

Figs. 11—18. Showing oral areas in postulated phylogenetic sequence (after Corliss)

(at—atrium ; bc—buccal cavity ; bo—buccal overture ; ci—cirrus ; cp—cyto-pharynx ; ct—cystostome ; cvp—contractile vacuole pore ; ma—macronucleus ; mi—micronucleus ; pm—paroral membrane ; prb—prebuccal area ; sb—sensory bristle ; ve—vestibulum)

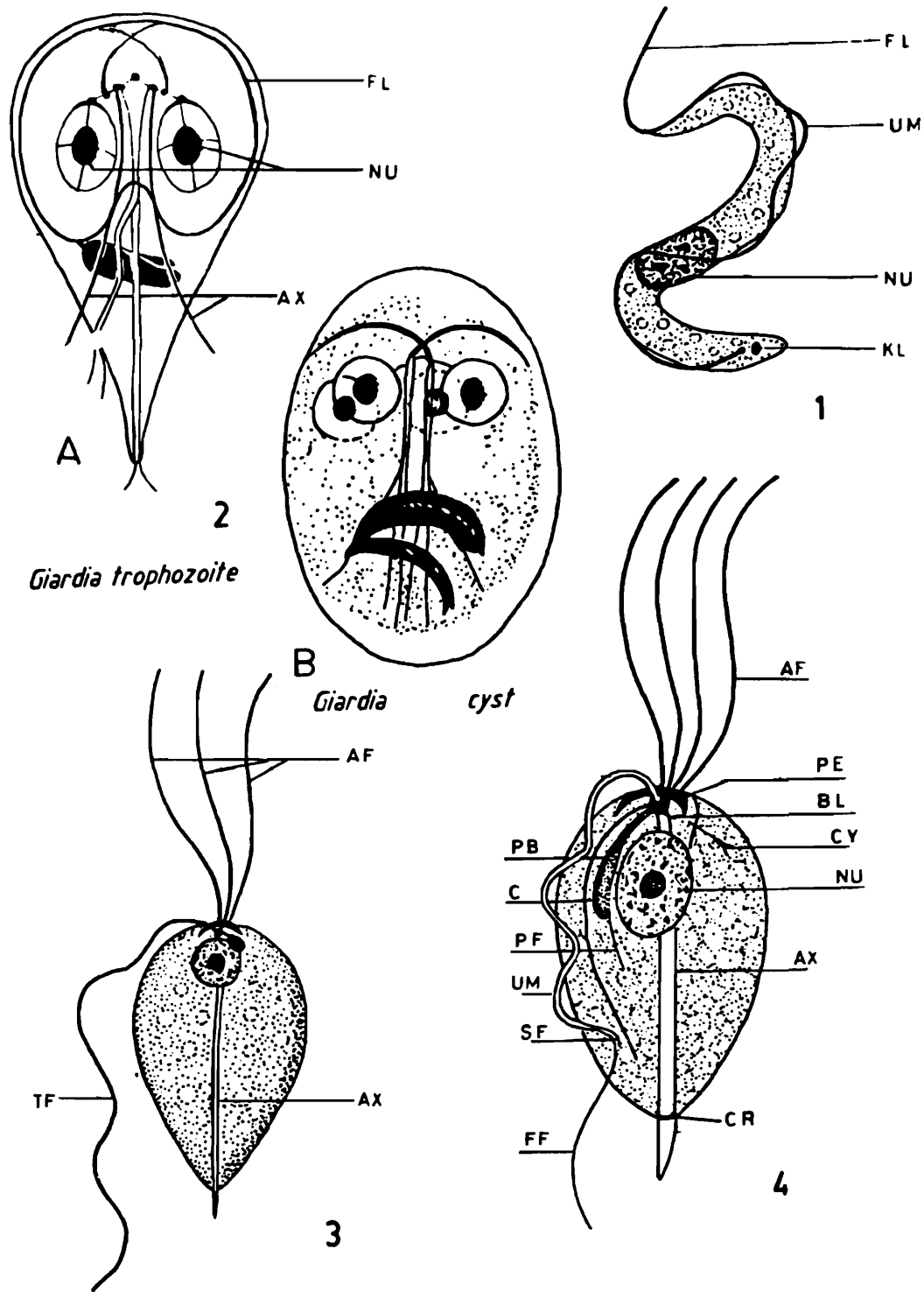


Plate 4

Figs. 1—4. Showing general structures of parasitic flagellates belonging to the genera *Trypanosoma* (fig. 1), *Giardia* (figs. 2A, B), *Monocercomonas* (fig. 3), *Trichomonas* (fig. 4). (AX—Axostyle ; AF—Anterior flagellum ; BL—Blepharoplast ; C—Costa ; CR—Chromatic ring ; CY—Cytostome ; FF—Free flagellum ; FL—Flagellum ; KL—Kinetoplast ; NU—Nucleus ; PB—Parabasal body ; PE—Pelta ; PF—Parabasal filament ; TF—Trailing flagellum ; UM—Undulating membrane)

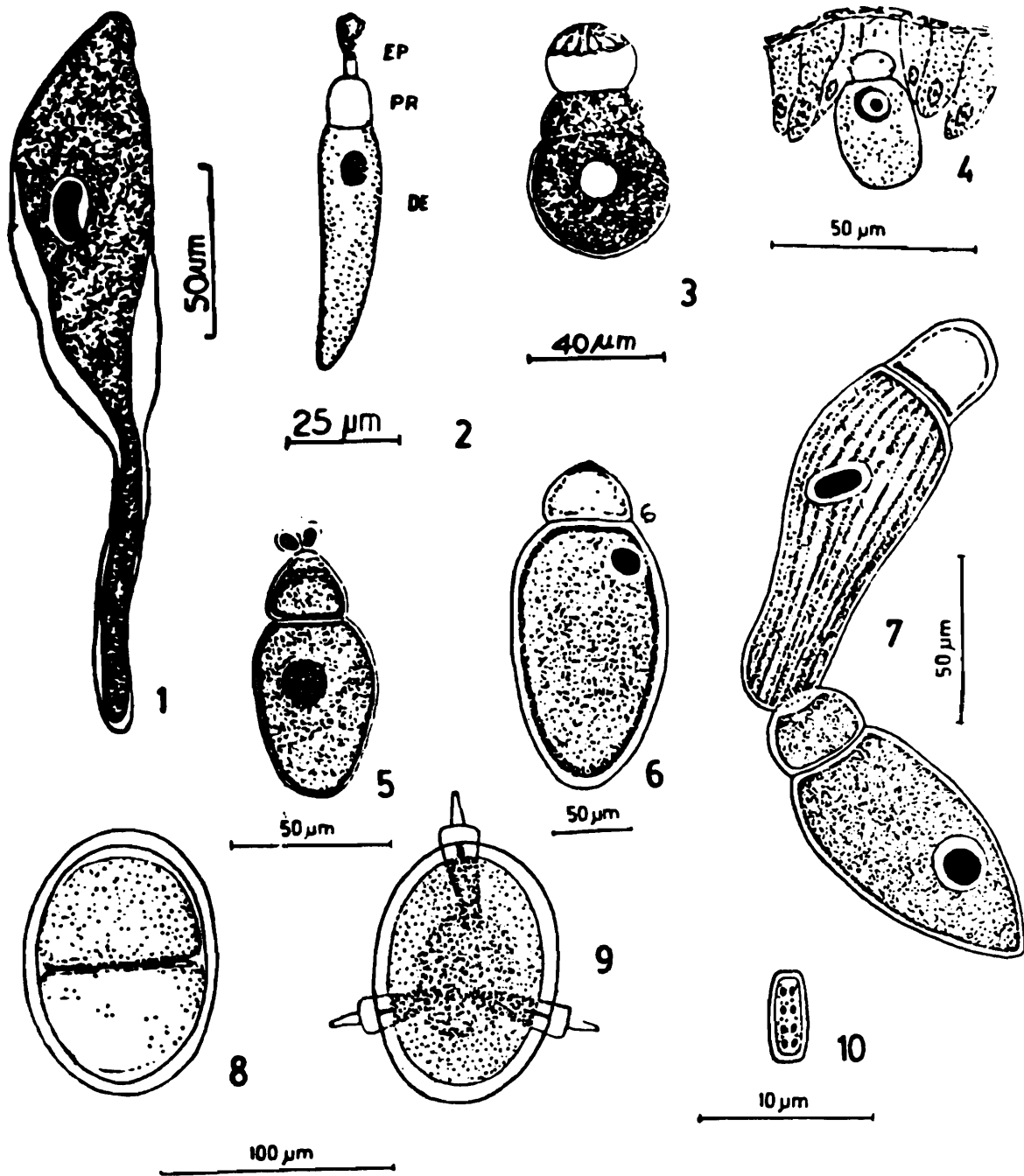


Plate 5

Figs. 1—10. Showing general structures and life cycle stages of some gregarines parasitising invertebrate hosts.

1. An aseptate gregarine of earthworms ;
 2. Septate gregarine of coccinellid beetle ;
 3. Septate gregarine of psocopteran insect ;
 - 4-10. Life cycle stages of a cephaline gregarine, *Gregarina bilobosa* from coleopteran insect (4. young trophozoite attached to the host gut epithelium ; 5. fully grown trophozoite ; 6. sporadin ; 7. sporadins in syzygy ; 8. a freshly formed gametocyst with two equal sized gametocytes ; 9. a mature gametocysts with three sporoducts ; 10. a barrel shaped spore showing linearly arranged sporozoites.
- (EP—Epimerite ; PR—Protomerite ; DE—Deutomerite)

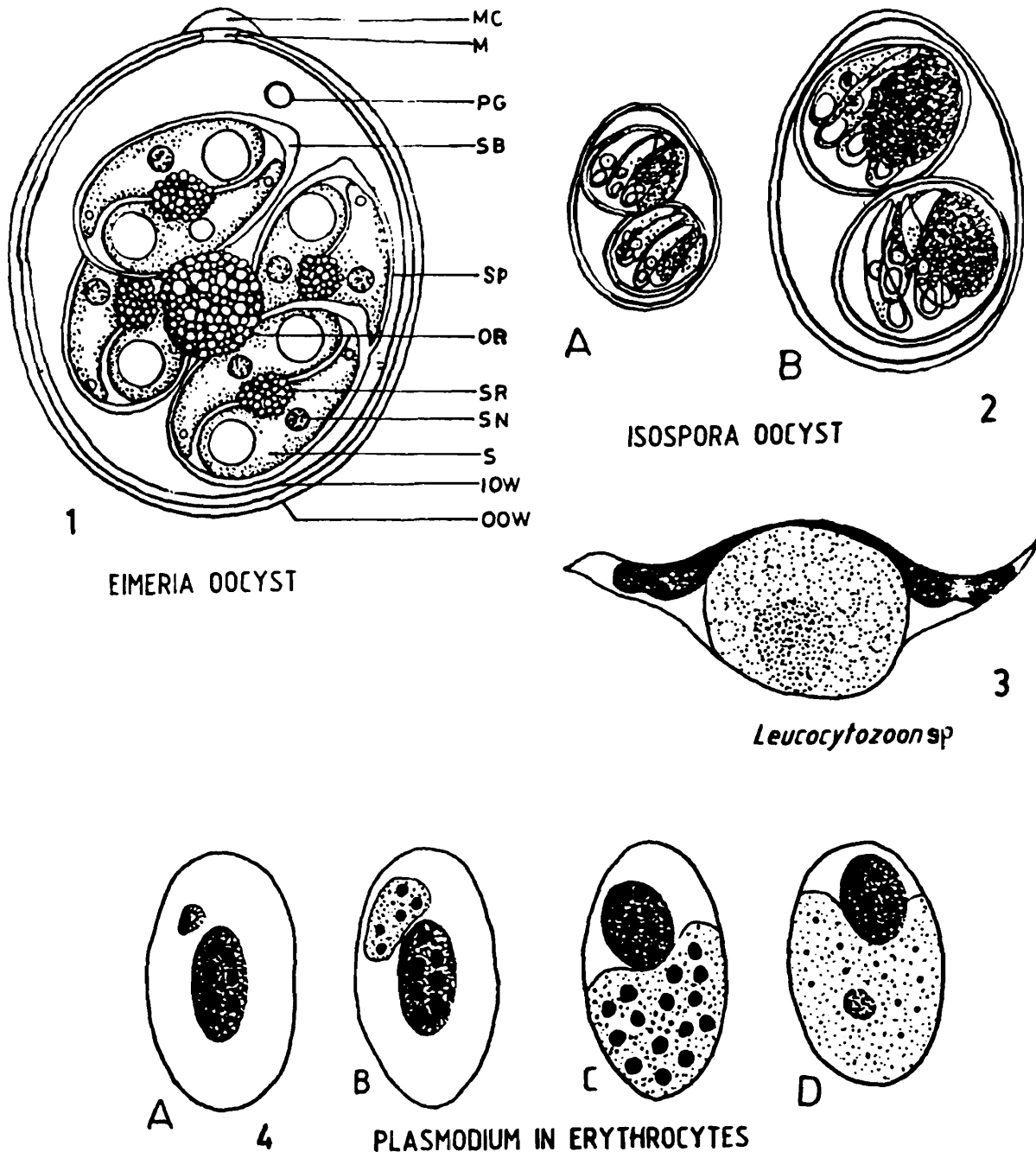


Plate 6

Figs. 1—4. Showing general structures and life cycle stages of some genera of *Emerina* and *Haemosporina*
 1. General structures of sporulated oocyst of *Eimeria* ; 2. Sporulated oocyst of *Isospora* (A. *Isospora revolta* ; B. *Isospora felis*). ; 3. General shape of a microgametocyte of *Leucocytozoon* ; 4. A-D. Some life cycle stages of *Plasmodium* in blood (A—Ring stage ; B. Growing schizont ; C. Segmenter ; D. Macrogametocyte)
 (IOW—Inner layer of oocyst wall ; M—Micropyle ; MC—Micropylar cap ; OOW—outer layer of oocyst wall ; OR—Oocyst residuum ; PG—Polar granule ; S—Sporozoite ; SB—Steida body ; SN—Sporozoite nucleus ; SP—Sporocyst ; SR—Sporocyst residuum)

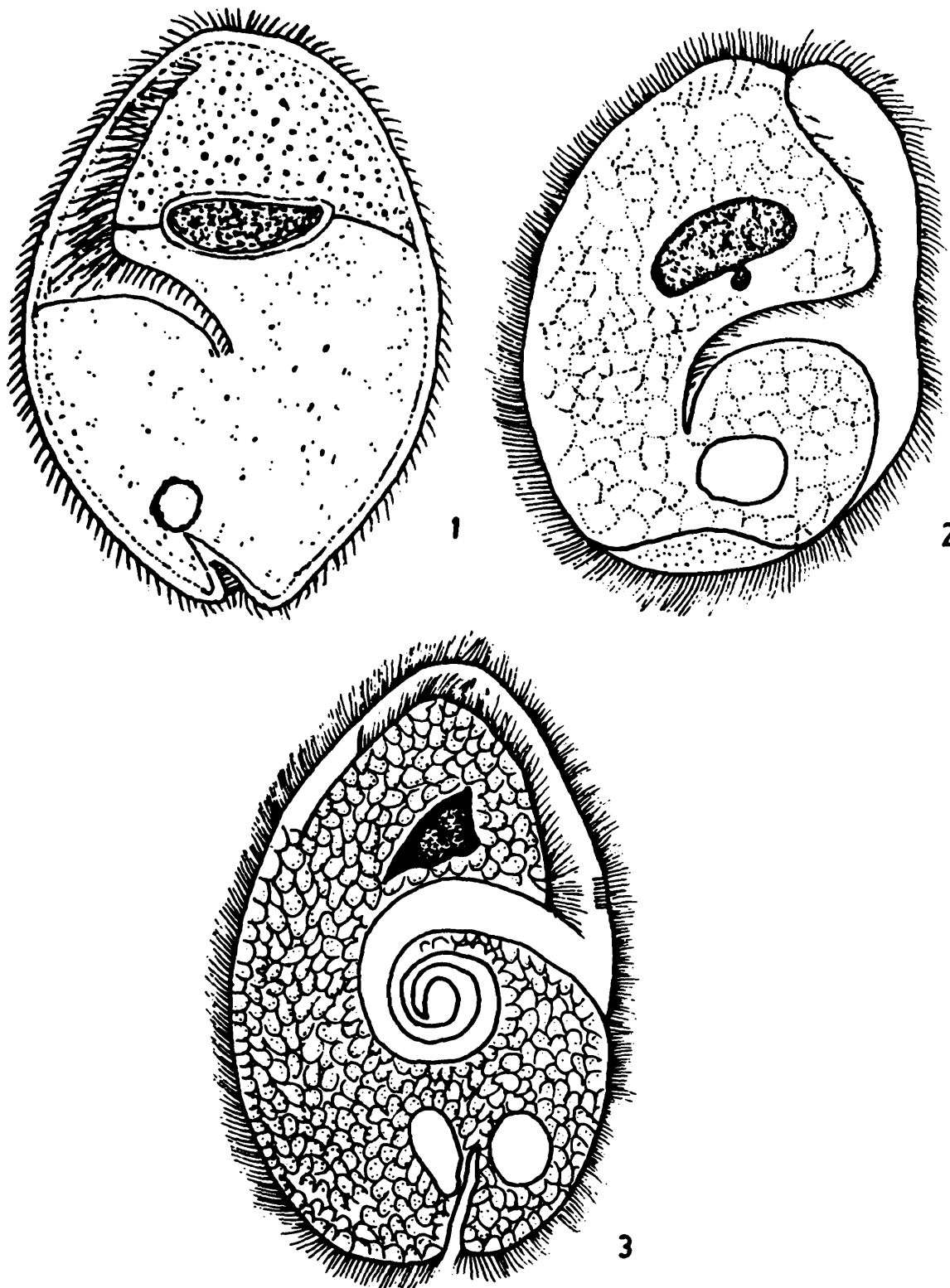


Plate 7

Figs. 1—3. Showing shape and morphological structures of three species of endocommusal heterotrichid ciliates inhabiting the gut of cockroach (fig. 1) and, toad and frog (figs. 2, 3)
1. *Nyctotherus ovalis* Leidy ; 2. *Nyctotheroides cordiformis* (Ehrenberg) ; 3. *Sicutophora macropharyngeus* (Bezzemberger)

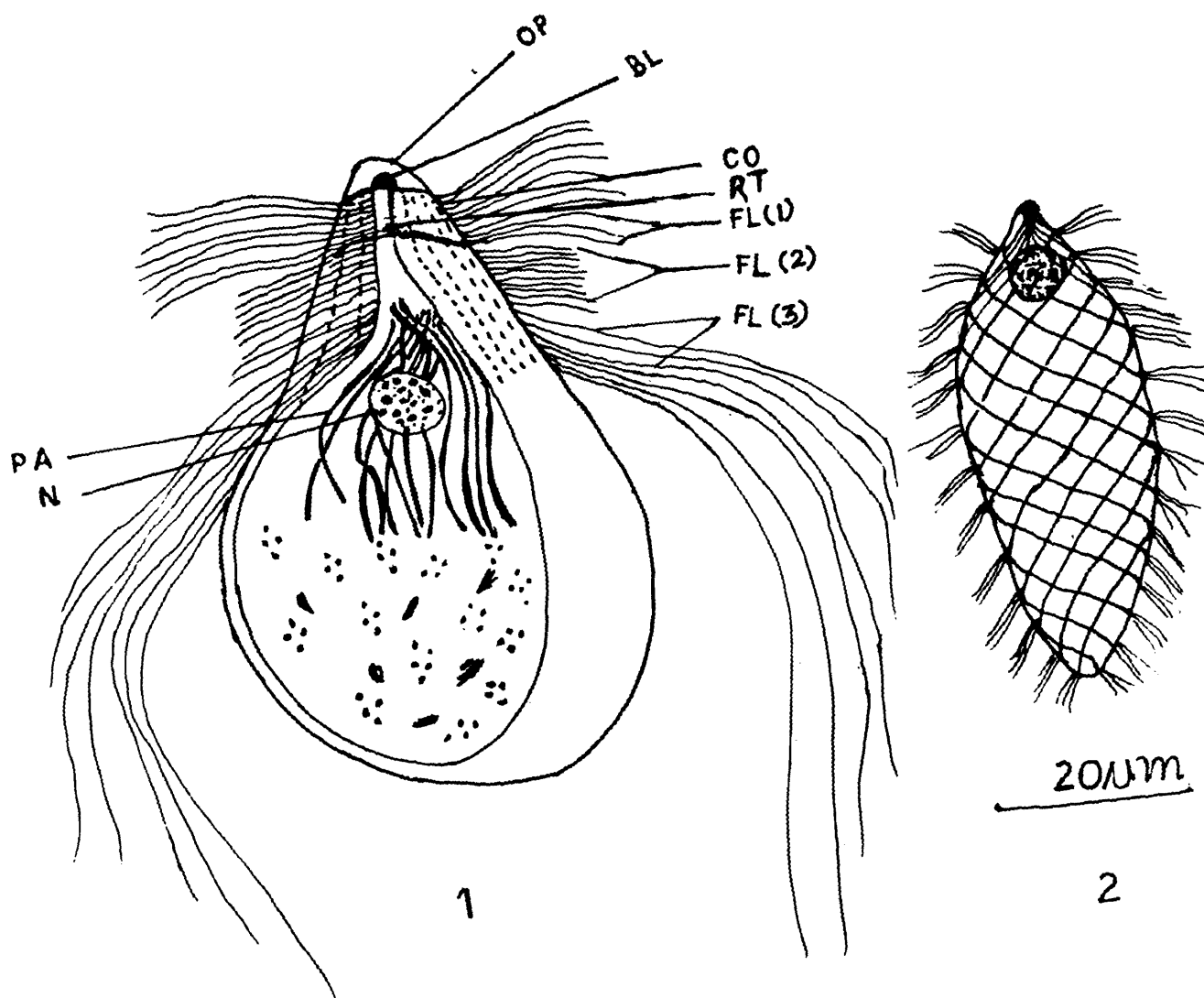


Plate 8

Fig. 1. Showing general structure of a hypermastigid flagellate, *Trichonympha* sp.
 Fig. 2. *Holomastigotes indica* sp. nov.

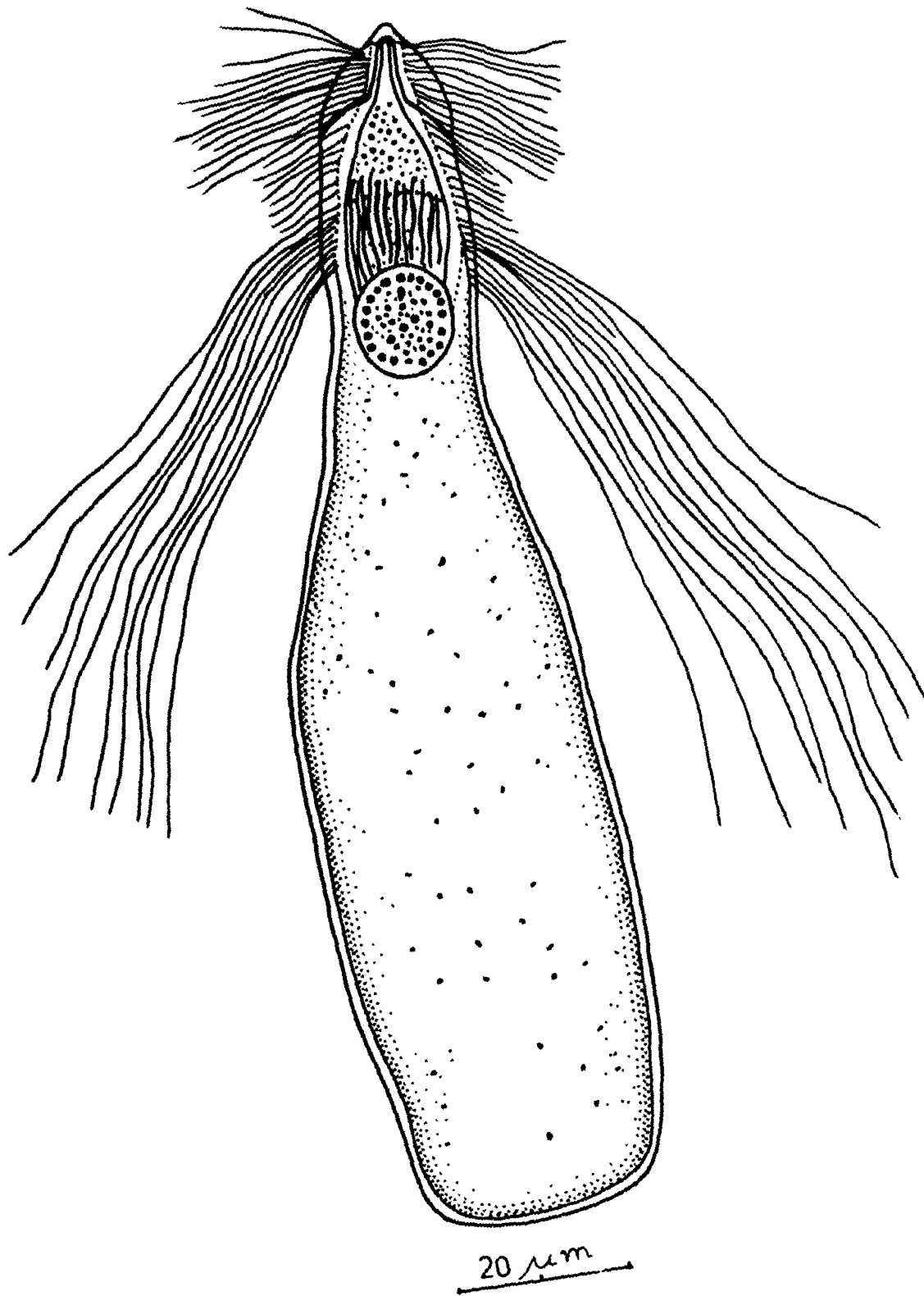
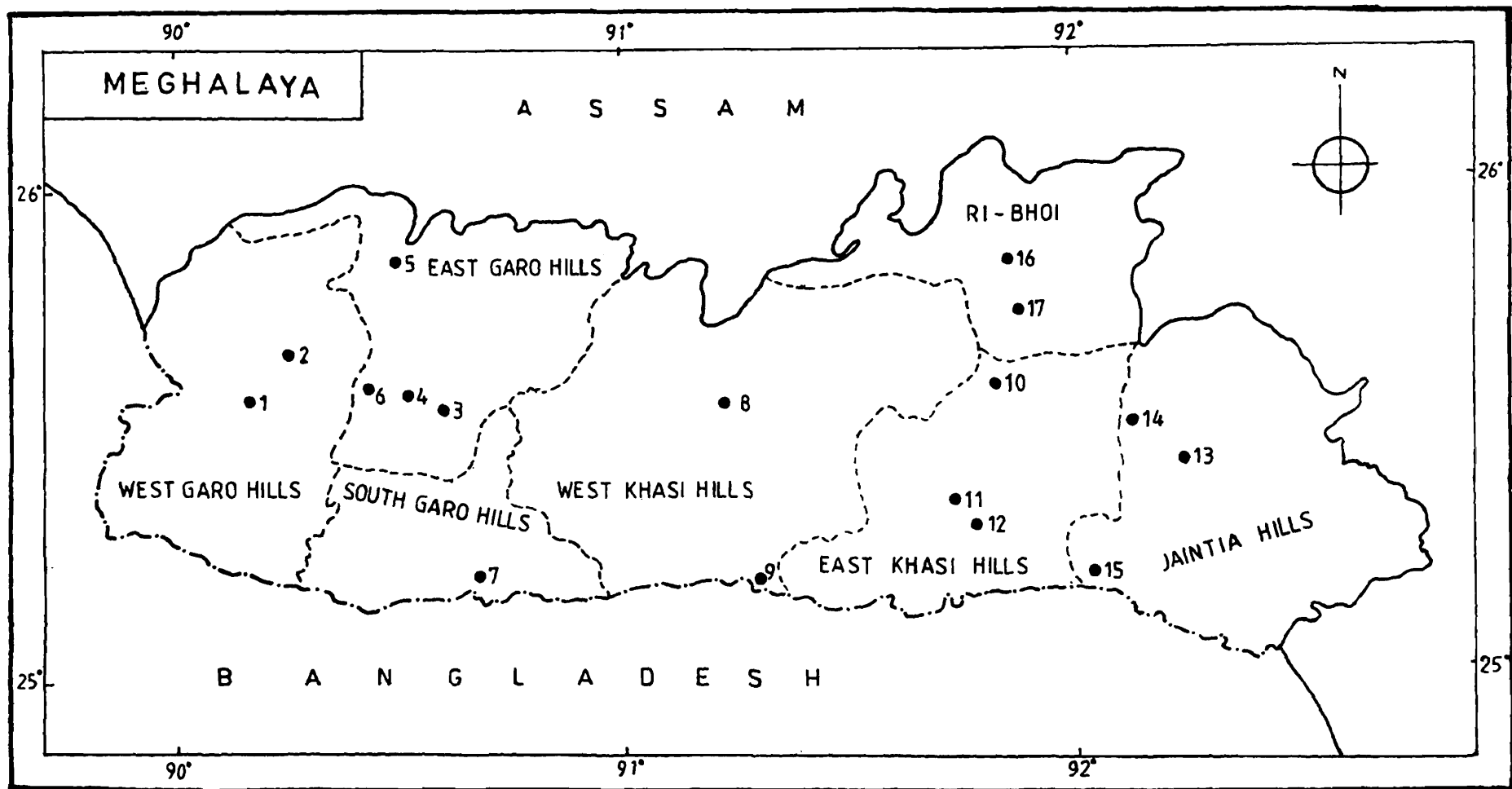


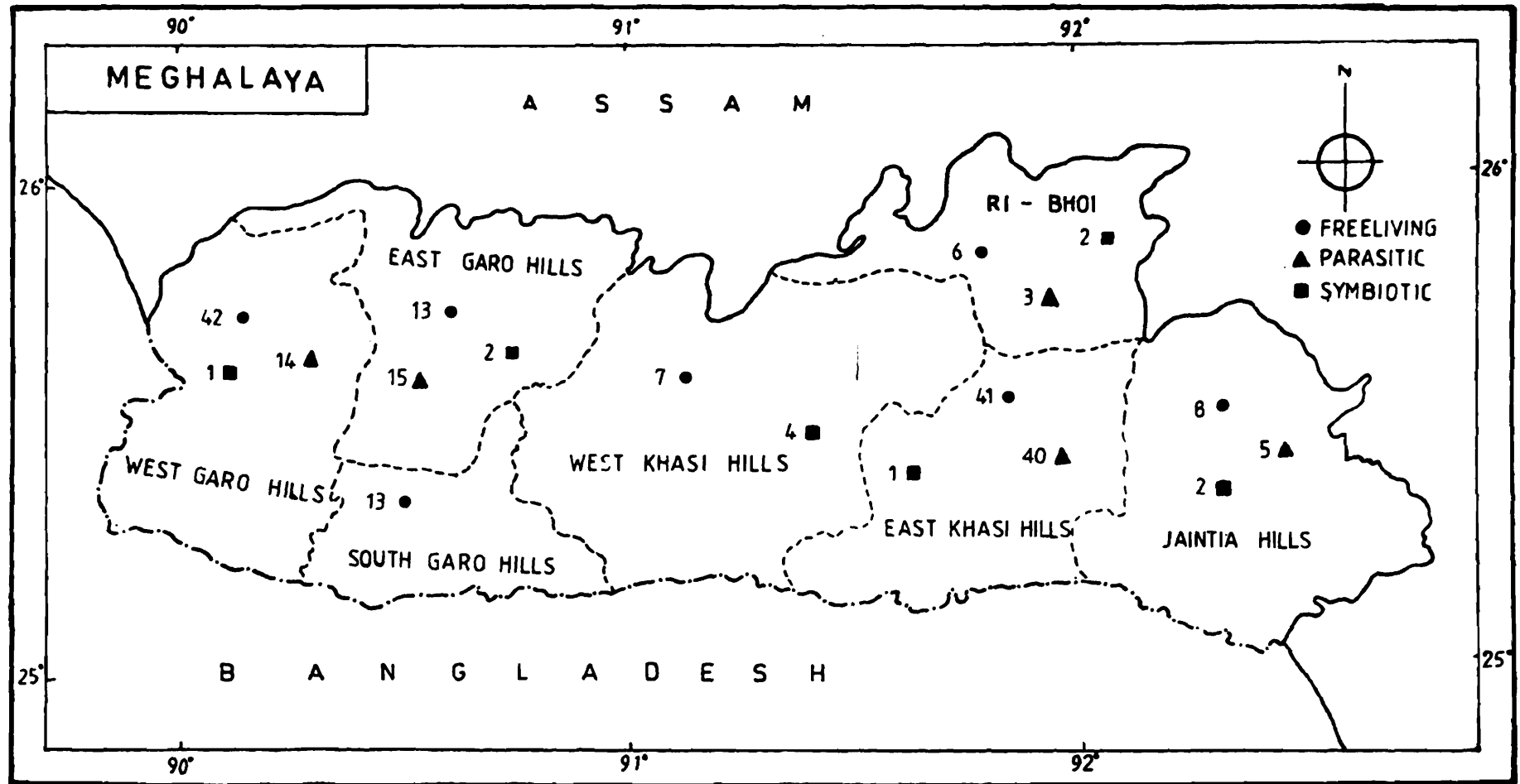
Plate 9

Fig. 1 *Trichosymoha meghalayensis* sp. nov.

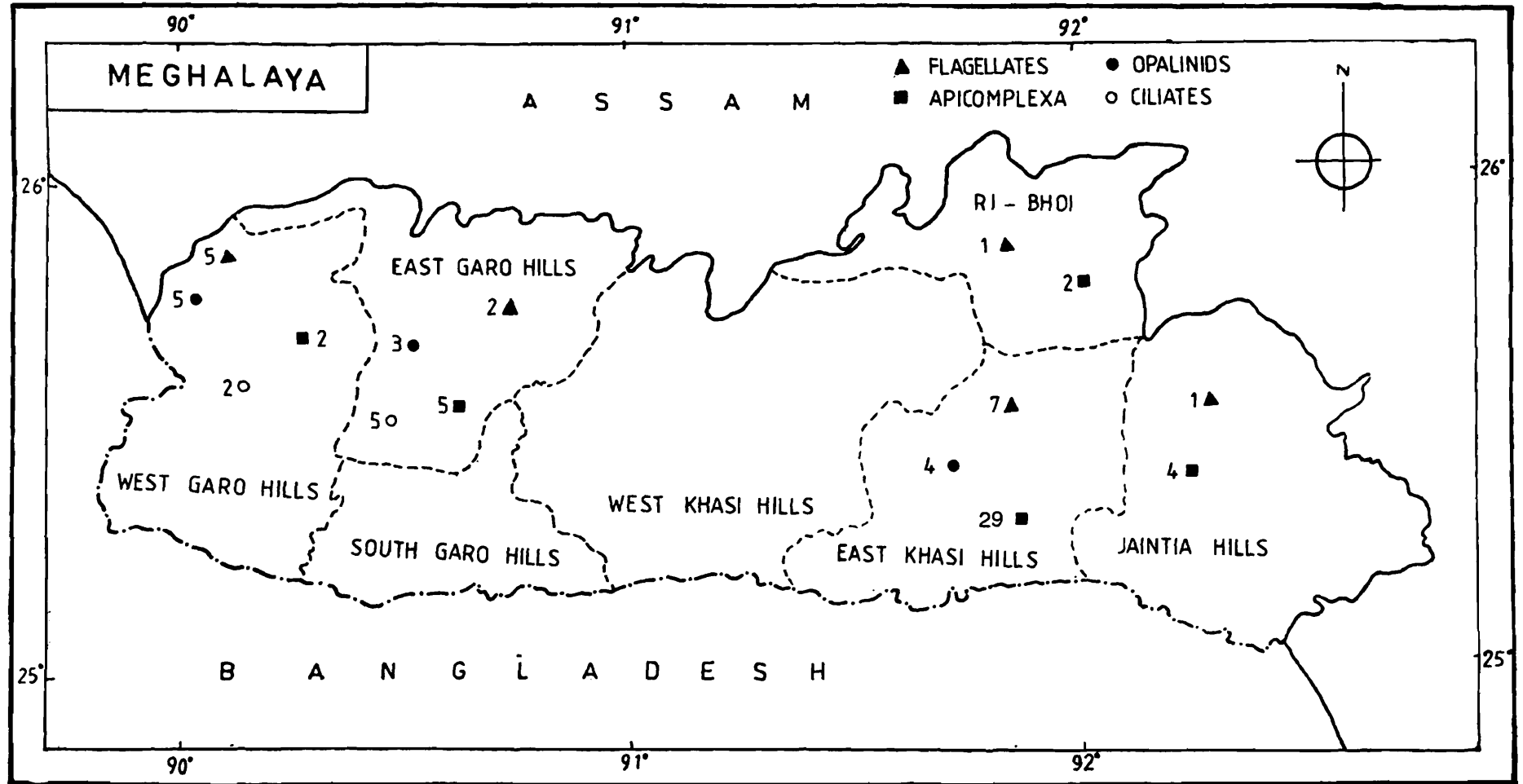


Map. 1. Showing collecting localities of protozoa in Meghalaya

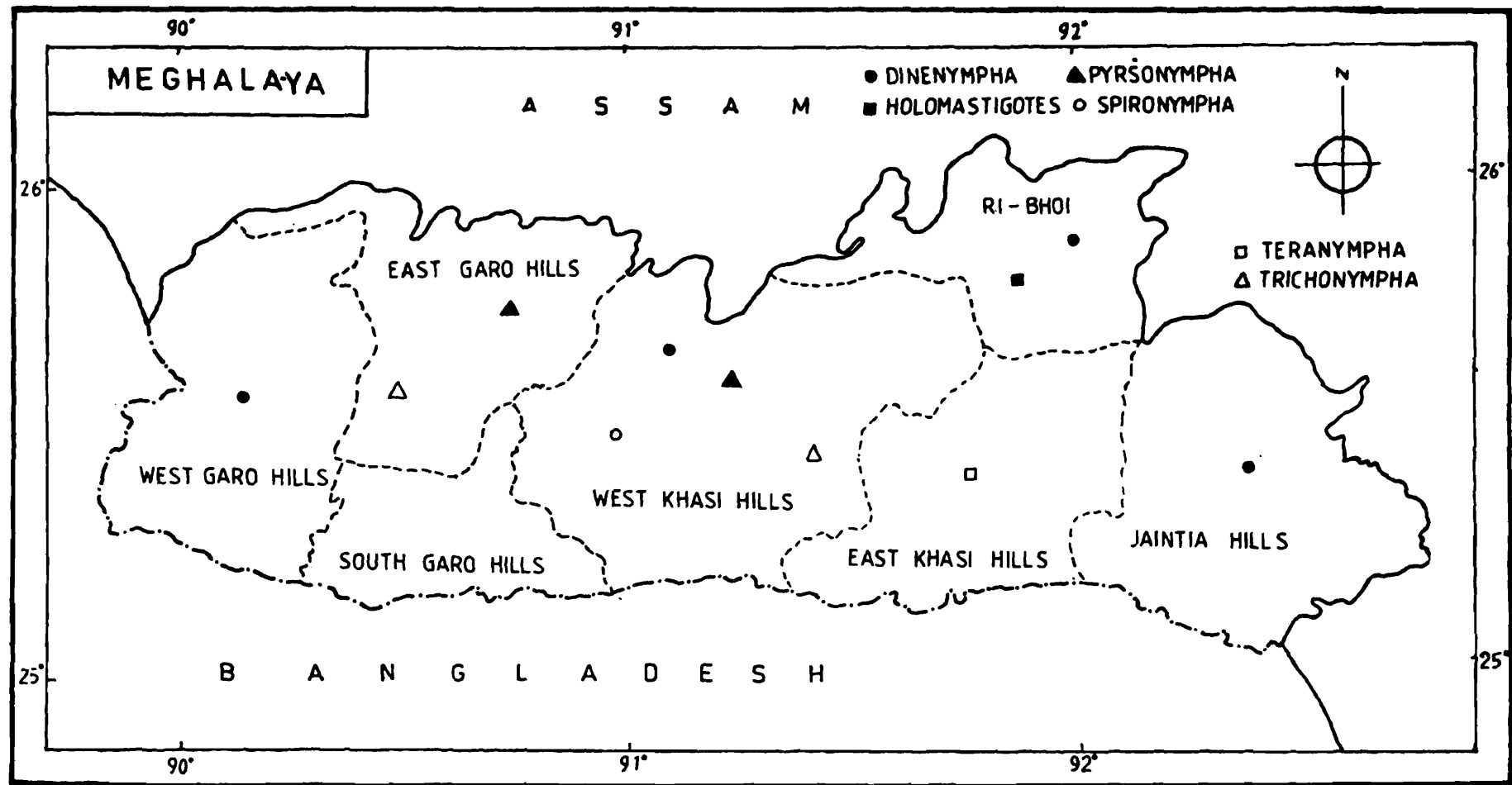
1. Tura ; 2. Rongram ; 3. William Nagar; 4. Rongrengri ; 5. Bojengdoba ; 6. Ransak Bazar ; 7. Bagmara ; 8. Nongstoin ; 9. Balat; 10. Shillong ; 11. Cherrapunjee ; 12. Mawsmai ; 13. Jowai ; 14. Thadleskein ; 15. Dawki ; 16. Nongpoh ; 17. Umsning.



Map. 2. Showing district-wise distribution of freelifving, parasitic and symbiotic protozoa (in number of species) in Meghalaya.



Map. 3. Showing group-wise distribution of parasitic protozoa, *viz.* flagellates, opalinids, apicomplexa and ciliates in number of species in Meghalaya.



Map. 4. Showing genus-wise distribution of flagellate symbiotes in each district of Meghalaya.