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Studies on Symbiotic Flagellates from some Indian Termites

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AND

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CONTENTS

INTRODUCTION

The present paper deals with a taxonomic study of the symbiotic flagellates from some wood-inhabiting termites of the families Kalotermitidae and Rhinotermitidae from different parts of India. The pioneering investigation on the taxonomy of this group in India dates back to 1890 when Simons first reported the occurrence of two flagellates of uncertain taxonomic status from Kolkata. Further the study of symbiotic flagellates from Indian termites attracted the attention of taxonomists since 1919 when Imms described two new species, namely *Trichomonas termitis* and *Trichonympha pristina* from a primitive Himalayan termite, *Archotermopsis wroughtoni* (Desneux). From 1919 onwards, knowledge of flagellates from Indian termites enormously enhanced with the pioneering work of De Mello and his collaborators. Indian authors who dealt with the termite flagellates during the second half of twentith century are Karandikar and Vittal (1954, 1956), Chakravarty and Banerjee (1956), Uttangi (1959, 1962), Das (1972-2005), Das and Choudhury (1972). Tiwari (1977) and Mukherjee and Maiti (1988, 1989). Recently, Das, Tiwari, Mandal and Sarkar (2000-2005) reported a good number of flagellate species from 3 termite hosts, namely, *Cryptotermes dudleyi, Coptotermes travians* and *Reticulitermes assamensis* collected in Andhra Pradesh (Das *et al.*, 2004) and in the eastern states of India (Tripura, Sikim, Meghalaya, Nagaland and Arunachal Pradesh (Das *et al.*, 2006). However, altogether 48 species of flagellates recovered from 9 species of termite hosts have been dealt in the present work in details. Apart from this, keys to these flagellate species based on their morphological features have been incorporated for their easy identification. Further, a systematic list of these flagellates, bibliography, illustrations, tables etc., are added features of the present contribution.

MATERIAL AND METHODS

The flagellate faunules studied in the present work were procured from following nine wood-inhabiting termites from some parts of India.

Family : KALOTERMITIDAE : (i) *Neotermes assamensis* Maiti and Saha was collected from several Mango trees (*Mangiflora indica*) by P.K. Maiti, from Dibrugarh and Jorhat, Assam. (ii) *Neotermes bosei* Snyder was collected from Dehra Dun, Uttaranchal from a Mango tree by B Mitra. (iii) *Neotermes dhirendrae* Bose was collected from a Mango tree by P.K. Maiti, from Chennai, Tamil Nadu. (iv) *Cryptotermes havilandi* (Sjostedt) was collected in many occasions in and around Kolkata, West Bengal inhabiting in Mango and Ficus (*Ficus bengalensis*) trees by P. Mukherjee.

Family : RHINOTERMITIDAE : (v) *Coptotermes heimi* (Wasmann) was collected from many localities in and around Kolkata, West Bengal by P. Mukherjee. (vi) *Coptotermes travians* (Haviland) was collected only from Jorhat, Assam by P. Mukherjee. (vii) *Heterotermes indicola* (Wasmann) was collected from many localities in and around Kolkata, West Bengal by P. Mukherjee. (viii) *Reticulitermes assamensis* Gardner was collected from exposed root of Pine tree at Shillong, Meghalaya by P. Mukherjee. (ix) *Reticulitermes tirapi* Chhotani and Das was collected by P.K. Maiti from the dead stump of an unknown tree from Namdhapa Biosphere Reserver, Arunachal Pradesh.

The infested logs, branches, stumps, etc., with the host termites were brought to the laboratory and were kept in the laboratory cages wherein the host termites were reared to serve as constant source of flagellate material. The entire posterior portion of the gut was removed from a termite by holding it in the region of the thorax with one forcep and grasping the posterior part of the abdomen with another. On a slide the gut was opened in a small amount of fluid as nearly as isotonic as possible with the contents of the termite gut (0.5% Sodium chloride has been used). The flagellates were then gently spread in NaCl fluid. To make good smears the termites were removed from the wood and kept for 2-3 days in desiccator with moist filter paper as diet and water as miosture source, after which smears were made. The smears were semidried and fixed in Schaudin's or Bouins fluid. The smears were then dipped slowly and preserved in 70% alcohol. After proper staining the smears were mounted with Canada Balsam. The specimens of the smears have been studied under a Stereoscopic Microscope and diagrams have been drawn with the aid of a Camera Lucida. The classification of symbiotic flagellates followed for the present purpose is that of Levine *et al.*, published in 1980.

STSTEMATIC LIST OF SYMBIOTIC FLAGELLATES RECOVERED FROM SOME TERMITES OF INDIA

Phylum SARCOMASTIGOPHORA

Subphylum MASTIGOPHORA

Class ZOOMASTIGOPHORA

Order OXYMONADIDA

Family OXYMONADIDAE

Genus ***Oxymonas*** Janicki

1. *Oxymonas grandis* Cleveland — *Neotermes assamensis*, *Neotermes bosei*

Genus ***Pyrsonympha*** Leidy

2. *Pyrsonympha grandis* Koidzumi	*Reticulitermes tirapi*
3. *Pyrsonympha granulata* Powell	*Reticulitermes assamensis* *Reticulitermes tirapi*
4. *Pyrsonympha rostrata* Mukherjee and Maiti	*Reticulitermes tirapi*
5. *Pyrsonympha tirapi* Mukherjee and Maiti	*Reticulitermes tirapi*

Genus ***Dinenympha*** Leidy

6. *Dinenympha mukundai* Mukherjee and Maiti	*Reticulitermes tirapi*
7. *Dinenympha nobilis* Koidzumi	*Reticulitermes tirapi*
8. *Dinenympha porteri* Koidzumi	*Reticulitermes assamensis* *Reticulitermes tirapi*
9. *Dinenympha rayi* Mukherjee and Maiti	*Reticulitermes tirapi*

Order TRICHOMONADIDA

Family DEVESCOVINIDAE

Genus ***Caduceia*** Franca

10. *Caduceia bugnioni* Kirby	*Neotermes dhirendrae*
11. *Caduceia theobromae* Franca	*Neotermes bosei*

Genus ***Devescovina*** Foa

12. *Devescovina cometoides* De Mello	*Neotermes bosei*
13. *Devescovina glabra* Grassi	*Neotermes bosei* *Cryptotermes havilandi*
14. *Devescovina gyrinoides* De Mello	*Neotermes bosei*
15. *Devescovina lemniscata* Kirby	*Neotermes assamensis* *Neotermes bosei* *Cryptotermes havilandi*
16. *Devescovina parasoma* Kirby	*Neotermes bosei* *Neotermes bosei*
17. *Devescovina similis* Kirby	*Neotermes bosei*
18. *Devescovina steini* Das	*Neotermes bosei*

Genus ***Foaina*** Janicki

19. *Foaina costata* Kirby	*Neotermes dhirendrae*
20. *Foaina exempta* Kirby	*Neotermes bosei*
21. *Foaina gracilis* Janicki	*Neotermes dhirendrae*

Family CALONYMPHIDAE

Genus ***Stephanonympha*** Janicki

22. *Stephanonympha campinae* De Mello	*Neotermes bosei*
23. *Stephanonympha minuta* Das and Choudhury	*Neotermes assamensis* *Neotermes bosei*
24. *Stephanonympha reenstiernai*	*Neotermes dhirendrae*
25. *Stephanonympha silvestrii* Janicki	*Neotermes assamensis*

Family TRICHOMONADIDAE

Genus ***Trichomitopsis*** Honigberg

26. *Trichomitopsis cartagoensis* (Kirby)	*Neotermes assamensis* *Neotermes bosei* *Neotermes dhirendrae*

Order HYPERMASTIGIDA

Family HOLOMASTIGOTIDAE

Genus ***Holomastigotoides*** Grassi and Foa

27. *Holomastigotoides bengalensis* Chakravarty and Banerjee	*Heterotermes indicola*
28. *Holomastigotoides campanula* De Mello	*Heterotermes indicola* *Coptotermes heimi*
29. *Holomastigotoides dharwarensis* Karandikar and Vittal	*Heterotermes indicola* *Coptotermes travians*
30. *Holomastigotoides globosus* De Mello	*Heterotermes indicola*
31. *Holomastigotoides hollandei* Das	*Heterotermes indicola*
32. *Holomastigotoides magnus* Uttangi	*Heterotermes indicola* *Coptotermes travians*
33. *Holomastigotoides ogivalis*	*Heterotermes indicola* *Coptotermes heimi*

34. ***Holomastigotoides rayi*** Karandidar and Vittal	*Heterotermes indicola*
35. ***Holomastogotoides saccusiformis*** Uttangi	*Heterotermes indicola*
36. ***Holomastigotoides sphaeroidalis*** De Mello	*Heterotermes indicola* *Coptotermes travians*
37. ***Holomastigotoides turboformis*** Uttangi	*Coptotermes heimi*

Family SPIROTRICHONYMPHIDAE

Genus ***Spirotrichonympha*** Grassi and Foa

38. *Spirotrichonympha froilanoi* Karandikar and Vittal	*Coptotermes heimi*
39. *Spirotrichonympha pyriformis* Chakravarty and Banernee	*Heterotermes indicola* *Coptotermes heimi*
40. *Spirotrichonympha roonwali* Das	*Coptotermes heimi*
41. *Spirotrichonympha rotunda* De Mello	*Reticulitermes tirapi*
42. *Spirotrichonympha ovalis* (Brown)	*Reticulitermes tirapi*
43. *Spirotrichonympha porteri* (Koidzumi)	*Reticulitermes tirapi*

Family EUCOMONYMPHIDAE

Genus ***Pseudotrichonympha*** Grassi and Foa

44. *Pseudotrichonympha cardiformis* Karandikar and Vittal	*Heterotermes indicola*
45. *Pseudotrichonympha indica* Chakravarty and Banerjee	*Heterotermes indicola* *Coptotermes heimi* *Coptotermes travians*
46. *Pseudotrichonympha subapicalis* Karandikar and Vittal	*Heterotermes indicola* *Coptotermes heimi* *Coptotermes travians*

Family TRICHONYMPHIDAE

Genus ***Trichonympha*** Leidy

47. *Trichonympha agilis* Leidy	*Reticulitermes tirapi*

Family TERATONYMPHIDAE

Genus ***Teranympha*** Koidzumi

48. *Teranympha mirabilis* Koidzumi	*Reticulitermes tirapi*

TAXONOMIC ACCOUNT

Genus *Oxymonas* Janicki

Diagnosis : Elongated clubshaped body with conspicuous rostellum and axostyle; two interconnected blepharoplasts each giving rise to two flagella.

1. *Oxymonas grandis* Cleveland
(Fig. 1)

1935. *Oxymonas grandis* Cleveland, *Biol. Bull.*, **69** : p. 54.

Type host : *Kalotermes (Neotermes) dalbergiae* Kalshoben, Indonesia.

Diagnosis : Body ellipsoidal in shape, gradually narrowed anteriorly and posterior end generally broadly rounded; anterior tip of the rostellum tubular upto a moderate length with rounded apical hold fast; blepharoplasts placed at one corner of the base of rostellum on the same side; axostyle scimitar shaped consisting of two portions; anterior portion of axostyle

Table 1 : Comparison of measurements of *Oxymonas grandis* Cleveland as recorded by different workers (in μm).

	Type specimens (Cleveland, 1935)		**Specimens (Das, 1974)**		**Specimens studied in the present work**		
	From *Neotermes dalbergiae*, Indonesia		**From *Neotermes bosei*, Jalpaiguri, West Bengal, India**		**From *Neotermes assamensis*, Assam, India**		**From *Neotermes bosei* Dehra Dun, India**
	Range	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Mean**
Length of body	76-183	121	78. 7-266.2	158.3	228-450	339	180
Width of body	31-79	52	18.7-45	30.7	30-72	51	30
Length of nucleus	20-23	21	8.5-17	12.1	18-30.4	24.2	10
Width of nucleus	20-23	21	5.1-6.8	5.9	9.6-26.4	18	9
Body ratio (body-length/ body-width)	–	–	3.5-8	5.7	6.2-7.6	6.9	6
Body-nuclear ratio (body-length/nuclear length)	–	–	10.1-12.6	11.9	12.6-14.8	13.7	18

with lightly stained fibrils extending into rostellum in the form of a bundle; posterior portion of axostyle running eccentrically almost throughout the full length of the body with closely adpressed fibers, some of which fraying moderately and irregularly in the posterior half, but having a slender distal tip at the posterior edge of the main body; nucleus ovoidal in shape and placed a little posterior to the shoulder of axostyle.

Remarks : The specimens studied are normally identical to the type specimens as figured by Cleveland (1935). But some morphological variations are also pronounced. The recurrent portion of axostyle described by Cleveland (1935) and pointed out to be a regular feature of the species by Cross (1946) is not at all observed in the specimens studied. Further, the axostyle reaches almost upto the posterior end of the body unlike in the specimens studied by Das (1974). Axostyle extended more towards the posterior end can be observed in the specimens recovered from *Neotermes assamensis* than those from *N. Bosei.*

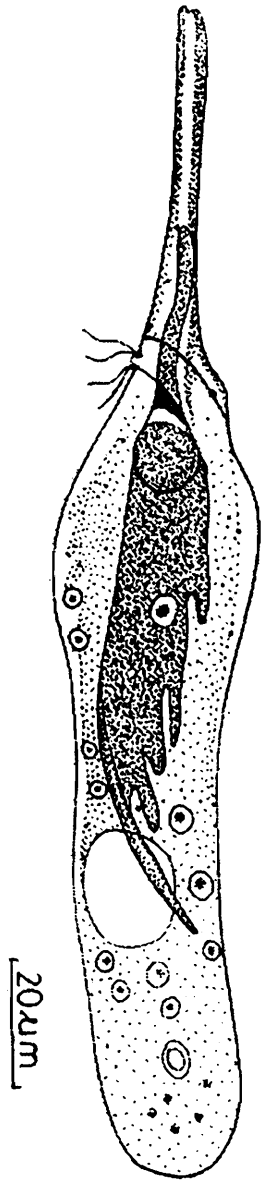

Fig. 1 : *Oxymonas grandis* Cleveland from *Neotermes bosei.*

Genus ***Pyrsonympha*** Leidy

Diagnosis : Body surface with 4–8 flagellar cords arranged lengthwise or spirally; flagella becoming free at the posterior extremity of the body; axostyle hanging freely in endoplasm, never projecting out of the body; centroblepharoplast a distinct granule located at the extreme anterior end, to which nucleus, axostyle and flagellar cords being attached.

Key to the species

1(2) Body surface always with 4 flagellar cords and with rostrum-like anterior prolongation ..... *P. rostrata*

2(1) Body surface with 4–8 flagellar cords and devoid of rostrum-like anterior prolongation

3(6) Flagellar cords spirally coiled on entire surface of the body in 2–3 turns, axostyle band shaped anteriorly and thence gradually narrowing posteriorly

4(5) Lateral margins of body smooth, endoplasm with numerous deeply stained granules of different sizes ..... *P. granulata*

5(4) Lateral margins of body not smooth, but distinctly ridged, endoplasm devoid of any deeply stained granule ..... *P. grandis*

6(3) Flagellar cords spirally coiled on anterior portion of the body in a single turn and thence running almost straight and parallel along the entire length of body, axostyle band-shaped throughout ..... *P. tirapi*

2. ***Pyrsonympha grandis*** Koidzumi

(Fig. 2)

1921. *Pyrsonympha grandis* Koidzumi, *Parasitology*, **13** : 281-288, pl. 14, figs. 54-64.

Type host : *Leucotermes (=Reticulitermes) speratus* Holmgren, Japan and *Leucotermes (=Reticulitermes) flaviceps* (Oshima), Formosa.

Diagnosis : Body somewhat elongately club-shaped, anteriorly generally twisted and much broader posteriorly; flagellar cords thickened into straight or wavy flagellar bands running backwards in dexiotropic spiral rows; ultimately, these flagellar bands becoming free at the posterior extremity of the body in a number of 4–8 flagella of moderate length, but occasionally becoming indistinct; axostyle thickened anteriorly, then gradually becoming much thinner and slender posteriorly; nucleus large, oval or pyriform in shape and placed at the extreme anterior end or middle of the body.

Remarks : The broader forms, thickened flagellar cords and much more extended axostyle of some specimens studied apparently differ from the typical specimens as described by Koidzumi (1921).

Table 2 : Comparison of measurements of *Pyrsonympha grandis* Koidzumi as recorded by different workers (in μm).

	Type specimens (Koidzumi, 1921) from *Reticulitermes speratus* and *R. flaviceps*, Japan and Formosa	Specimens studied in the present work	
		From *Reticulitermes tirapi*, Arunachal Pradesh, India	
	Range	Range	Mean
Length of body	40-170	55-90	72.5
Width of body	19-50	20-36	28
Length of nucleus	–	15-20	17.5
Width of nucleus	–	4-6	5
Body ratio (body-length/body-width)	2.3-3.4	2.5-2.7	2.6
Nuclear ratio (nuclear length/ nuclear width)	–	3.3-3.5	3.4

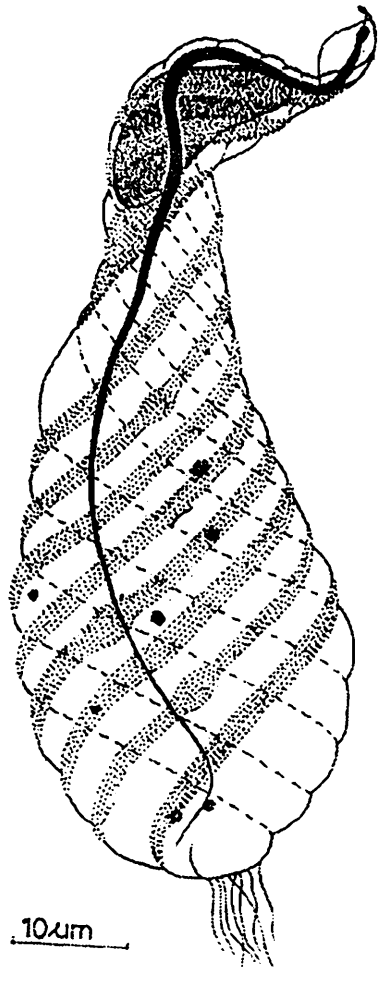

Fig. 2 : *Pyrsonympha grandis* Koidzumi from *Reticulitermes tirapi.*

3. *Pyrsonympha granulata* Powell
(Fig. 3)

1929. *Pyrsonympha granulata* Powell, *Univ. Calif. Publ. Zool.*, **31** : 183-185, pl. 9, figs. 3 and 4.

Type host : *Reticulitermes hesperus* Banks, San Francisco, California.

Diagnosis : Body somewhat club-shaped, being broadened posteriorly and tapering anteriorly; flagellar cords thickened into flagellar bands encircling the entire body to make two to two and a half complete turns; axostyle with anterior half uniformly thickened but posterior half gradually thinner, mostly longer than the body and curved back anteriorly; nucleus remaing at the extreme anterior end of the body, close behind the centroblepharoplast.

Table 3 : Comparison of measurements of *Pyrsonympha granulata* Powell as recorded by different workers (in μm).

	Type specimens (Powell, 1928)		Specimens studied in the present work			
	From *Reticulitermes hesperus*, California		From *Reticulitermes tirapi*, Arunachal Pradesh, India		From *Reticulitermes assamensis*, Meghalaya, India	
	Range	Mean	Range	Mean	Range	Mean
Length of body	40-120	80	56.4-84	70.2	60-160	110
Width of body	5-35	20	21.6-27	24.3	12-32	27
Length of nucleus	–	–	8.4-15.6	12	6-12	9
Width of nucleus	–	–	6-8	7	4-6	5
Body ratio (body-length/body-width)	3.2-8	5.7	2.6-3.04	2.8	5	–
Nuclear ratio (nuclear-length/ nuclear-width)	–	–	1.4-1.9	1.6	1.5-2	1.9

Remarks : The large majority of the material studied shows certain variations beyond the more important features of *P. granulata*, as mentioned below. In the individuals of present study, flagellar cords are being observed to be thickened into flagellar bands, while in all individuals of typical *P. granulata* the flagellar cords have been indicated as simple, thin, thread-like. Considering the variation of the species among different hosts under present report, the individuals obtained from *Reticulitermes tirapi* are much more broader than those procured from *R. assamensis*. Moreover, in the specimens of *R. assamensis* the flagellar bands make one and a half complete turns, whereas, in the specimens of *R. tirapi* they usually make two and a half turns.

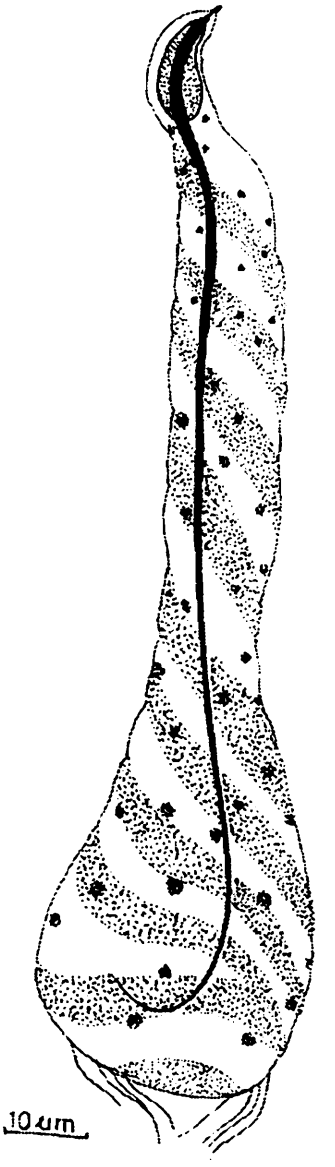

Fig. 3 : *Pyrsonympha granulata* Powell from *Reticulitermes assamensis.*

4. ***Pyrsonympha rostrata*** Mukherjee and Maiti
(Fig. 4)

1988. *Pyrsonympha rostrata* Mukherjee and Maiti, *Proc. Zool. Soc. Calcutta*, **38** : 41-43, text-fig 2, pl. 1, figs. 2, 3.

Type host : *Reticulitermes tirapi* Chhotani and Das, Arunachal Pradesh, India.

Diagnosis : Body elongated with anterior half gradually narrowing anteriorly forming a rostrum and posterior half gradually broadening posteriorly with a rounded margin; flagellar cords four in number, two arising from the centroblepharoplast on either side of the body and encircling spirally the whole body into complete 3–4 turns; axostyle appearing as a slender cord, thickened anteriorly then gradually much thinner posteriorly and terminating almost at the middle of the body; nucleus small, round and situated almost at or near the middle of the body just nearly at the commencement of the rostrum.

Table 4 : Measurements of *Pyrsonympha rostrata* Mukherjee and Maiti (in µm) from *Reticulitermes tirapi*, Arunachal Pradesh, India.

	Range	Mean
Length of body	62.4-110	86.2
Width of body	16.8-25	20.9
Length of nucleus	4.8-8.4	6.6
Width of nucleus	2.4-8.4	5.4
Body ratio (body length/bodywidth)	2.8-4.4	3.6
Nuclear ratio (nuclear length/nuclear width)	1-2.5	1.75

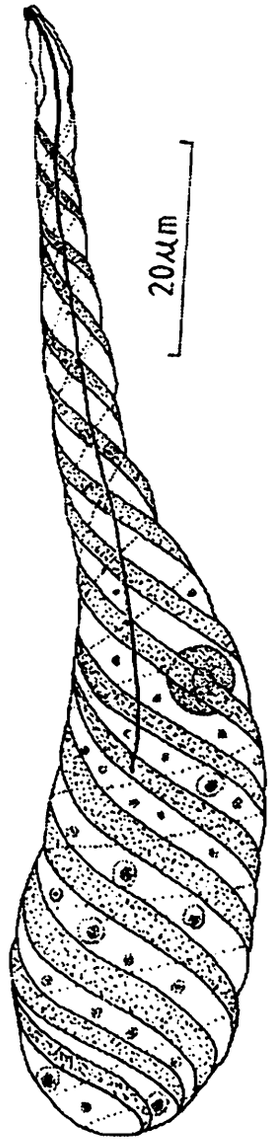

Fig. 4 : *Pyrsonympha rostrata* Mukherjee and Maiti from *Reticulitermes tirapi.*

Remarks : *Pyrsonympha rostrata* Mukherjee and Maiti is a very distinct species in having four flagellar cords and axostyle sometimes extending beyond the middle and rarely upto the posterior end of the body.

5. ***Pyrsonympha tirapi*** Mukherjee and Maiti
(Fig. 5)

1988. *Pyrsonympha tirapi* Mukherjee and Maiti, *Proc. Zool. Soc.*, Calcutta, **38** : 38-41, text–fig. 1, pl. 1, figs. 1, 2.

Type host : *Reticulitermes tirapi* Chhotani and Das, Namdhapa, Arunachal Pradesh, India.

Diagnosis : Body club-shaped, elongated and substraight, much longer than broad, narrowing anteriorly and broadening posteriorly with a round margin; flagellar cords arranged in spiral bands encircling anterior portion of the body into a single turn, then running almost straight and parallel to the body; axostyle appearing as a narrow band of uniform thickness, running posteriorly through the middle of the body, terminating at the posterior sixth of the body, and hanging freely in the endoplasm; nucleus large, varying from spherical to kidney-shaped and placed slightly below the anterior broad margin.

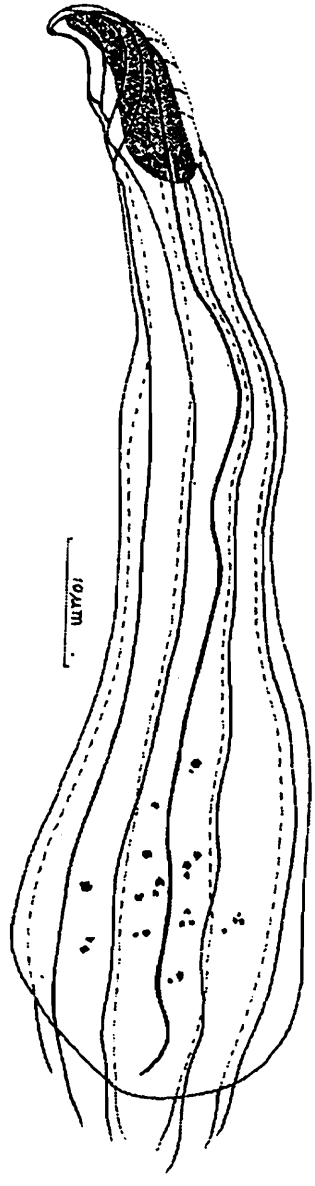

Fig. 5 : *Pyrsonympha tirapi* Mukherjee and Maiti from *Reticulitermes tirapi.*

Table 5 : Measurements of *Pyrsonympha tirapi* Mukherjee and Maiti (in µm) from *Reticulitermes tirapi*, Arunachal Pradesh, India.

	Adult		Young	
	Range	Mean	Range	Mean
Length of body	78-96	87	44.4-57.6	51
Width of body	16.5-30	23.2	12-15.6	13.8
Length of nucleus	10-18	14	8.4-12	10.2
Width of nucleus	4.8-11	7.9	3.6-7.2	5.4
Body ratio (body length/body width)	3.2-4.7	3.9	2.3-4	3.15
Nuclear ratio (nuclear length/nuclear width)	1.2-3.5	2.3	1.4-3.3	2.3

Remarks : *Pyrsonympha tirapi* Mukherjee and Maiti is a very distinct species in having flagellar cords sometimes running parallel to the body throughout or spirally coiled only in one turn on the anterior half of the body then almost parallel to the posterior half without showing any spiralling.

Genus *Dinenympha* Leidy

Diagnosis : Body surface with 4–8 flagellar cords arranged always spirally; flagella terminating freely or sometimes united together at the posterior end; axostyle not hanging freely in endoplasm, rather fixed to lateral or posterior margin of the body, rarely projecting out; centroblepharoplast, a distinctly stained granule at the extreme anterior end, to which attached the axostyle, flagellar cords and nucleus.

Key to the species

1(4) Entire body spirally twisted, terminal end of axostyle sometimes protruding out of the posterior end of the body

2(3) Protruding portion of axostyle having rhombic enlargement, axostyle narrowly band-like throughout, nucleus placed at the extreme anterior end of the body ..... *D. porteri*

3(2) Protruding portion of axostyle having no such enlargement, axostyle thickened uniformly throughout, except somewhat thinner at the middle, nucleus placed far below the anterior end of the body ..... *D. nobilis*

4(1) Only anterior portion of the body spirally twisted, terminal end of the axostyle never protruding out of the posterior end of the body

5(6) Body with prominent ridges on lateral margins, flagellar bands with wavy outline, axostyle always single, nucleus small, either rounded or oval in shape ..... *D. rayi*

6(5) Body with smooth lateral margins, devoid of any ridge, flagellar bands with smooth outline, axostyle occasionally folded and bifurcated posteriorly, nucleus large and triangular in shape ..... *D. mukundai*

6. ***Dinenympha mukundai*** Mukherjee and Maiti
(Fig. 6)

1989. *Dinenympha mukundai* Mukherjee and Maiti, *Arch. Protistenk.*, **137** : 92-93, fig. 1-5.

Type host : ***Reticulitermes tirapi*** Chhotani and Das, Namdhapa, Arunachal Pradesh, India.

Diagnosis : Body more or less elongately club shaped with narrowing anterior end and gradually attaining maximum width posteriorly; flagellar bands encircling the whole body spirally in two and a half turns and generally attaining greater thickness gradually to the posterior portion; axostyle seen distinctly as a thin rod like slender cord with almost uniform thickness throughout its length, at times becoming slightly thinner towards the terminal end, and fixed either to the lateral wall or to the posterior tip of the body; nucleus mostly triangular in shape and occupying the extreme anterior end.

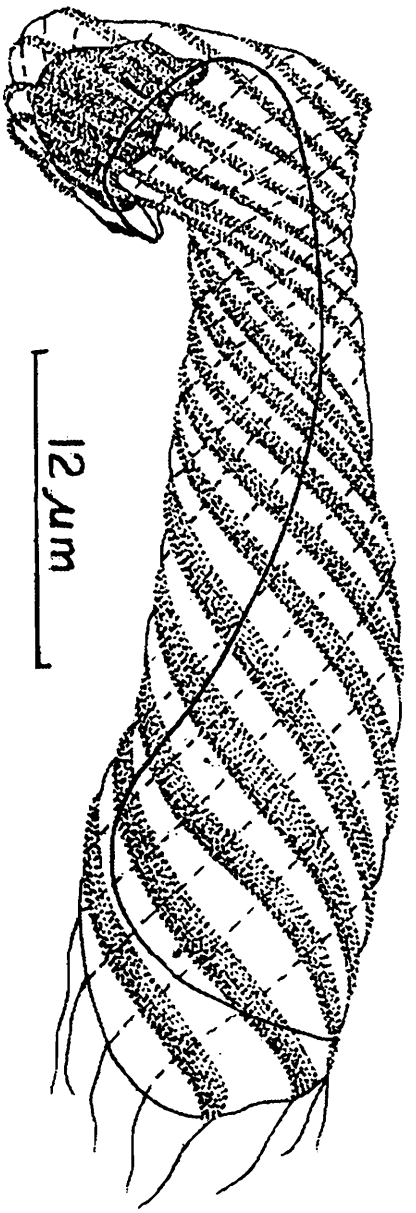

Fig. 6 : *Dinenympha mukundai* Mukherjee and Maiti from *Reticulitermes tirapi.*

Table 6 : Measurements of *Dinenympha mukundai* Mukherjee and Maiti (in µm) from *Reticuliterms tirapi*, Arunachal Pradesh, India.

	Adult		Young	
	Range	Mean	Range	Mean
Length of body	48-60	54	22-31.2	26.6
Width of body	10.8-14.4	12.6	4.6-8.4	6.5
Length of nucleus	8.4-10.2	9.3	4-5	4.5
Width of nucleus	3.6-9.6	6.6	2.4-3.6	3
Body ratio (body length/body width)	4.1-4.4	4.2	3.7-5	4.3
Nuclear ratio (nuclear length/nuclear width)	1.3-2.3	1.8	1.3-1.6	1.4

Remarks : *Dinenympha mukundai* Mukherjee and Maiti is a distinct species in having bifurcated axostyle.

7. ***Dinenympha nobilis*** Koidzumi
(Fig. 7)

1921. *Dinenympha nobilis* Koidzumi, *Parasitology*, **13** : p. 292, pl. 15, figs. 73-75.

Type host : *Reticulitermes speratus* Holmgren, Japan.

Diagnosis : Body elongately club-shaped, slender, somewhat straight but twisted entirely with narrowly rounded anterior end and pointed or rounded posterior end; flagellar cords uniformly thickened into flagellar bands encircling the entire body spirally in two complete

Table 7 : Comparison of measurements of *Dinenympha nobilis* Koidzumi as recorded by different workers (in µm).

	Type specimens (Koidzumi, 1921) from *Leucotermes* (= *Reticulitermes*) *speratus*, Japan	Specimens studied in the present work From *Reticulitermes tirapi*, Jorhat, India	
	Range	Range	Mean
Length of body	30-60	38.4-120	79.2
Width of body	5-10	6-15	10.5
Length of nucleus	–	4-6	5
Width of nucleus	–	2.4-3	2.7
Body ratio (body-length/body-width)	6	6.4-8	7.2
Nuclear ratio (nuclear length/nuclear width)	–	1.6-2	1.8

turns keeping equal distance from each; axostyle seen as more or less a distinct slender cord, fairly thickened throughout its entire length except somewhat thinner at the middle and rarely the extreme posterior end protruding out of the body; nucleus oval in shape and placed more posteriorly from the anterior end the body; a thickened thread-like rhizoplast, connecting the centroblepharoplast and nucleus distinctly seen, sometimes with anterior tip appearing like a knob.

Remarks : The specimens studied are very much similar to those observed by Koidzumi, excepting some variations rendering difficulty in their identity as *D. nobilis* as could be studied at a glance. The narrow, stout, much elongated body with mostly pointed terminal end, prominent axostyle projecting out of the end, and thickened rhizoplast had not been mentioned by Koidzumi in typical *D. nobilis*.

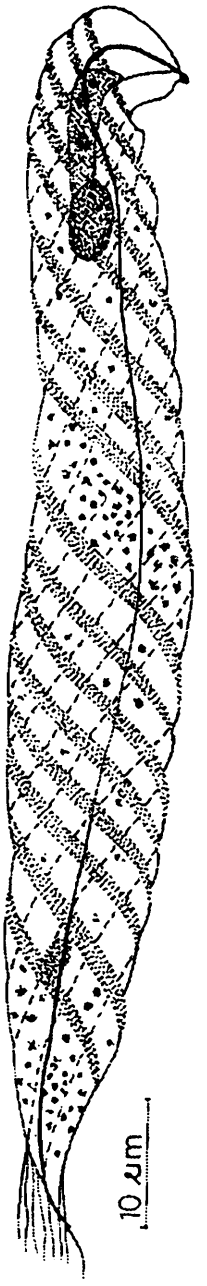

Fig. 7 : *Dinenympha nobilis* Koidzumi from *Reticulitermes tirapi.*

8. *Dinenympha porteri* Koidzumi
(Fig. 8)

1921. *Dinenympha porteri* Koidzumi, *Parasitology*, **13** : 294-295, pl. XV, figs. 79-84.

Type host : *Reticulitermes speratus* Holmgren, Japan.

Diagnosis : Body elongated, flattened and ribbon-like with tapering anterior and posterior ends; flagellar cords seen as somewhat straight and slightly thickened bands, placed on fairly distinct ridges of lateral margins of the body and arranged in equally spaced spiral rows encircling the whole body in about two turns; axostyle narrowly band-like throughout, protruding for a variable extent beyond the posterior end of the body with a rhombic enlargement; nucleus large, elongately oval and placed at the anterior end.

Table 8 : Comparison of measurements of *Dinenympha porteri* Koidzumi as recorded by different workers (in μm).

	Type specimens (Koidzumi, 1921)	Specimens studied in the present work			
	From *Leucotermes* (= *Reticulitermes*) *speratus*, Japan	From *Reticulitermes assamensis*, Meghalaya, India		From *Reticulitermes tirapi*, Arunachal Pradesh, India	
	Range	Range	Mean	Range	Mean
Length of body	25-80	48-100	74	54-150	102
Width of body	6-15	4.8-9.6	7.2	4.8-22	13.4
Length of nucleus	–	12-18	15	9-22	15.5
Width of nucleus	–	3.6-8.4	6	3-5	4
Body ratio (body-length/body-width)	4.16-5.33	10-11.4	10.7	7.5-10	8.75
Nuclear ratio (nuclear-length/nuclear-width)	–	3.3-2.1	2.7	3-4.4	3.7

Remarks : In majority of specimens, body is covered with coat of hair-like filamentous appendages. Regarding the disposition of the coat 4 types are distinguishable in the present work—

(1) Body fully naked with no filamentous appendages. (2) The anterior end as well as the posterior end of the body consisting of a group of filamentous appendages. (3) Body thickly covered with filamentous appendages, diffusely distributed over the entire surface. (4) These appendages are most dense at the posterior end, while still dense medially than the anterior end.

Out of these four types first three types have been recognized here with dense population. From the original description present specimens vary in being longer, twisting of the body and occasional protruberence of the axostyle beyond the posterior end of the body. The individuals from the termite *Reticulitermes assamensis* are much more slender than those from *R. tirapi*. But the material studied from both the hosts are much more longer than that from the type host.

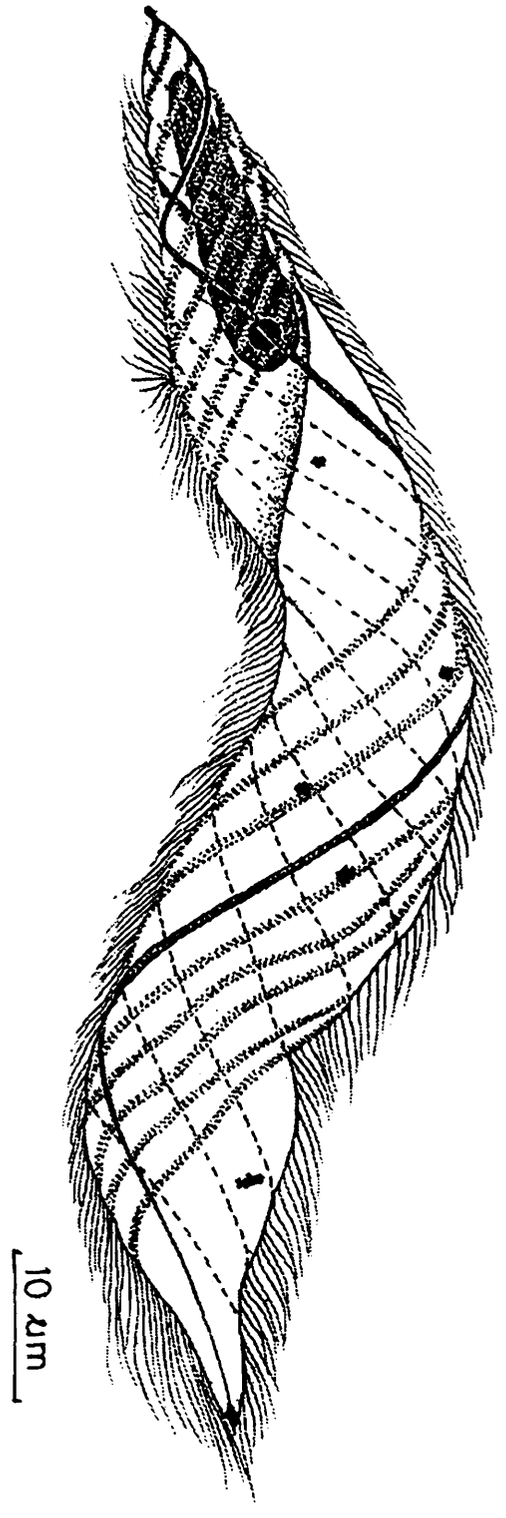

Fig. 8 : *Dinenympha porteri* Koidzumi from *Reticulitermes tirapi.*

9. ***Dinenympha rayi*** Mukherjee and Maiti
(Fig. 9)

1989. *Dinenympha rayi* Mukherjee and Maiti, *Arch. Protistenk.*, **137** : 93-95, figs. 6-9.

Type host : *Reticulitermes tirapi* Chhotani and Das, Namdhapa, Arunachal Pradesh, India.

Diagnosis : Body elongately club shaped with bluntly pointed anterior and rounded posterior ends, slightly twisted near the middle at the completion of the first turn of flagellar bands; flagellar cords making a loop around the anterior tapering end of the body, arranged in spirally coiled flagellar bands encircling the whole body into two turns with the lateral edges

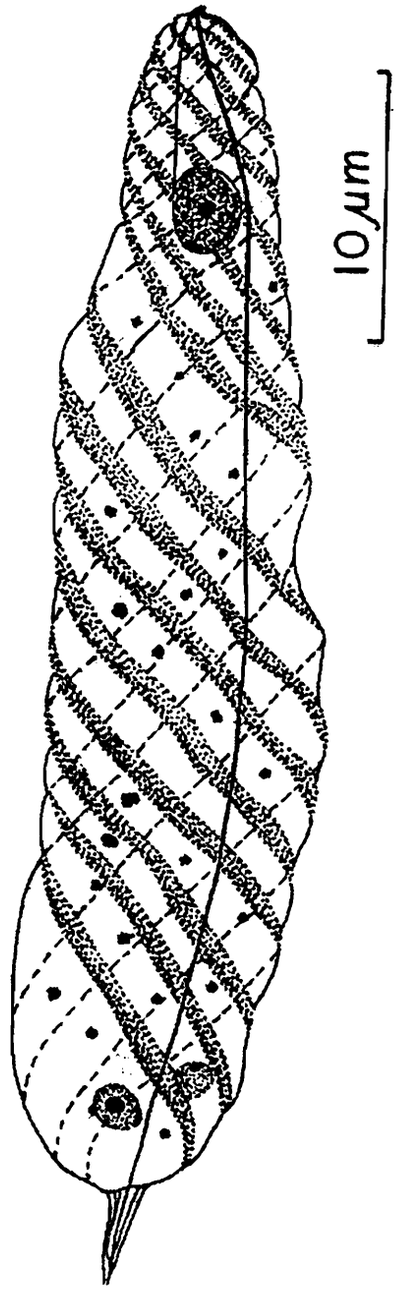

Fig. 9 : *Dinenympha rayi* Mukherjee and Maiti from *Reticulitermes tirapi.*

highly ridged; axostyle running distinctly as a slender cord throughout its entire length, slightly thickened at the anterior portion, thence gradually becoming thinner to the posterior extremity and ultimately protruding out of the body upto the length of posterior free flagella; nucleus round or oval.

Table 9 : Measurements of *Dinenympha rayi* Mukherjee and Maiti (in μm) from *Reticulitermes tirapi*, Arunachal Pradesh, India.

	Adult		Young	
	Range	Mean	Range	Mean
Length of body	40-60	50	32.4-44.4	38.4
Width of body	10-14	12	9.6-12	10.8
Length of nucleus	4.8-6	5.4	3.6-4	3.8
Width of nucleus	3-4.8	3.9	2.4-3.6	3
Body ratio (body length/body width)	4-4.5	4.2	3.3-3.7	3.5
Nuclear ratio (nuclear length/nuclear width)	1.2-1.6	1.4	1.1-1.5	1.3

Remarks : *Dinenympha rayi* Mukherjee and Maiti is a very distinct species in having very regularly arranged prominent ridges on the body surface.

Genus *Caduceia* Franca

Diagnosis : Body with 3 slender anterior flagella and 1 trailing flagellum; trailing flagellum much shorter than body; blepharoplast group consisting of closely aggregated granules of different sizes, placed at the very edge of the body anterior to the cresta; trunk of axostyle always filamentous and terminating within cytoplasm.

Key to the species

1(2) Parabasal body with broad and loose turns, cresta lengrh more than 5 mm. .... *C. theobromae*

2(1) Parabasal body with narrow and close turns, cresta length less than 5 mm. .... *C. bugnioni*

10. *Caduceia bugnioni* Kirby

(Fig. 10A)

1942. *Caduceia bugnioni* Kirby, *Univ. Calif. Publ. Zool.*, **45** : p. 103, fig. A, 2, pl. 11, figs. 6-10, pl. 12, figs. 11-13.

Type host : *Neotermes greeni* (Desneux), Sri Lanka.

Diagnosis : Body spherical in shape, narrowly rounded anteriorly with a flattened, extended papilla, broadest at the middle, and broadly rounded posteriorly; body in some forms ovoidal with equally rounded anterior and posterior ends; trailing flagellum narrowly band like; cresta seen as small, triangular body with broad proximal and bluntly pointed distal ends; its anteromedial edge incurved or sometimes substraight and posteromedial edge incurved and little longer than the anteromedial edge, sometimes even almost equal; parabasal apparatus arising from the blepharoplast group as a slender filament normally on right hand of the nucleus, coiled around the trunk of the axostyle in a somewhat close spiral of mostly 6 turns, sometimes 3-5 turns also; the first two turns of parabasal body very much loosely coiled leaving a wide gap between them; parabasal filament seen as alternatively lightly and heavily stained loops within the core of parabasal body; axostyle generally recurved within cytoplasm at the posterior end, sometimes extends upto the posterior surface of the body; the capitulum of axostyle a simple flattened expansion and its trunk gradually diminishes in diameter then becoming very much slender and pointed at posterior extremity; nucleus broadly ovoidal with somewhat peaked anterior and rounded posterior ends.

Table 10 : Comparison of measurements of *Caduceia bugnioni* Kirby as recorded by different workers (in μm).

	Type specimens (Kirby, 1941)	**Specimens studied in the present work**	
	From *Neotermes greeni*, Ceylon	**From *Neotermes dhirendrae*, Chennai, India**	
	Range	**Range**	**Mean**
Length of body	48-80	45-90	67.5
Width of body	18-40	37-54	45.5
Body ratio (body-length/ body-width)	2-2.6	1.4-1.6	1.5
Length of nucleus	6.3-9.2	6-7.2	6.6
Width of nucleus	2.3-4	3-3.6	3.3
Nuclear ratio (nuclear length/ nuclear width)	2.3-2.7	2	–
Length of cresta	2.5-4	2.4-3	2.7
Length of anteromedial edge of cresta	–	1.5-1.8	1.6
Length of trailing flagellum	–	40-60	50

Remarks : The species recovered from the present host agrees with the typical description of Kirby, in its diagnostic features, although some variations are not unçommon. The absence of chromatic shield and surface adherent rods does agree with the original description of Kirby. On the contrary, protruberance of anterior part of the body and deeply stained rectangular mass below the parabasal body are lacking in the type specimens.

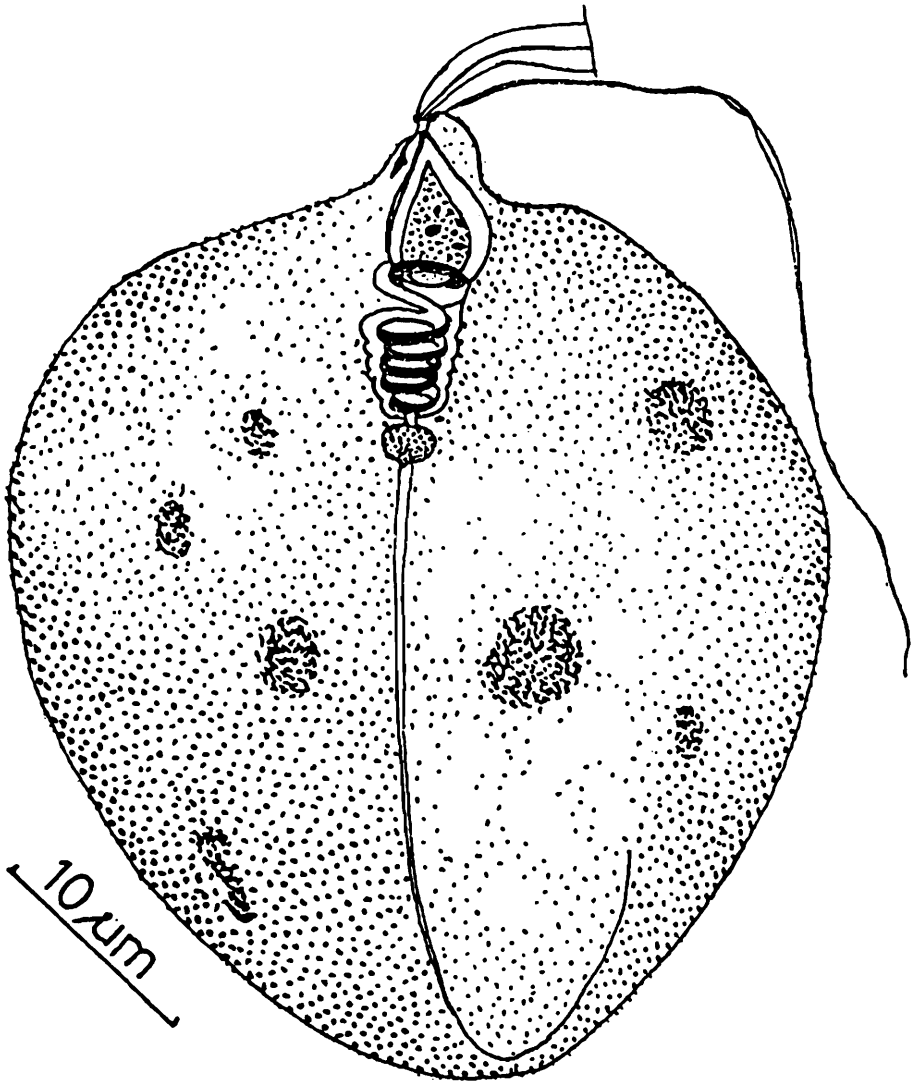

Fig. 10A : *Caduceia bugnioni* Kirby from *Neotermes dhirendrae.*

11. *Caduceia theobromae* Franca
(Fig. 10B)

1918. *Caduceia theobromae* Franca, *Bull. Soc. Port. Sci. Nat.*, **8** : p. 94, pl. 2, figs. 1-8, figs. A, B, C-3, D-2.

Type host : *Neotermes gestri* Silvestri, Island of St. Thomas (Franca).

Diagnosis : Body typically oval in shape, rounded both anteriorly and posteriorly; trailing flagellum is narrowly band-like; cresta seen as elongated triangular body with broad proximal and gradually tapering distal ends; its anteromedial edge almost straight; posteromedial edge

of cresta having sharp bent at the junction with anteromedial edge and sometimes curved inwardly; parabasal body coiled very loosely around the trunk of axostyle mostly in 3, sometimes in 4 broad turns; its first turn always surrounding the posterior end of nucleus in widely coiled loop; trunk of axostyle stouter at its anterior portion, gradually becoming filamentous posteriorly into a slender thread, mostly reaching upto the posterior extremity of the body, sometimes curved within cytoplasm; nucleus large and oval in shape.

Table 11 : Measurements of *Caduceia theobromae* Franca (in µm) from *Neotermes bosei* Dehra Dun, Uttaranchal, India.

	Range	Mean
Length of body	40-54	47
Width of body	30-40.8	35.4
Body ratio (body-length/body-width)	1.3	–
Length of nucleus	4-6.5	5.2
Width of nucleus	2-3.6	2.8
Nuclear ratio (nuclear length/nuclear width)	1.8-2	1.9
Length of cresta	9.6-12	10.8
Length of anteromedial edge of cresta	2.4-3.6	3
Length of trailing flagellum	30-45	37.5

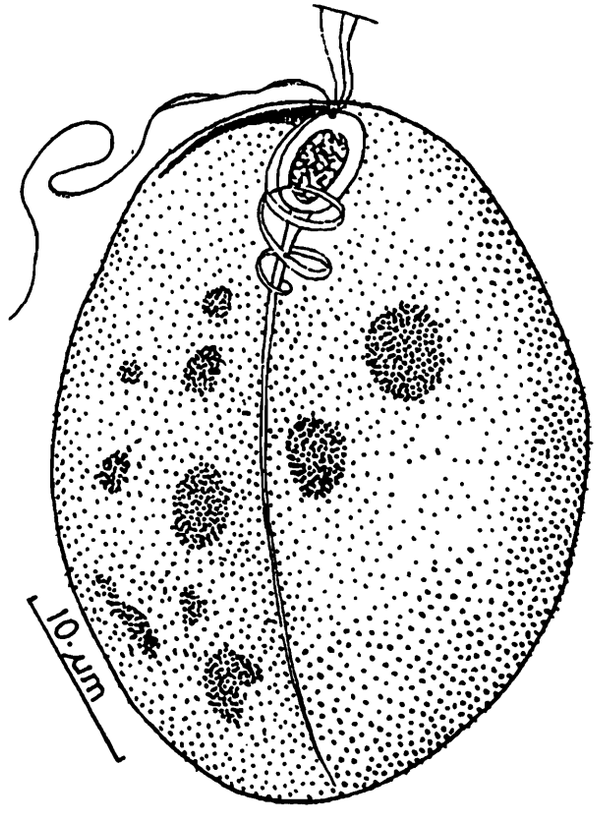

Fig. 10B : *Caduceia theobromae* Franca from *Neotermes bosei.*

Remarks : The species had been found very occasionally from *Neotermes bosei* Snyder.

Genus *Devescovina* Foa

Diagnosis : Body mostly anteriorly flattened to form a prominent papilla containing sometimes karyomastigont complex therein; 3 slender anterior flagella and 1 trailing flagellum; trailing flagellum about 1-1.5 times the body length; parabasal body always extended beyond the nucleus and coiled around the trunk of axostyle; trunk of axostyle some times very stout and protruding out of the posterior end of the body or not so.

Key to the species

1(8) Trailing flagellum broadly band shaped

2(5) Cresta length below 9 μm

3(4) Body completely ovoidal in shape, as long as broad, trunk of axostyle always protruding out of the posterior end of the body as a stout rod ..... *D. steini*

4(3) Body elongated in shape and about 4 times as longer as broad, trunk of axostyle terminating within cytoplasm as a stout rod ..... *D. similis*

5(2) Cresta length above 9 μm

6(7) Body broadly ovoidal in shape with posterior tail-like appendage, parabasal body with 3-5 compact turns around the trunk of axostyle, posterior portion of axostyle stouter enough and protruding out of the body ..... *D. gyrinoides*

7(6) Body narrowly elongated in shape with pointed posterior end, parabasal body with usually 2–3 loose turns around the trunk of axostyle, posterior portion of axostyle filamentous extending upto the posterior end but never protruding out..... ..... *D. lemniscata*

8(1) Trailing flagellum narrowly band shaped

9(10) Cresta very minute sized (below 5 μm) ..... *D. cometoides*

10(9) Cresta length above 5 μm

11(12) Trunk of axostyle posteriorly stouter and protruding out of the body .... *D. parasoma*

12(11) Trunk of axostyle posteriorly filamentous and never protruding out of the body .... *D. glabra*

12. *Devescovina cometoides* De Mello and De Brito

(Fig. 11)

1929. *Devescovina cometoides* De Mello and De Brito, *C. R. Soc. Biol.*, **101** : p. 394 (*nom. nud.*)

Type host : *Kalotermes* sp., Daman, India.

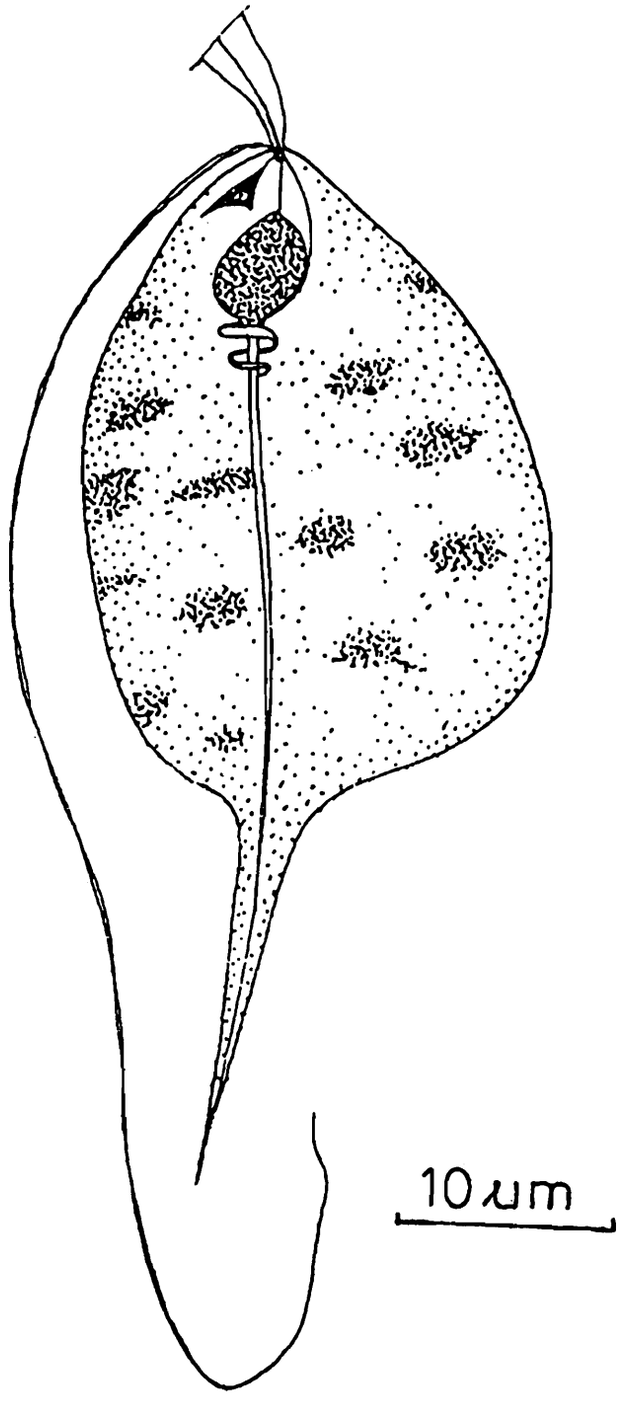

Fig. 11 : *Devescovina cometoides* De Mello and De Brito from *Neotermes bosei.*

Diagnosis : Body broadly ovoidal in shape, anteriorly obtusely pointed and posteriorly gradually or abruptly tapering with pointed end; trailing flagellum narrowly band-shaped, sometimes becoming very narrow cord-like; cresta very short with broad proximal and bluntly pointed distal ends; its anteromedial edge slightly incurved or substraight and equal to distinctly incurved posteromedial edge; parabasal apparatus coiled around the trunk of axostyle in loose spiral of two turns; axostyle stout at the anterior end; its trunk gradually tapering to a filamentous posterior part; nucleus ovoidal in form with rounded ends.

Table 12 : Comparison of measurements of *Devescovina cometoides* De Mello and De Brito as recorded by different workers (in μm).

	Type specimens (De Mello and De Brito, 1929)	Specimens studied in the present work	
	From *Kalotermes* sp., Daman, India	From *Neotermes bosei*, Dehra Dun, India	
		Range	Mean
Length of body	35-58	45-70	57.5
Width of body	6-17	15-30	22.5
Body ratio (body-length/ body-width)	–	2.3-3	2.6
Length of nucleus	5-6	4.2-5	4.6
Width of nucleus	2.5-3.5	2-3	2.5
Nuclear ratio (nuclear length/ nuclear width)	–	1.6-2.1	1.8
Length of cresta	2.5-3.5	3.6-4.2	3.9
Length of anteromedial edge of cresta	1.5-2	2-3.5	2.7
Length of trailing flagellum	–	65-75	70

Remarks : A few broad specimens recorded here with protruding axostyle along with cytoplasm giving the appearance of "tad-pole", seem to be unusual shape of the species, but in other detailed morphology, they are none else than *D. cometoides*. Present study reveals that the material recovered from *Neotermes bosei* have much more body dimension than those from *Kalotermes* sp.

13. *Devescovina glabra* Grassi
(Fig. 12)

1917. *Devescovina glabra* Grassi, *Mem. R. Accad. Lincei,* (5)**12** : p. 54, pl. 9, figs. 18-27.

Type host : *Cryptotermes havilandi* (Sjostedt), Nigeria.

Diagnosis : Body broadly oval with bluntly pointed both ends; trailing flagellum appearing as narrow band with gradually tapering terminal ends; cresta medium sized to much prolonged with broad proximal and bluntly pointed distal ends; its anteromedial edge slightly incurved; parabasal body turning almost close together usually thrice or twice around the trunk of axostyle; capitulum of axostyle stout at its anterior portion; its trunk extended as a filament upto the pointed end of the body or recurved within cytoplasm; nucleus oval in shape.

Table 13 : Comparison of measurements of *Devescovina glabra* Grassi as recorded by different workers (in μm).

	Type specimens (Grassi, 1917)		Specimens (Das, 1974)		Specimens studied in the present work			
	From *Cryptotermes havilandi*, Nigeria		From *Cryptotermes havilandi*, Falta, West Bengal, India		From *Cryptotermes havilandi*, Kolkata, West Bengal, India		From *Neotermes bosei*, Dehra Dun, Uttaranchal, India	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Length of body	27-58	44	34-44.2	38.1	35-42	38.5	38.4-55.2	46.8
Width of body	11-20	15	10.2-15.3	12.5	19-20.4	19.7	21.6-30	25.8
Length of nucleus	5-6	5.5	3.4-5.1	4.4	5.5-6	5.8	4.8-6	5.4
Width of nucleus	3.5-4.5	4.4	3.0-3.5	3.2	2.4-3.6	3	3.6-5	4.3
Body ratio (body-length/ body-width)	–	2.9 : 1	2.5:1-3:1	2.8:1	1.8-2	1.9	1.7-1.8	1.75
Nuclear ratio (nuclear length/ nuclear width)	–	–	–	–	1.6-2.2	1.9	1.2-1.3	1.25
Length of cresta	6-8	7	5.7-6.2	5.9	5.4-6	5.7	6-7.2	6.6
Length of anteromedial edge of cresta	–	–	–	–	1.8-2.4	2.1	2.4-3.6	3
Length of trailing flagellum	–	–	51-60	56	60-70	65	65-85	75

Remarks : In the large majority of the individuals studied in the present work, the trailing flagellum has been found to be narrowly band-shaped as compared to cord-like form in the individuals studied by Das (1974). In the individuals from *Cryptotermes havilandi* parabasal body has been observed to have 2–3 turns unlike one and a half turns in the specimens dealt

by Das. In the individuals from *Neotermes bosei* body varies from perfectly oval to spherical in shape with anterior flattened papilla and rounded posterior end. Cresta is found to be very narrow with sharply pointed distal end. Parabasal body has much more dimension with 3 to 4 turns. The individuals recovered from *N. bosei* are much more longer than those from *C. havilandi* studied in the present work.

Moreover, the deeply stained granules below the nucleus have not been observed in any individual, as being found in the specimens described by Grassi (1917), Kirby (1941) and Das (1974).

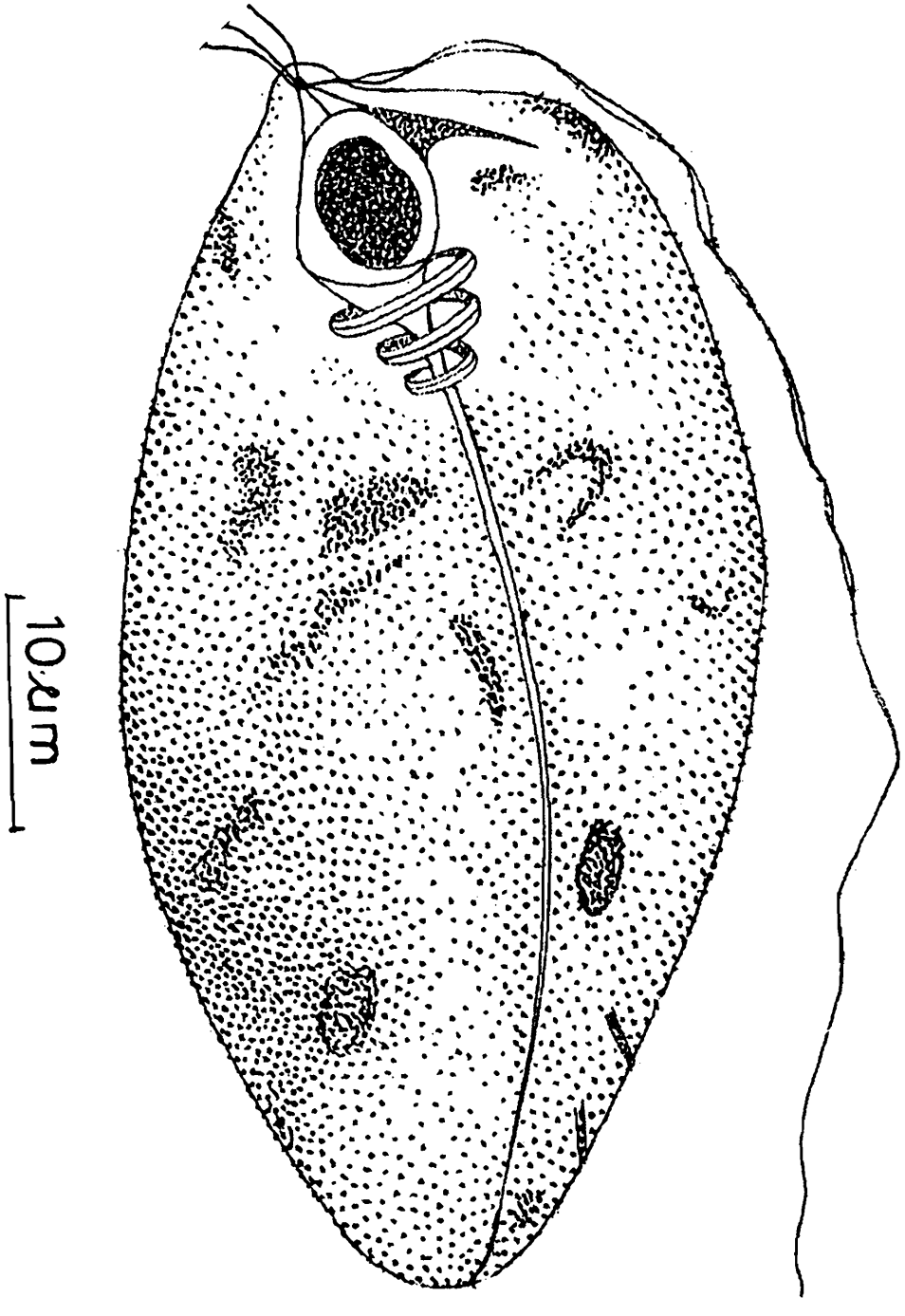

Fig. 12 : *Devescovina glabra* Grassi from *Neotermes bosei.*

14. *Devescovina gyrinoides* De Mello
(Fig. 13)

1946. *Devescovina gyrinoides* De Mello, *An. Inst. Med. Trop.*, **3** : 30-35, fig. 1.

Type host : *Cryptotermes* sp., India.

Diagnosis : Body ovoidal in shape or appearing like a tad-pole with obtusely pointed anterior end, middle portion attaining maximum breadth and a tail-like process posteriorly; trailing flagellum flattened, broad, ribbon-like with gradually slender terminal ends; cresta elongately triangular in shape, with broad proximal and bluntly or narrowly pointed distal ends, and with both the margins incurved at basal fifth; its anteromedial edge almost straight and one-fourth as long as the posteromedial edge; parabasal body having 3–5 turns around the trunk of axostyle in almost close spiral; axostyle distinctly visible at the posterior portion, indistinct at the anterior portion; its capitulum a flat mere expansion of apical portion and the trunk stouter running along the posterior tail-like appendage, thence protruding very little out of the posterior extremity of the body; anterior lamella passing near the anterior edge of the papilla, then turning posteriorly with the free end coming in contact with the nuclear membrane; nucleus large and ovoidal in shape with blunt anterior and pointed posterior ends.

Table 14 : Measurements of *Devescovina gyrinoides* De Mello (in μm) from *Neotermes bosei*, Dehra Dun, Uttranchal, India.

	Range	Mean
Length of body	68-90	79
Width of body	33-60	46.5
Body ratio (body-length/body-width)	1.5-2.06	2.03
Length of nucleus	4.8-7	5.9
Width of nucleus	3.2-5	4.1
Nuclear ratio (nuclear length/nuclear width)	1.4-1.5	1.45
Length of cresta	12-25	18.5
Length of anteromedial edge of cresta	3.6-4	3.8
Length of trailing flagellum	90-135	112.5

Remarks : The material studied posses all the typical characters of *D. gyrinoides* such as longer cresta, broadly ribbon-like trailing flagellum, stouter axostyle protruding out of the posterior extremity of the body.

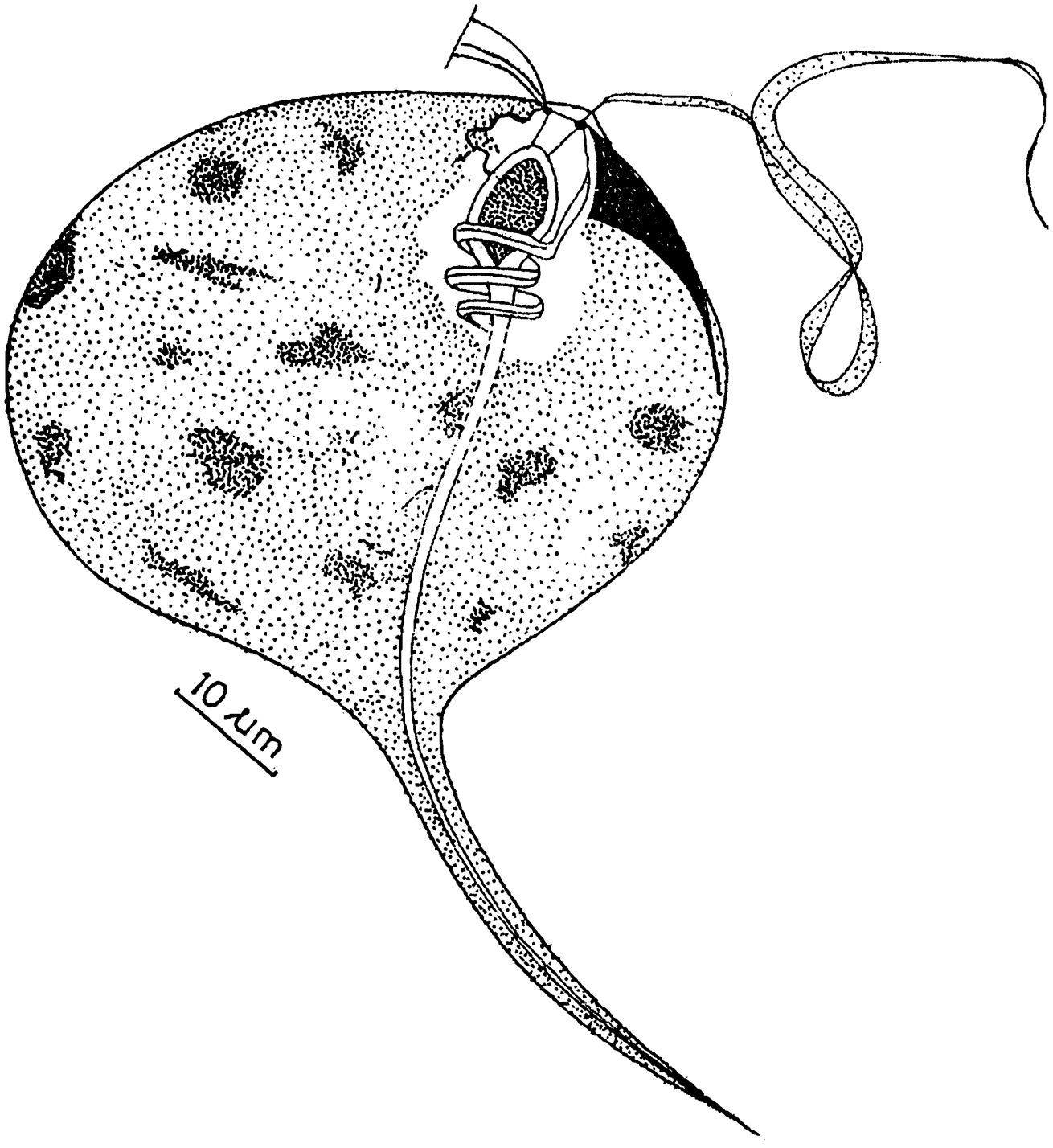

Fig. 13 : *Devescovina gyrinoides* De Mello from *Neotermes bosei.*

15. *Devescovina lemniscata* Kirby
(Fig. 14)

1926. *Devescovina lemniscata* Kirby, *Univ. Calif. Publ. Zool.*, **29** : p. 103, figs. B, C pl. 1, figs. 1-11.

Type host : *Cryptotermes hermsi* Kirby, Fanning Island.

Diagnosis : Body more or less pyriform; trailing flagellum markedly broad ribbon-shaped with gradually tapering terminal ends; cresta seen as elongated triangular body with broad,

straight proximal edge and gradually tapering to a sharply pointed distal end; parabasal body turning twice, thrice or four times around the trunk of axostyle; axostyle running through the body as a curved or straight rod upto the pointed extremity; its capitulum extended on one side of the nucleus as a flattened spoon lying against the nuclear membrane and the trunk stout at the anterior end then becoming filamentous at the posterior portion; anterior lamella seen as a prominent filament passing near the anterior edge of the papilla, then approaching to nuclear membrane; nucleus ellipsoidal in shape with blunt anterior and pointed posterior ends.

Table 15 : Comparison of measurements of *Devescovina lemniscata* Kirby as recorded by different workers (in µm).

	Type specimens (Kirby, 1929)		**Specimens (Das, 1974)**		**Specimens studied in the present work**				
	From *Cryptotermes hermsi*, Fanning Island		**From *Cryptotermes havilandi*, Falta, West Bengal, India**		**From *Cryptotermes havilandi*, Kolkata, West Bengal, India**		**From *Neotermes bosei*, Dehra Dun, Uttaranchal, India**		**From *Neotermes assamensis*, Jorhat, Assam, India**
	Range	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Mean**
Length of body	21-51	35	51-71.4	58.6	33.6-85	59.3	42-78	60	72
Width of body	9-17	12.5	11.9-22.1	19.8	18-26.4	22.2	16.8-39.6	28.2	26.4
Body ratio (body-length/ body-width)	2.3-3	–	3.2-4.2	–	1.8-2.5	3.2	1.9-2.5	2.2	2.7
Length of nucleus	5.5-7	6	5.1-6.8	6.2	4.8-7.2	6	4.8-6	5.4	7.2
Width of nucleus	3-4	3.5	3-3.4	3.2	2.4-5	3.7	3-3.6	3.3	3.6
Length of trailing flagellum	–	–	61.2-83.2	71.5	50-100	75	70-120	95	120
Length of cresta	7-9	8	11-12.7	12.5	9.6-10.2	9.9	10.8-14.4	12.6	9.6
Length of ante-romedial edge of cresta	–	2.5	2.5-3	–	2.4-3	2.7	3-3.6	3.3	2.5
Nuclear ratio (nuclear length/ nuclear width)	1.7-1.8	–	1.7-2	–	1.4-2	1.7	1.6	–	2

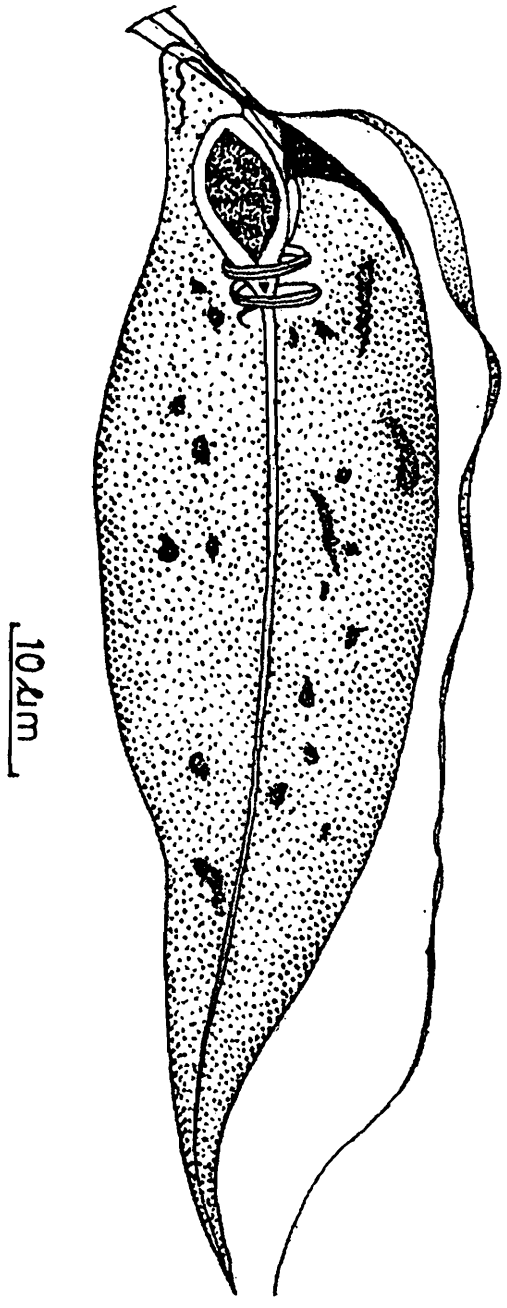

Fig. 14 : *Devescovina lemniscata* Kirby from *Cryptotermes havilandi.*

Remarks : There exist great variations in its shape of the body, form of cresta, number of parabasal turns, trunk of axostyle etc. in different specimens from various hosts as have been observed in a long series of specimens studied. Body sometimes is broadly rounded with constricted anterior end and gradually tapering or rounded posterior end. The posterior part of cresta sometimes is seen protruding outside the usual contour of the body with cytoplasmic mass. The parabasal body with two and a half turns are commonly found in the individuals from *Cryptotermes havilandi*, while the same with three or four turns in those from *Neotermes bosei*, and mostly with two turns in those from *N. assamensis*. Axostyle is found also curved back within cytoplasm in subround forms. Some specimens from *C. havilandi* are exceptionally smaller than those from *N. bosei* and *N. assamensis*.

16. *Devescovina parasoma* Kirby
(Fig. 15)

1941. *Devescovina parasoma* Kirby, *Univ. Calif. Publ. Zool.*, **45** : p. 46, figs. B, 14, pl. 3, fig. 29, pl. 4, figs. 30-32.

Type host : *Neotermes tectonae* (Dammerman), Java and Sumatra, Indonesia.

Diagnosis : Body pyriform in shape with anterior end obtusely pointed and posterior end gradually tapering like a tail; trailing flagellum appearing as a narrow band gradually tapering towards the terminal ends; cresta medium in size, with broad proximal end and sharply pointed, sometimes curved distal end; its anteromedial edge incurved; parabasal body coiled around the trunk of axostyle apparently in close spiral of 2 to 3 turns diminishing in diameter; axostyle with capitulum, a simple, flat expansion; its trunk, stout particularly in its posterior portion, extending through the body straight or slightly curved and mostly projecting a few micron beyond the posterior end of the body; nucleus oval in shape.

Table 16 : Comparison of measurements of *Devescovina parasoma* Kirby as recorded by different workers (in μm).

	Type specimens (Kirby, 1941)	Specimens studied in the present work			
	From *Neotermes tectonae*, Java	From *Neotermes bosei*, Dehra Dun, Uttaranchal, India		From *Neotermes assamensis*, Jorhat, Assam, India	
	Range	Range	Mean	Range	Mean
Length of body	24-60	48-90	69	50-54	52
Width of body	11-27	14.4-40	27.2	28-31.2	23.6
Length of nucleus	4.4-6.2	3.6-10	6.8	4-6	5
Width of nucleus	3.6-5.3	2.4-5	3.7	3-3.6	3.3
Length of cresta	4.4-6	4.8-10	7.1	4.8-6	5.4
Length of antero-medial edge of cresta	2-2.5	1.2-2.4	1.8	1.2-2.4	1.8
Length of trailing flagellum	–	70-110	90	80-100	90
Body ratio (body-length/ body-width)	2.1-2.1	2.2-3.3	2.75	1.73-1.78	1.75
Nuclear ratio (nuclear-length/nuclear-width)	1.1-1.2	1.5-2	1.75	1.3-1.6	1.45

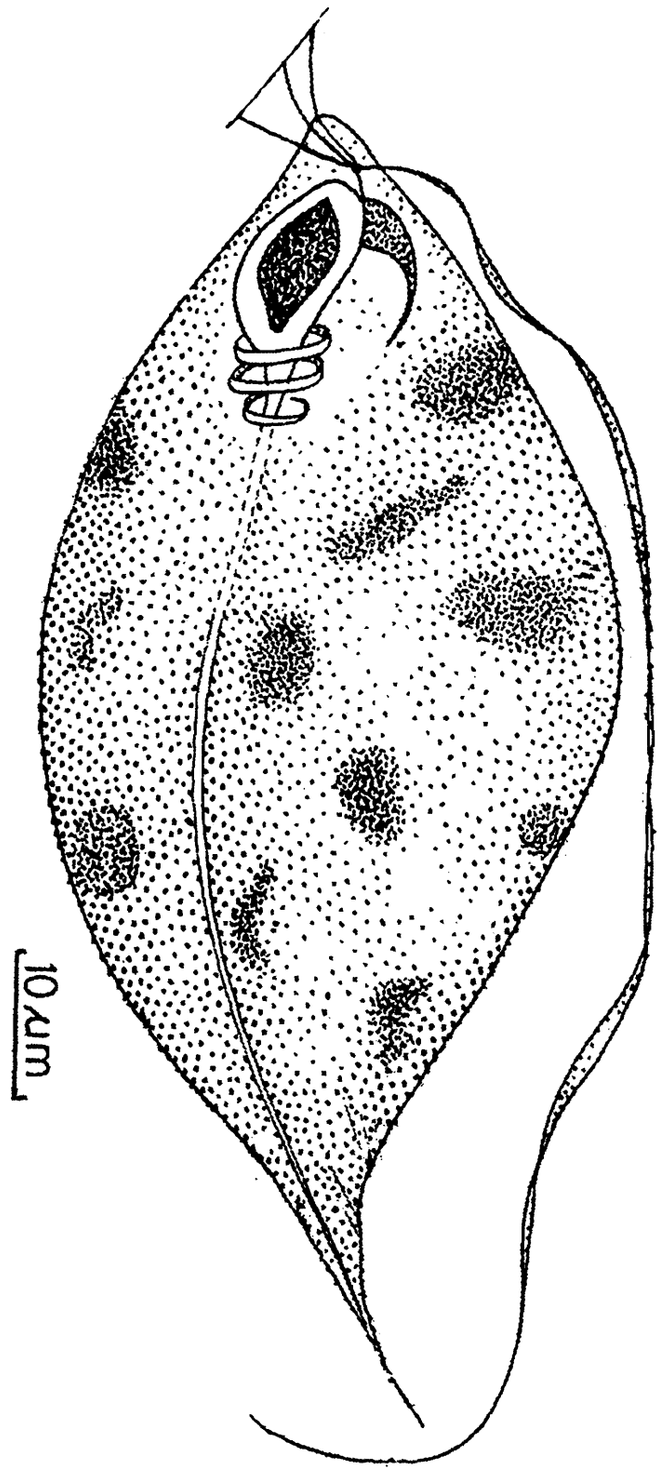

Fig. 15 : *Devescovina parasoma* Kirby from *Neotermes bosei.*

Remarks : The large majority of specimens studied are in conformity with the typical ***D. parasoma*** except some variations noticed. The parabasal spiral varies between 2 and 3 turns as against 1 to 4 turns in type-specimens along with 3 to 4 turns in majority of specimens as referred by Kirby (1941).

17. *Devescovina similis* Kirby
(Fig. 16)

1941. *Devescovina similis* Kirby, *Univ. Calif. Publ. Zool.*, **45** : p. 67, fig. C, 7.

Type host : *Cryptotermes* sp, Madagascar.

Diagnosis : Body somewhat oblong or elliptical with blunt anterior end and gradually tapering on posterior fifth, terminating comparatively in narrow end; anterior flagella quite slender; trailing flagellum a flattened band-like ribbon so as upto its middle whence gradually becoming slender; cresta moderate sized with broad proximal and bluntly pointed distal ends; its anteromedial edge incurved, much shorter than posteromedial edge; parabasal body coiled around the trunk of axostyle in somewhat close spiral with 3 turns, occasionally with 2 turns; its last turn attaining less diameter than the preceeding ones; axostyle a stout rod, usually running straight, occasionally slightly curved, and terminating mostly within cytoplasm; its capitulum a broad and flattened expansion and the trunk indistinct but posteriorly much more stained terminating as a stout rod with a blunt tip; anterior lamella thickened as a very prominent ribbon-like structure passing near the anterior edge of the papilla close to the roots of the anterior flagella, then turning posteriorly towards the lateral side; nucleus fairly large and broadly ovoidal in shape with blunt ends.

Table 17 : Comparison of measurements of *Devescovina similis* Kirby as recorded by different workers (in μm).

	Type specimens (Kirby, 1941)	**Specimens studied in the present work**	
	From *Cryptotermes* sp., Madagascar	**From *Neotermes bosei*, Dehra Dun, India**	
	Range	**Range**	**Mean**
Length of body	38-58	65-80	72.5
Width of body	8.5-12.5	20-25	22.5
Body ratio (body-length/ body-width)	–	3.2	–
Length of nucleus	5-5.8	6-6.5	6.2
Width of nucleus	3.3-4.1	3.6-4.6	4.1
Nuclear ratio (nuclear length/ nuclear width)	–	1.3-1.6	1.4
Length of cresta	5.3-7	6-6.5	6.2
Anteromedial edge of cresta	2-2.5	2-2.4	2.2

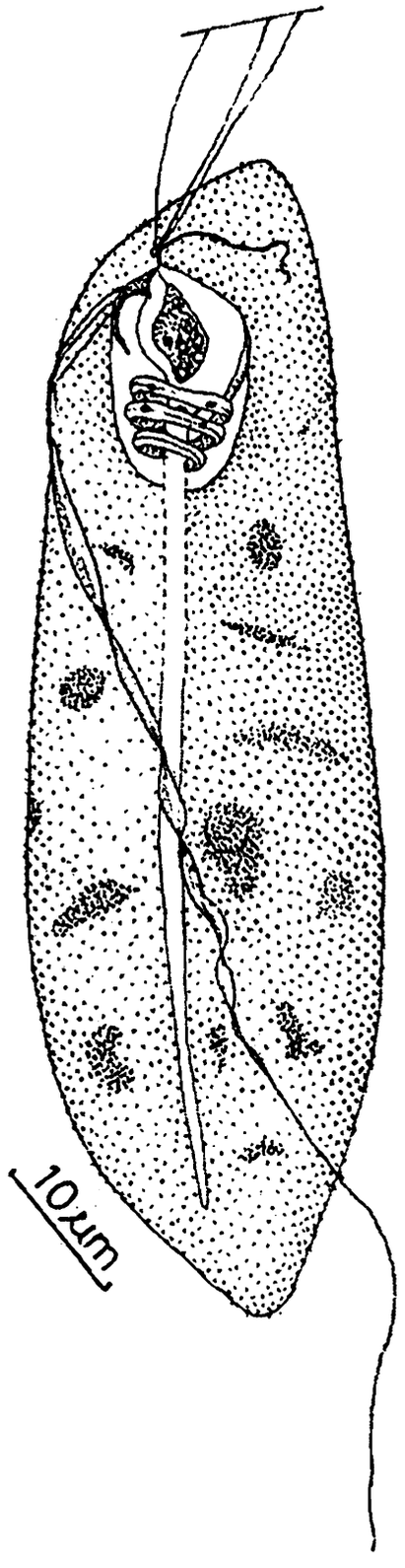

Fig. 16 : *Devescovina similis* Kirby from *Neotermes bosei.*

Remarks : The specimens examined are easily recognised as *D. similis* for their characteristic slender body forms and tightly coiled parabasal body. The presence of stout axostyle with its broadly expanded capitulum and anterior lamella in the species studied are neither described nor illustrated by Kirby (1941) in its original designation.

18. *Devescovina steini* Das
(Fig. 17)

1974. *Devescovina steini* Das, *Arch. Protistenk.*, **116** : 286-287, fig. 1, pl. 42, fig. 32.

Type host : *Cryptotermes havilandi* (Sjostedt), Falta, West Bengal, India.

Diagnosis : Body ovoidal in shape with rounded anterior end, middle portion attaining mostly the maximum width and rounded posterior end; trailing flagellum flattened to give a broad ribbon-like appearance and becoming gradually cord-like at terminal ends; cresta medium sized with broad proximal end and sharply pointed or bluntly pointed distal end; its anteromedial edge almost straight; parabasal body turning 2-3 times around the trunk of the axostyle in close spiral; axostyle stout throughout its length with the capitulum a simple, flat expansion and the trunk running straight throughout its length, projecting out from the posterior end of the body as a stout blunt rod but retaining the same diameter as in its anterior included portion; nucleus ovoidal in shape with blunt terminal ends.

Table 18 : Comparison of measurements of *Devescovina steini* Das as recorded by Indian workers (in µm).

	Type specimens (Das, 1974)		**Specimens studied in the present work**	
	From *Cryptotermes havilandi*, Falta, West Bengal, India		**From *Neotermes bosei*, Dehra Dun, Uttaranchal, India**	
	Range	**Mean**	**Range**	**Mean**
Length of body	34-44.2	40.4	30-70	50
Width of body	18.7-25.5	22.5	25-40	32.5
Body ratio (body-length/ body-width)	1.6-2	1.8 : 1	1.2-1.3	1.25
Length of nucleus	5.1-5.9	5.5	5-7	6
Width of nucleus	3.4-4.2	3.6	2.4-3	2.7
Nuclear ratio (nuclear length/ nuclear width)	1.4-1.5	1.45	2-2.8	2.4
Length of cresta	8.2-13.9	8.5	6-7.2	6.6
Length of anteromedial edge of cresta	–	–	2.4-3	2.7
Length of trailing flagellum	42.5-54	50.2	40-100	70

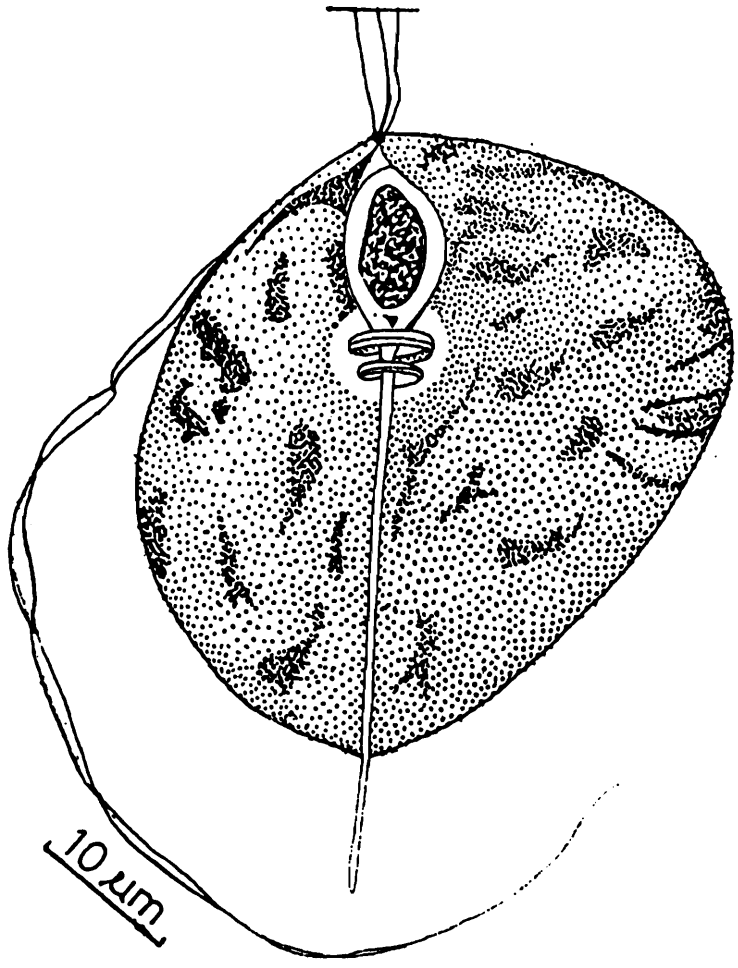

Fig. 17 : *Devescovina steini* Das from *Neotermes bosei.*

Remarks : Large majority of the specimens are exactly similar to typical *D. steini* except some characters indicating some variations. In most of the specimens, the axostyle is very stout throughout, which is gradually tapering as given by the original author. Further, the parabasal body is provided with two turns in most cases as in type specimens, but occasionally there may be even three turns also.

Genus ***Foaina*** Janicki

Diagnosis : Trailing flagellum exceeding twice the body-length; parabasal body never extending beyond the nucleus; trunk of axostyle always very stout and protruding out of the posterior end of the body.

Key to the species

1(2). Axostyle having a cusp at the terminal end, parabasal body band-like without any free terminal filament ..... *F. gracilis*

2(1). Axostyle devoid of any cusp, parabasal body anteriorly thickened but terminating posteriorly into a free filament.

3(4). Proximal portion of trailing flagellum adhered to the body surface, free parabasal filament very long and forming no loop around the posterior end of nucleus, cresta length 15 µm ..... *F. costata*

4(3). Proximal portion of trailing flagellum not adhered to the body surface, rather free, free parabasal filament short and forming a loop around the posterior end of nucleus, cresta length 3.7 µm ..... *F. exempta*

19. *Foaina costata* Kirby
(Fig. 18)

1942. *Foaina costata* Kirby, *Univ. Calif. Publ. Zool.*, **45** : 194-195, fig. A, 11, pl. 25, figs. 26-29.

Type host : *Neotermes insularis* (Walker), Australia.

Diagnosis : Body almost spherical in shape with comparatively narrow posterior end; trailing flagellum a narrow band apparently adhered to the surface of body along the full length of the cresta; cresta long, narrow, gradually tapering posteriorly and terminating into a blunt end; its anteromedial edge very short and straight and posteromedial edge mostly attaining the full length sometimes two-thirds of the body; parabasal body turning as a thick

Table 19 : Comparison of measurements of *Foaina costata* Kirby as recorded by different workers (in µm).

	Type specimens (Kirby, 1942)	**Specimens studied in the present work**	
	From *Neotermes insularis*, Australia	**From *Neotermes dhirendrae*, Chennai, India**	
	Range	**Range**	**Mean**
Length of body	15-35	12-55	33.5
Width of body	7-17	9.6-35	22.3
Body ratio (body-length/ body-width)	2.05-2.14	1.2	–
Length of nucleus	3.2-4.6	3-10	6.5
Width of nucleus	2.2-3	2.5-3	2.7
Nuclear ratio (nuclear length/ nuclear width)	1.4-1.5	1.2	–
Length of cresta	11-29	12-40	26
Length of anteromedial edge of cresta	–	1-1.2	1.1
Length of trailing flagellum	–	30-120	75

band along the side of nucleus, then terminating into a long filament extended upto the middle of the body obliquely; axostyle moderately stout, gradually tapering posteriorly; its capitulum moderately expanded and flattened along the side of the nucleus and the trunk generally a stout rod extending in a straight course mostly in the cytoplasm then becoming almost filamentous in its protruding end; nucleus elongately oval and large.

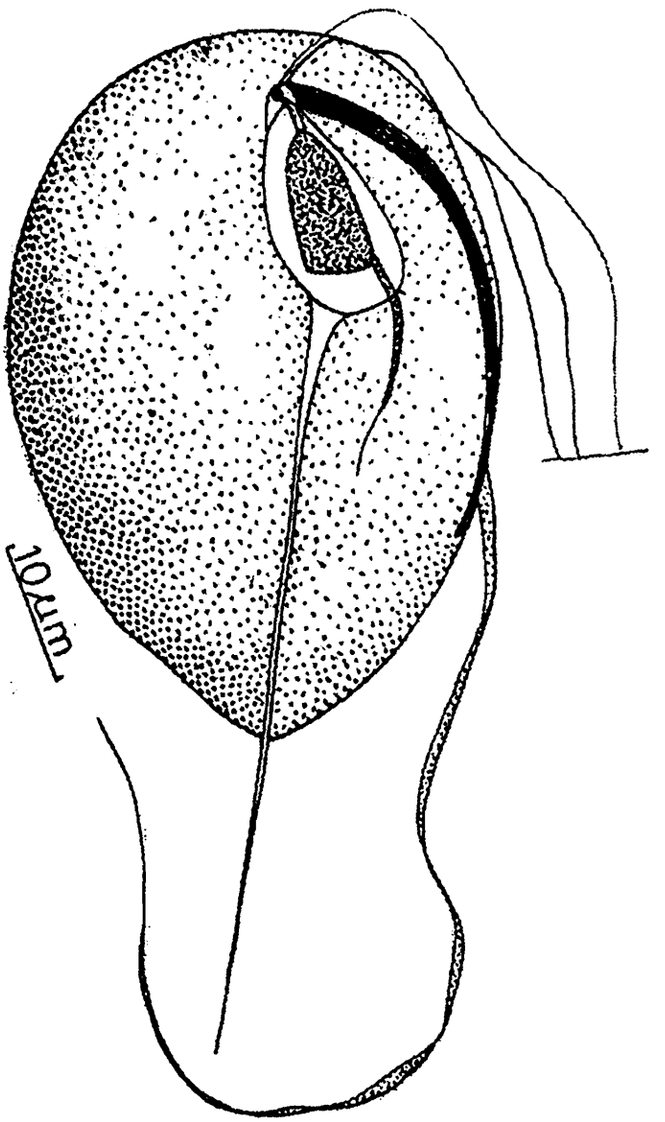

Fig. 18 : *Foaina costata* Kirby from *Neotermes dhirendrae.*

Remarks : In all essential characters, particularly the adpressed trailing flagellum along the proximal part of the body surface, the specimens studied can easily be recognised as *Foina costata* Kirby. In some rare cases, the trailing flagellum is also free, variously curved or looped away from the body surface, which had already been referred by Kirby in his original description. However, the specimens studied are much smaller, but wider than those described from the type host. The parabasal body is sometimes found continuing transversely along the posterior margin of nucleus and finally touching the peripheral surface of the body.

20. *Foaina exempta* Kirby
(Fig. 19)

1942. *Foaina exempta* Kirby, *Univ. Calif. Publ. Zool.*, **45** : 198-199, pl. 24, fig. 13, fig. A, 5.

Type host : *Neotermes insularis* (Walker), Australia.

Diagnosis : Body elongately oval in shape with an anterior blunt end having a distinct papilla and posteriorly tapering gradually into a somewhat pointed end; trailing flagellum a moderately stout cord, somewhat flattened; cresta small with very little broad proximal and sharply pointed distal ends; its anteromedial edge incurved; parabasal body forming a band-like loop over the posterior portion of nucleus, then continuing as a short free filament and running obliquely beyond nucleus; axostyle a stout rod running through cytoplasm in a straight course and protruded out of the body with gradual tapering terminal end; nucleus oval in shape with bluntly pointed ends.

Remarks : The specimens studied from *N. bosei* remain in full conformity with those recorded from *N. insularis* only having minor difference in morphometry.

Table 20 : Comparison of measurements of *Foaina exempta* Kirby as recorded by different workers (in μm).

	Type specimens (Kirby, 1942)	**Specimens studied in the present work**	
	From *Neotermes insularis*, Australia	**From *Neotermes bosei*, Dehra Dun, India**	
	Range	**Range**	**Mean**
Length of body	8-39	22-40	31
Width of body	4.5-16	7.2-20	13.6
Body ratio (body-length/ body-width)	1.7-2.4	2-3.05	2.5
Length of nucleus	1.7-4.5	5-6	5.5
Width of nucleus	1-3.5	3-3.6	3.3
Nuclear ratio (nuclear length/ nuclear width)	1.2-1.7	1.6	–
Length of cresta	3-6	3.5-4	3.7
Length of anteromedial edge of cresta	–	1-1.2	1.1
Length of trailing flagellum	–	50-90	70

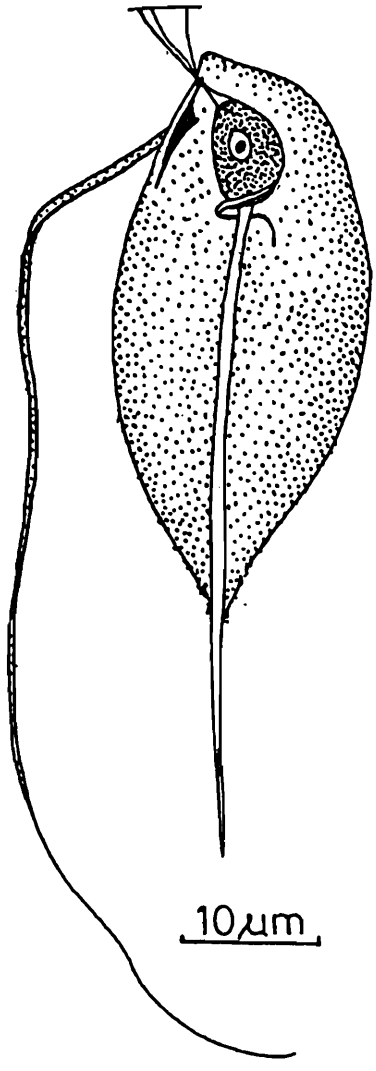

Fig. 19 : *Foaina exempta* Kirby from *Neotermes bosei.*

21. ***Foaina gracilis*** Janicki
(Fig. 20)

1915. *Foaina gracilis* Janicki, *Zeitschr. Wiss. Zool.*, **92** : p. 615, pl. 18, figs. 62-64.

Type host : *Neotermes connexus* Snyder, Hawaii.

Diagnosis : Body somewhat oval in shape, broadest at the middle, with rounded anterior and somewhat bluntly pointed posterior ends; trailing flagellum narrowly ribbon-like and entirely free except at its proximal attachment with the blepharoplast; cresta with somewhat broad incurved anteromedial and gradually narrowing posteromedial edges; parabasal body very simple in structure, turning transversely across the posterior level of nuclear membrane as a C-form band; capitulum of axostyle usually a moderately expanded, flattened structure along one side of the nucleus; trunk of axostyle a stout rod extending through the cytoplasm in a straight course, ultimately projecting out from the posterior end of the body and with always an elongated cusp prolonged in a terminal filament; nucleus elongately oval in shape, placed just beyond the anterior extremity of the body.

Table 21 : Comparison of measurements of *Foaina gracilis* Janicki as recorded by different workers (in μm).

	Type specimens (Janicki, 1915)		Specimens studied in the present work	
	From *Neotermes connexus*, Hawaii		From *Neotermes dhirendrae*, Chennai, India	
	Range	Mean	Range	Mean
Length of body	15-34	24	13.2-30	21.6
Width of body	8-18	13	8.4-22	15.2
Body ratio (body-length/body-width)	1.8	–	1.5	–
Length of nucleus	4.4-5.3	–	4.8-5	4.9
Width of nucleus	2.5-3	–	3-3.6	3.3
Nuclear ratio (nuclear length/nuclear width)	1.7	–	1.3-1.6	1.4
Length of cresta	3-5	–	4.8-8	6.4
Length of anteromedial edge of cresta	–	–	1-1.2	1.1
Length of trailing flagellum	–	–	28-65	46.5

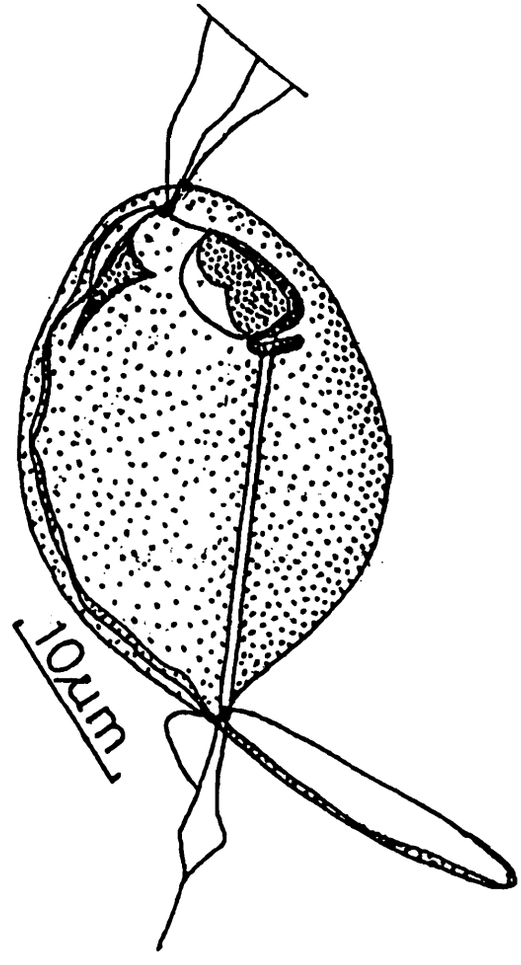

Fig. 20 : *Foaina gracilis* Janicki from *Neotermes dhirendrae.*

Remarks : *Foina gracilis* is reported here with abundance from *Neotermes dhirendrae* Bose. The immediate identity of the species becomes very easy by the presence of characteristic C-formed parabasal body. The only variation could be noted in some specimens as to the narrowly ribbon-like trailing flagellum as against moderately stout cord-like trailing flagellum in type specimens.

Genus ***Stephanonympha*** Janicki

Diagnosis : Large body with numerous nuclei arranged concentrically or in spiral rows at the anterior half of the body; each nucleus associated with four flagella, and an axial filament, a parabasal body and a blepharoplast; all the axial filaments joined together to form an axial bundle.

Key to the species

1(4). Parabasal body smaller than nucleus

2(3). Nuclei arranged in single spiral series ..... *S. minuta*

3(2). Nuclei arranged in 2-3 spiral series ..... *S. silvestrii*

4(1). Parabasal body as large as nucleus

5(6). Nuclei ovoidal in shape, widely spaced and arranged in 2-4 spiral series ... *S. campinae*

6(5). Nuclei oval in shape, closely embedded and arranged in 4-6 spiral series ..... *S. reenstiernai*

22. ***Stephanonympha campinae*** De Mello
(Fig. 21)

1945. *Stephanonympha campinae* De Mello, *Parasitology*, **44** : 31-32, pl. VI.

Type host : *Neotermes hirtellus* (Silvestri), Brazil.

Diagnosis : Body ovoidal in shape, rounded both anteriorly and posteriorly and the middle portion attaining maximum width; nuclei ovoidal in shape, comparatively larger and 15-24 in number, remaining closely arranged in 3-4 spiral series and confined to anterior end of the body; flagella exceptionally long and slender; closely adhered to nucleus a lightly stained and ovoidal parabasal body as large as nucleus; axial filament bordering closely the nuclear membrane and running in the direction towards posterior portion of the body; multifibered axial bundle formed behind the nuclear crown, terminating posteriorly mostly some distance before the interior boundary of ectoplasm, and sometimes extending even beyond the boundary of the body.

Table 22 : Comparison of measurements of *Stephanonympha campinae* De Mello as recorded by different workers (in μm).

	Type specimens (De Mello, 1954)	Specimens studied in the present work	
	From *Neotermes hirtellus*, Brazil	From *Neotermes bosei*, Dehra Dun, India	
	Range	Range	Mean
Length of body	60-100	51.6-70	60.8
Width of body	30-150	48-66.5	57.2
Body ratio (body-length/body-width)	2	1.05-1.07	1.06
Length of nucleus	2.0-2.5	4.8-5	4.9
Width of nucleus	–	3.6-4.8	4.2
Nuclear ratio (nuclear length/nuclear width)	–	1.04-1.3	1.18
Length of parabasal body	–	4.5-5	4.7
Length of flagella	35-40	17-25	21

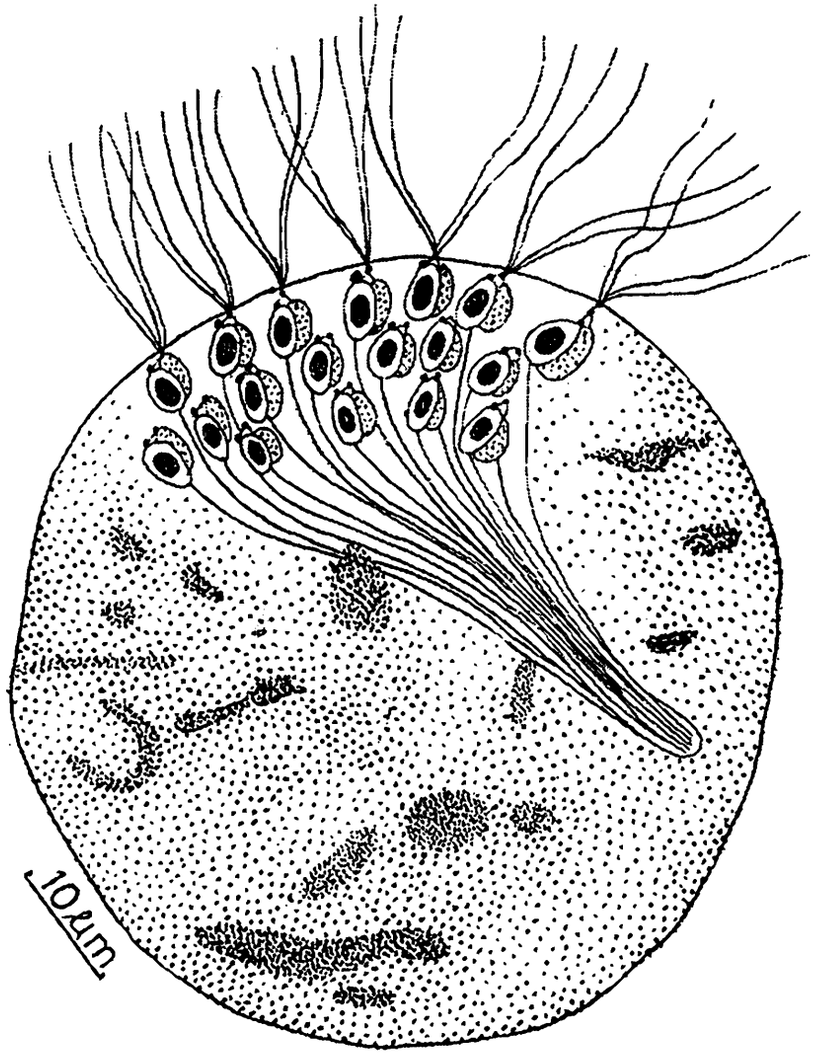

Fig. 21 : *Stephanonympha campinae* De Mello from *Neotermes bosei.*

Remarks : The detailed study of *S. campinae* shows certain variations which create some confusions for its own identity when compared with the description of type specimens. For example, the number of nuclei varies between 15-24 arranged in 2-4 spiral rows against 15-60 arranged in 3-6 spiral rows mentioned by De Mello. Likewise, the discrete cresta referred by De Mello could hardly be observed in the specimens studied.

23. *Stephanonympha minuta* Das and Choudhury
(Fig. 22)

1972. *Stephanonympha minuta* Das and Choudhury, *Proc. Zool. Soc.*, Calcutta, **25** : 26-27, fig. 1, pl. 1, fig. 1.

Type host : *Neotermes bosei* Snyder, West Bengal, India.

Diagnosis : Body oval with broadly rounded anterior and posterior ends; nuclei oval, 8-12 in number, set close together and arranged in single spiral row at the anterior most portion of the body; flagella slender; close to the anterior end of each nucleus a spherical, lightly stained parabasal body, diameter of which less than that of nucleus; axial filament running along the nuclear membrane and then extending posteriorly within endoplasm; axial bundle running a short distance behind the nuclear crown and terminating posteriorly much before the interior boundary of the ectoplasm.

Table 23 : Comparison of measurements of *Stephanonympha minuta* Das and Choudhury as recorded by Indian workers (in µm).

	Type specimens (Das and Choudhury, 1972)		Specimens studied in the present work		
	From *Neotermes bosei*, West Bengal, India		From *Neotermes bosei*, Dehra Dun, Uttaranchal, India		From *Neotermes assamensis*, Dibrugarh, Assam, India
	Range	Mean	Range	Mean	Mean
Length of body	28-36	34	42-85	63.5	78
Width of body	20-29.7	26.3	40.8-50.4	45.6	72
Body ratio (body-length/ body-width)	1.1-1.4	1.3	1.02-1.6	1.31	1.08
Length of nucleus	–	–	2.6-3	2.8	6
Width of nucleus	–	–	1.9-2.0	1.95	3.6
Nuclear ratio (nuclear-length/ nuclear-width)	–	–	1.3-1.5	1.4	1.6
Length of parabasal body	–	–	1.2-1.8	1.5	5
Length of flagella	–	–	6-12	9	12

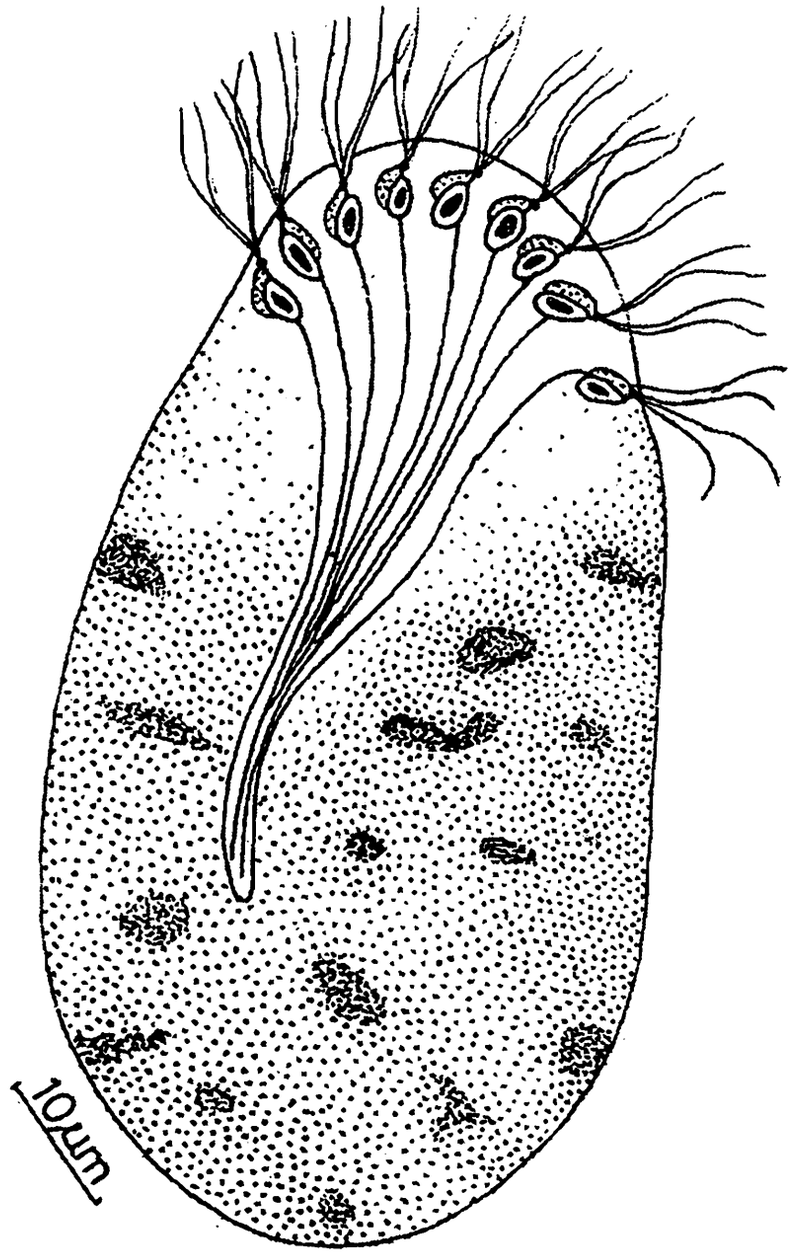

Fig. 22 : ***Stephanonympha minuta*** Das and Choudhuri from ***Neotermes bosei.***

Remarks : The specimens studied are mostly identical with type specimens, particularly in having minimum number of nuclei arranged only in a single spiral series at the anterior end of the body. However, in the present study material, the number of nuclei varies from 8-10 in the host *Neotermes bosei,* which remains almost constant to a number of 15 in the individuals from *N. assamensis.* In some of the specimens from *N. bosei,* axial bundle terminates within endoplasm far above the posterior boundary of the body, which extends upto the posterior extremity of the body in *S. minuta.* The axial bundle maintains such pattern in the individuals from *N. assamensis.* Now, considering the contour of body, although it is a very much variable feature within all flagellates as reported by previous workers, the individuals are mostly oval, sometimes vary from spherical to ovoidal in both the hosts of present study. But in the original description the body of individuals had been reported to be oval only.

24. *Stephanonympha reenstiernai* De Mello
(Fig. 23)

1946. *Stephanonympha reenstiernai* De Mello, *An. Inst. Med. Trop.*, **3** : p. 37.

Type host : *Cryptotermes* sp., India.

Diagnosis : Body typically ovoidal or spheroidal in shape with broadly rounded anterior and posterior poles and the middle portion attaining maximum width; nuclei oval in shape, very much closely set together; about 70 nuclei found to be arranged in 4 spiral series, occupying the broad anterior portion and extending upto middle of the body; parabasal body oval and as large as nucleus, remaining at one side or over the nucleus as a cap; axial filament running along the nuclear membrane and then downwards into endoplasm; multifibered axial bundle formed far behind the nuclear crown and terminating near the posterior extremity of the body.

Table 24 : Comparison of measurements of *Stephanonympha reenstiernai* De Mello as recorded by different workers (in μm).

	Type specimens (De Mello,1946)	**Specimens studied in the present work**	
	From *Cryptotermes* sp., India	**From *Neotermes dhirendrae*, Chennai, India**	
	Range	**Range**	**Mean**
Length of body	22-55	90-120	105
Width of body	20-50	85-96	90.5
Length of nucleus	–	4.8-5	4.9
Width of nucleus	–	2.4-2.6	2.5
Length of parabasal body	–	4-4.5	4.2
Length of flagella	–	8-15	11.5
Body ratio (body-length/ body-width)	1.1	1.05-1.07	1.06
Nuclear ratio (nuclear length/ nuclear width)	–	1.92-2	1.96

Remarks : The individuals of present report are recognised easily as representatives of *S. reenstiernai* of De Mello due to their typical ovoidal or spherical forms with its numerous nuclei (70-100) arranged in 4-6 spiral series, parabasal body as large as nucleus and axostyle hardly protruding out of the body.

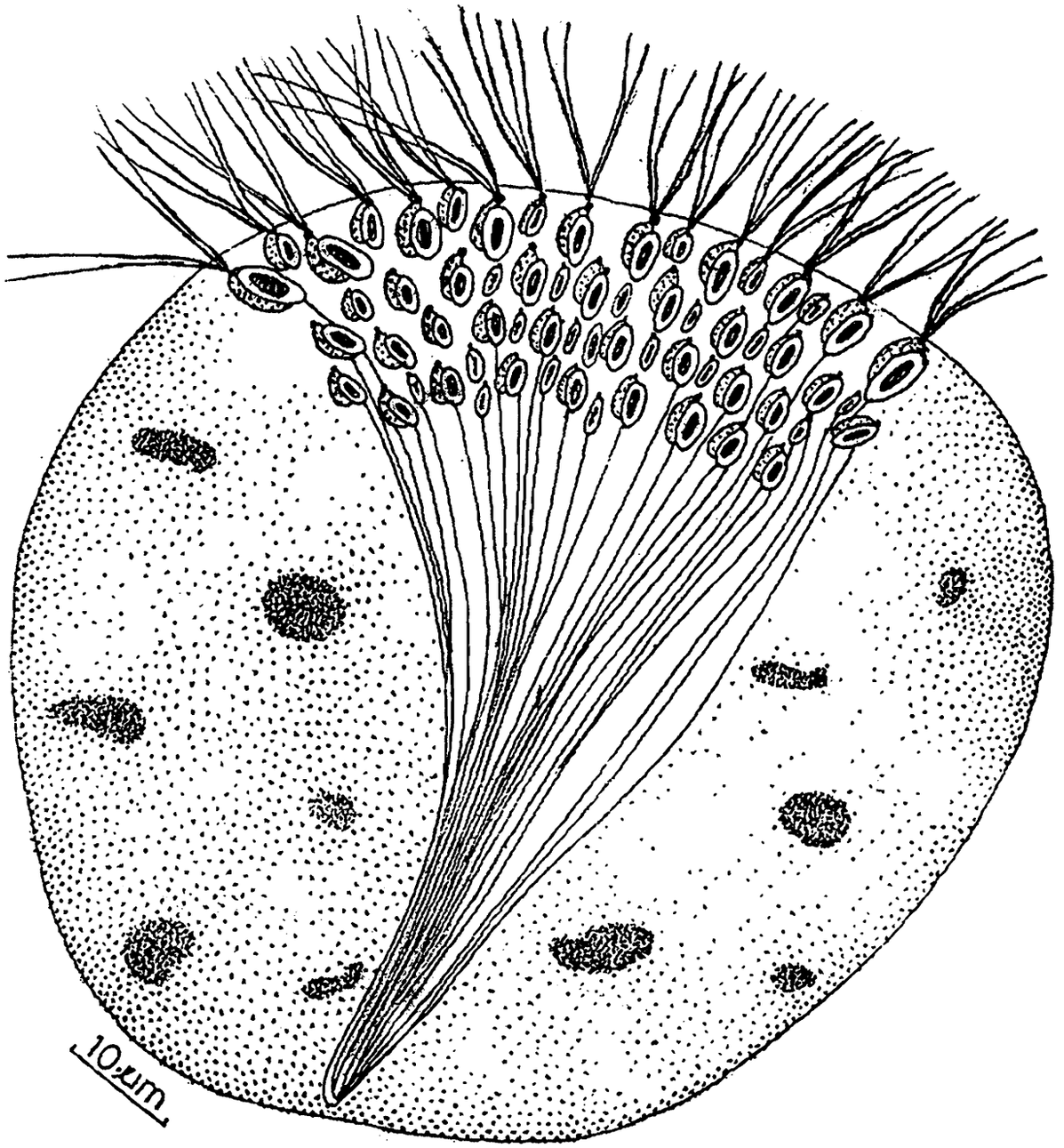

Fig. 23 : *Stephanonympha reenstiernai* De Mello form *Neotermes dhirendrae.*

25. ***Stephanonympha silvestrii*** Janicki

(Fig. 24)

1911. *Stephanonympha silvestrii* Janicki, *Biol. Central*, **31** : 325.

Type host : *Cryptotermes havilandi* (Sjostedt), Nigeria.

Diagnosis : Body ovoidal or spheroidal in shape; nuclei oval in shape, near about 30 in number, almost closely embedded in 2-4 spiral series at the anterior portion of the body; parabasal body oval, much smaller than nucleus, remaining in close association with it; four flagella running forward; axial filament extending downwards to form the axial bundle behind

the nuclear crown and terminating mostly before the posterior extremity of the body, sometimes continueing upto posterior end.

Table 25 : Comparison of measurements of *Stephanonympha silvestrii* Janicki as recorded by different Indian workers (in μm).

	Specimens studied by Das and Choudhury, 1972		Specimens studied in the present work						
	From *Cryptotermes havilandi*, Kolkata, West Bengal, India		From *Cryptotermes havilandi*, Kolkata, West Bengal, India		From *Neotermes bosei*, Dehra Dun, Uttaranchal, India		From *Neotermes dhirendrae*, Chennai, Tamil Nadu, India		From *Neotermes assamensis*, Jorhat, Assam, India
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Mean
Length of body	45-56.2	49.3	66-72	69	60-75	67.5	90	78-84	81
Width of body	31.5-41.2	33.7	60-66	63	50.4-74	62.2	86	42-72	57
Body ratio (body-length/ body-width)	1.3-1.6	1.5	1-1.1	1.05	1.01-1.1	1.05	1.04	1.1-1.8	1.4
Length of nucleus	–	–	2.9-3.2	3	2.5-3	2.7	4.8	3.5-4	3.7
Width of nucleus	–	–	1.8-2	1.9	1.5-1.8	1.6	2.4	2.4-3	2.7
Nuclear ratio (nuclear-length/ nuclear-width)	–	–	1.6	–	1.6	–	2	1.3-1.4	1.3
Length of parabasal body	–	–	1.8	–	1.2	–	2.5	2.4	–
Length of flagella	–	–	12-14	13	10-15	12.5	1.4	12-14	13

Remarks : The specimens recorded are very much similar to those of *S. silvestrii* Var. *Cryptotermes hailandi* Grassi, subsequently placed under *S. hailandi* by Kirby (1926) and thereafter synonymised under *S. silvestrii* by Grassi (1952) (see Das *et al.*, 1993 and Das, *in press*). The number of flagella emerging from each blepharoplast has been observed as 4 although Kirby mentioned the number of flagella varying between 2-4. In the present study the number of nuclei varies between 25-50 arranged in 2-4 spiral series. Long series of material studied from different hosts indicate its wide range of variation in body shape varying from oval to spheroidal.

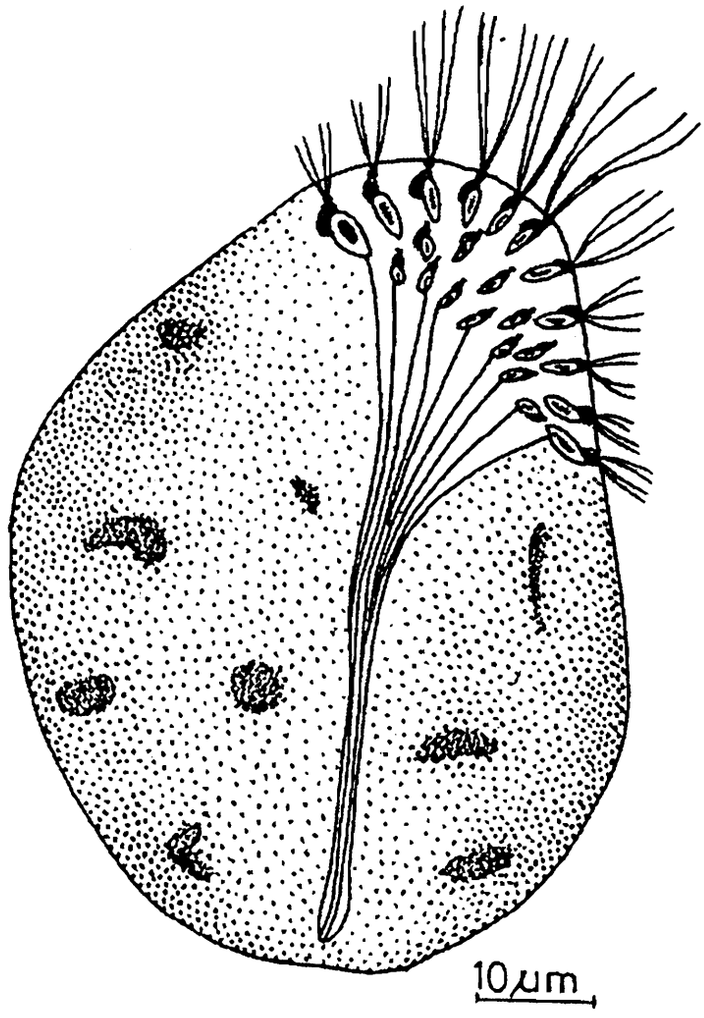

Fig. 24 : *Stephanonympha silvestrii* Janciki from *Neotermes bosei.*

Genus ***Trichomitopsis*** Honigberg

Diagnosis : Blepharoplast giving origin of undulating membrane, costa and parabasal body; undulating membrane continued posteriorly as free flagellum; trunk of axostyle stout; costa very prominent.

26. ***Trichomitopsis cartagoensis*** (Kirby)
(Fig. 25)

1936. *Trichomitopsis (Trichomonas) cartagoensis* (Kirby), Honigberg, *J. Proto Zool.*, **10** : p. 53.

Type host : *Kalotermes contracticornis* Snyder, Cartago, Costa Rica.

Diagnosis : Body pyriform, ellipsoidal or subspheroidal, provided with a conical extension at anterior end; blepharoplast, a single granule of fairly large in size and placed at the base of the conical process on the anterior tip of the body; anterior flagella four in number and slender, originating from the blepharoplast as a single root; undulating membrane prominent, provided with distinct folds of moderate height bordering the body surface and posteriorly remaining attached to body surface, being projected into 3-4 small pointed folds; free portion

of undulating membrane at the posterior end of the body becomeing slender, filamentous and moderately long; costa stout, band-like of uniform thickness throughout entire length and being originated from the blepharoplast as a thin filament, running along one side of the body then terminating at the posterior end of the body; costa heavily stained with Iron-Haematoxylin; parabasal body slender and short thread-like structure, curved on a short radius and ultimately becoming attached to the nucleus; capitulum of axostyle broadly expanded, stout trunk posteriorly tapering gradually; nucleus spherical or broadly ellipsoidal and situated a little behind the blepharoplast.

Table 26 : Comparison of measurements of *Trichomitopsis cartagoensis* Kirby as recorded by different workers (in μm).

	Type specimens (Kirby, 1931)	**Specimens studied in the present work**					
	From *Kalotermes contracticornis*, Costa Rica	**From *Neotermes bosei*, Dehra Dun, Uttaranchal, India**		**From *Neotermes dhirendrae*, Chennai, Tamil Nadu, India**		**From *Neotermes assamensis*, Dibrugarh, Assam, India**	
	Range	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**
Length of body	14-29	32.4-36	34.2	21.6-32.4	27	30-36	33
Width of body	6-14	21.6-26	23.8	6-9.6	7.8	14.4-30	22.2
Length of nucleus	3-4	8.4-9	8.7	3.8-4.8	4.3	4.8-7	5.9
Width of nucleus	4-5	6-6.5	6.2	3.6-3.8	3.7	4-8	6
Body ratio (body-length/ body-width)	2.07-2.3	1.3-1.5	1.4	3.3-3.6	3.4	1.5-2	1.7
Nuclear ratio (body-length/ nuclear length)	0.75-0.8	1.3-1.4	1.35	1-1.2	1.1	1-1.2	1.1

Remarks : The individuals of present investigation are almost similar to the specimens originally described by Kirby. Still few variations can be traced out in the individuals under report. The most distinct variation is the absence of cytostome in all individuals studied in contrast to type specimens wherein the cytostome is a conspicuous broad crescentic area bordered dorsally by the edge of the capitulum. The next variation lies in the posterior portion of the trunk of axostyle which is not so enlarged as in type specimens. In the type specimens the parabasal body had not been observed to reach upto nucleus, but in all the individuals

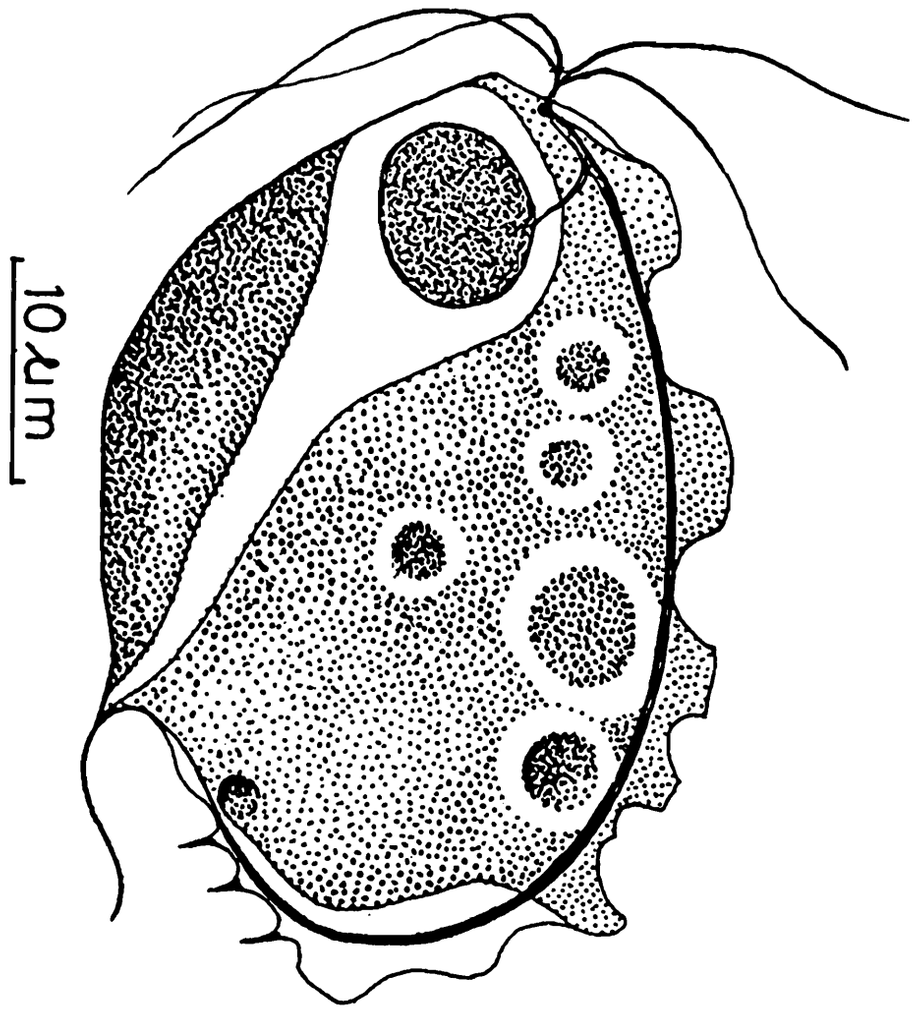

Fig. 25 : *Trichomitopsis cartagoensis* (Kirby) from *Neotermes assamensis.*

studied, it touches posteriorly the anterior portion of nuclear membrane. A prominent rhizoplast is observed in all the individuals, connecting the nucleus with blepharoplast, which had not been pointed out in type specimens. The individuals studied from different hosts at present time are in full conformity except in the degree of thickness of the undulating membrane. Its ridges are much more broader and thicker in the specimens from *Neotermes assamensis* than those from *N. dhirendrae* and *N. bosei.*

Genus ***Holomastigotoides*** Grassi and Foa

Diagnosis : Body usually large and covered with 12-40 spiral rows of flagella; nucleus located near the anterior end of the body and surrounded by a dense mass of cytoplasm.

Key to the species

1(10). Anterior pole of body with a finger-like projection

2(9). Prenuclear zone well developed

3(6). Posterior portion of body glabrous

4(5). Dexiotropic spiral rows of flagella compactly arranged and not equally spaced..... ..... *H. bengalensis*

5(4). Dexiotropic spiral rows of flagella distantly arranged and equally spaced..... *H. rayi*

6(3). Posterior portion of body not glabrous

7(8). Body almost round in shape, axostyle extending upto the posterior end of the body ..... *H. hollandei*

8(7). Body bell-like in shape, axostyle extending upto the middle of the body ... *H. ogivalis*

9(2). Prenuclear zone absent, body top-like in shape ..... *H. turboformis*

10(1). Anterior pole of body without any finger-like projection

11(18). Prenuclear zone absent

12(15). Body covered with one type of flagella

13(14). Body perfectly oval in shape ..... *H. globosus*

14(13). Body perfectly spherical in shape ..... *H. sphaeroidalis*

15(12). Body covered with two types of flagella

16(17). Body ball-jar like in shape without apical knob ..... *H. campanula*

17(16). Body baloon-like in shape ..... *H. saccusiformis*

18(11). Prenuclear zone present

19(20). Body larger and oval in shape, posterior portion glabrous, axostyle distinct .... *H. magnus*

20(19). Body smaller and spheroidal in shape, posterior portion not glabrous, axostyle indistinct ..... *H. dharwarensis*

27. ***Holomastigotoides bengalensis*** Chakravarty and Banerjee (Fig. 26)

1956. *Holomastigotoides bengalensis* Chakravarty and Banerjee, *Proc. Zool. Soc., Calcutta*, **9** : 36-39, Fig. 1, A-N.

Type host : *Heterotermes indicola* (Wasmann), Kolkata, West Bengal, India.

Diagnosis : Body oval or elliptical in shape with anterior end terminating into a blunt finger-like projection and the posterior end narrowly rounded; shorter flagella occupying the major portion of the body in 24-36 dexiotropic rows comparatively much more wider in the anterior portion than on the posterior portion; a portion of the posterior part of the body bearing much more longer flagella; axostyle well developed extending almost upto the posterior extremity of the body, made up of few protoplasmic fibers aggregated posteriorly into a bundle; prenuclear zone a densely granulated conical area; nucleus oval in shape and situated near the anterior end of the body.

Table 27 : Comparison of measurements of *Holomastigotoides bengalensis* Chakravarty and Banerjee as recorded by different Indian workers (in µm).

	Type specimens (Chakravarty and Banerjee, 1956)	**Specimens studied in the present work**
	From *Heterotermes indicola*, Kolkata, West Bengal, India	**From *Heterotermes indicola*, Chandannagar, West Bengal, India**
Length of body	81.9 (27.8-135)	127.5 (60-195)
Width of body	53.2 (21.4-87.5)	83 (50-116)
Length of the nucleus	–	15.5 (10-21)
Width of the nucleus	–	13.2 (8-18.5)
Length of shorter flagella	–	6.5 (5-8)
Length of longer flagella	–	12 (10-14)
Body ratio (body length/body width)	1.5 (1.2-1.8)	1.4 (1.2-1.6)
Body nuclear ratio (body length/nuclear length)	–	7.6 (6-9.2)

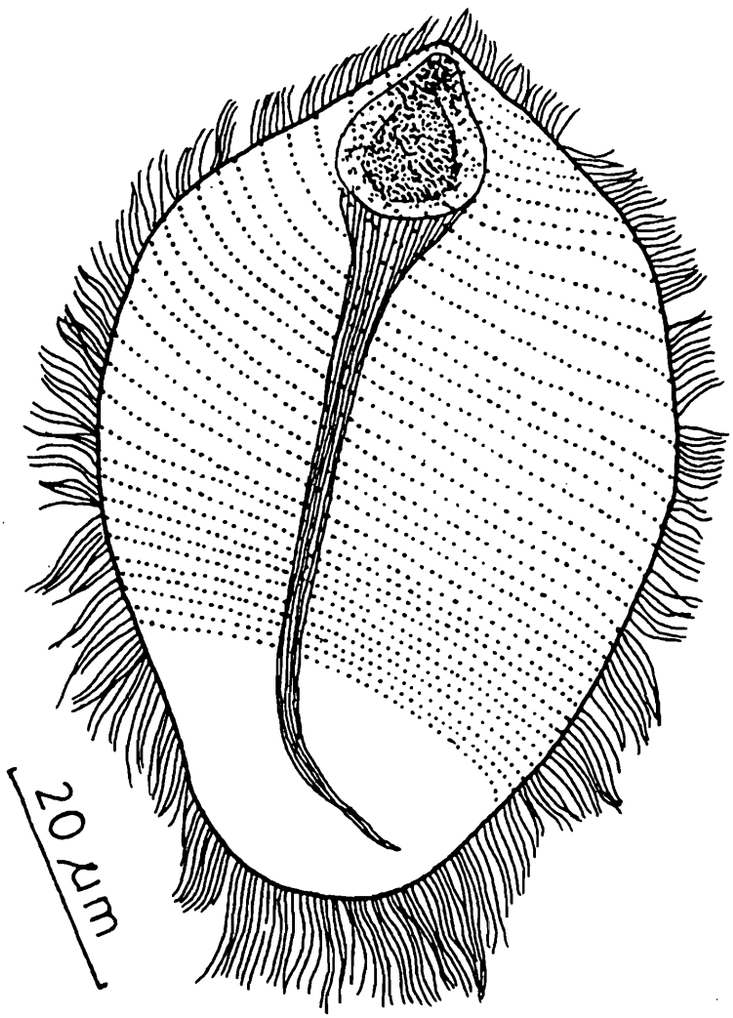

Fig. 26 : *Holomastigotoides bengalensis* Chakravarty and Banerjee from *Heterotermes indicola*.

Remarks : In the present work the species represented by numerous specimens, has been recovered which are mostly typical *H. bengalensis* exhibiting variation in their body dimension.

28. ***Holomastigotoides campanula*** De Mello
(Fig. 27)

1928. *Holomastigotoides campanula* De Mello, *Arqu. Esc. Med. Cirurg., Nova Goa,* 9(A) 3 : p. 250.

Type host : *Heterotermes* (=*Leucotermes*) *indicola* (Wasmann), Brancavara (Diu), India

Diagnosis : Body looking like a bell-jar without its apical knob; its anterior end broadly rounded without a finger-like projection, while the posterior surface mostly flat; shorter flagella (8 μm) covering the whole of the body in 45 dexiotropic rows arranged in uniform distance and longer flagella (13 μm) densely covering only the posterior surface of the body; nucleus more or less round or transversely oval in shape, and located near the anterior pole of the body; axostyle somewhat distinct and running beyond the middle of the body as a single conical fibrous structure gradually tapering posteriorly and ending almost at the posterior end.

Table 28 : Comparison of measurements of *Holomastigotoides campanula* De Mello as recorded by different workers (in μm).

	Type specimens (De Mello, 1928)	Specimens studied in the present work
	From *Heterotermes indicola*, Kolkata, West Bengal, India	From *Heterotermes indicola*, Kolkata & Chandannagar, West Bengal, India
Length of body	70 (37.5-118)	96 (60-132)
Width of body	76 (62-100)	82 (50-114)
Length of nucleus	Not given	16.2 (8.4-24)
Width of nucleus	Not given	13.2 (9.6-16.8)
Length of shorter flagella	Not given	8 (7-9)
Length of longer flagella	Not given	13 (12-14)
Body ratio (body length/body width)	0.9	1.15 (1.2-1.1)
Body nuclear ratio (body length/nuclear length)	–	6.3 (5.5-7.1)

Remarks : Karandikar and Vittal observed the species quite common in *Heterotermes malabaricus* Snyder, less so in *Coptotermes heimi* (Wasmann). But during the present study, the species is found abundantly in both *H. indicola* and *C. heimi*. The individuals recovered from both the hosts do not show any striking variation from those which were described earlier as typical *H. campanula*. Yet, the only character worth noting here is the presence of

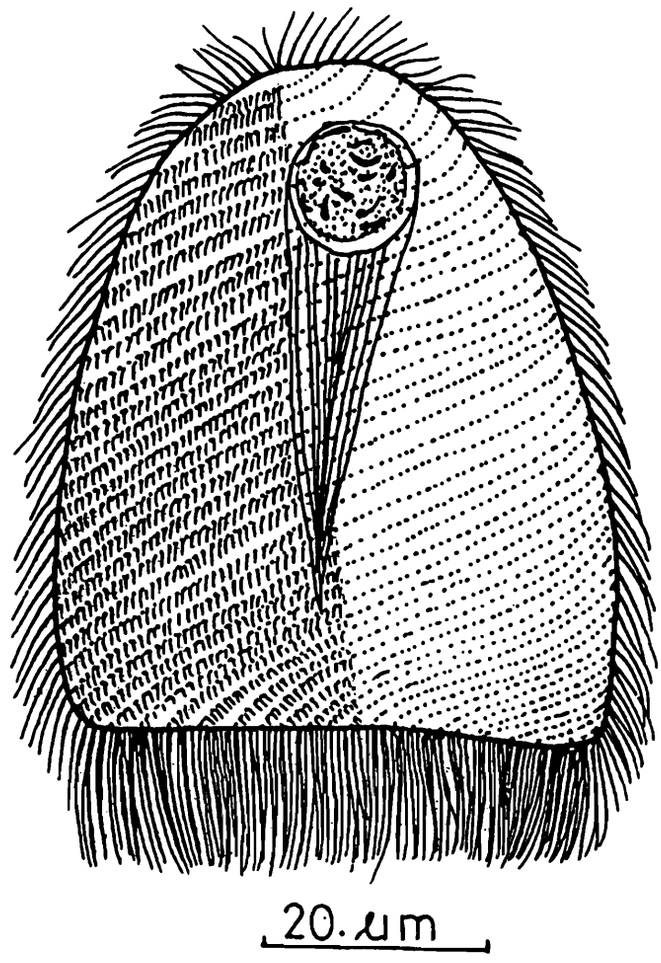

Fig. 27 : *Holomastigotoides campanula* De Mello from *Heterotermes indicola.*

spreading out of posterior part of the axostyle into 3-4 columns of fibers with extended spreading out of the posterior part of the axostyle with extended length. Occasionally subround individuals with posterior bulging have been found. The specimens recovered from *C. heimi* show less body dimension that that of the specimens collected from *H. indicola.*

29. ***Holomastigotoides dharwarensis*** Karandikar and Vittal
(Fig. 28)

1954. *Holomastigotoides dharwarensis* Karandikar & Vittal, *J. Univ. Bombay*, **23**(3B) : 17-18, fig. 17.

Type host : *Heterotermes malabaricus* Snyder and *Coptotermes heimi* (Wasmann), Dharwar, Karnataka

Diagnosis : Body typically spheroidial in shape; first type of flagella (8-10 µm) arranged in 25 dexiotropic rows somewhat closely and almost equally spaced all over the body; second type of flagella (14-16 µm) longer and found on the posterior margin of the body; nucleus transversely oval in shape and placed near the anterior end of the body; prenuclear zone faintly visible; axostyle indistinct and fibrous extending from the nucleus upto the middle of the body with gradually tapering end.

Table 29 : Comparison of measurements of *Holomastigotoides dharwarensis* as recorded from different hosts (in μm).

	Type specimens (Karandikar and Vittal, 1954)	Specimens studied in the present Work		
	From *Heterotermes malabaricus* and *Coptotermes heimi*, Dharwar, Karnataka, India	From *Heterotermes indicola*, Chandannagar, West Bengal, India		From *Coptotermes travians*, Jorhat, Assam, India
		Range	Mean	Mean
Length of body	Diameter 80	30-66	48	126
Width of body	–	42-72	57	132
Length of nucleus	–	6-9.6	7.8	20
Width of nucleus	–	12-18	15	40
Length of shorter flagella	8-10	8-10	9	12
Length of longer flagella	16-18	14-16	15	18
Body ratio (body length/ body width)	–	–	0.9	0.9
Body nuclear ratio (body length/nuclear length)	–	–	6.8	6.3

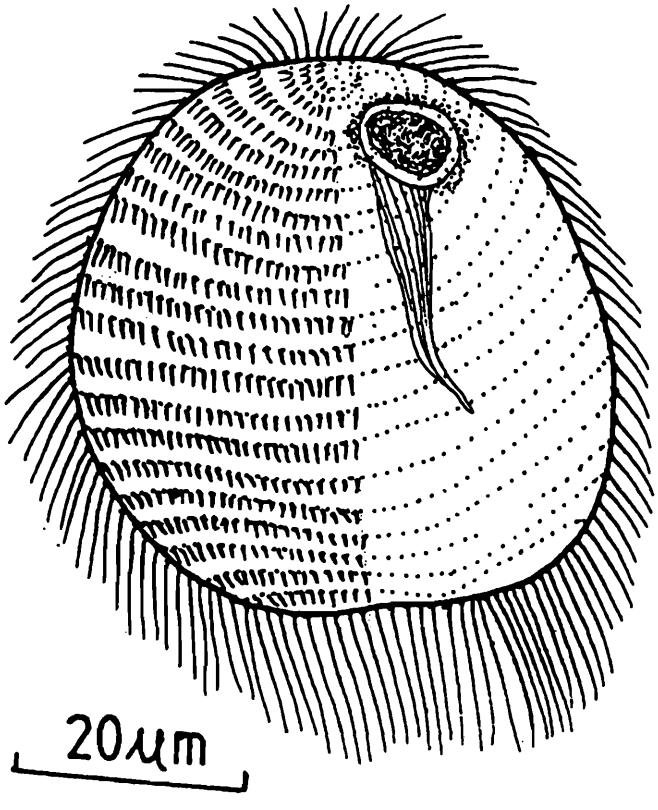

Fig. 28 : *Holomastigotoides dharwarensis* Karandikar and Vittal from *Heterotermes indicola.*

Remarks : The individuals recovered from two hosts, *Heterotermes indicola* and *Coptotermes travians,* are in full conformity with typical forms as conceived by the original authors.

30. ***Holomastigotoides globosus*** De Mello
(Fig. 29)

1937. *Holomastigotoides globosus* De Mello, *C. R. 11th. Cong. Int. Zool.*, 1935, **2** : p. 1371.

Type host : *Coptotermes* sp. and *Heterotermes* sp., Brancavara, Goa, India.

Diagnosis : Body perfectly oval or elongately oval in shape; single type of flagella covering the entire body, arranged in 50-55 dexiotropic rows spaced very closely and regularly; nucleus typically round occupying the anterior end of the body; axostyle faintly seen and reached upto the middle of the body.

Table 30 : Comparison of measurements of *Holomastigotoides globosus* De Mello as recorded by different workers (in μm).

	Type specimens (De Mello, 1937)	Type specimens (Das, 1976)	Specimens studied in the present work	
	From *Heterotermes* sp., Diu, India	From *Heterotermes indicola*, Barrackpur, West Bengal, India	From *Heterotermes indicola*, Chandannagar, West Bengal, India	
			Range	Mean
Length of body	76.8 (65-90)	105.2 (90.5-124.1)	70-132	101
Width of body	60.3 (45-75)	65.4 (56.1-81.6)	50-78	64
Length of nucleus	–	12 (10.5-15.3)	10-25	17.5
Width of nucleus	–	9.7 (8.2-11)	8-18	13
Length of flagella	–	5-8	4-9	6.5
Body ratio (body length/body width)	1.3	1.6 (1.5-1.8)	1.4-1.7	1.5
Body nuclear ratio (body length/nuclear length)	–	8.8 (8.1-10.4)	5.2-7	6.1

Remarks : In the present study, some narrowly elongated forms are also encountered in the gut contents of *Heterotermes indicola* (Wasmann), collected from Chandannagar, West Bengal, India, which seem to be unusual forms of the species described by the original author.

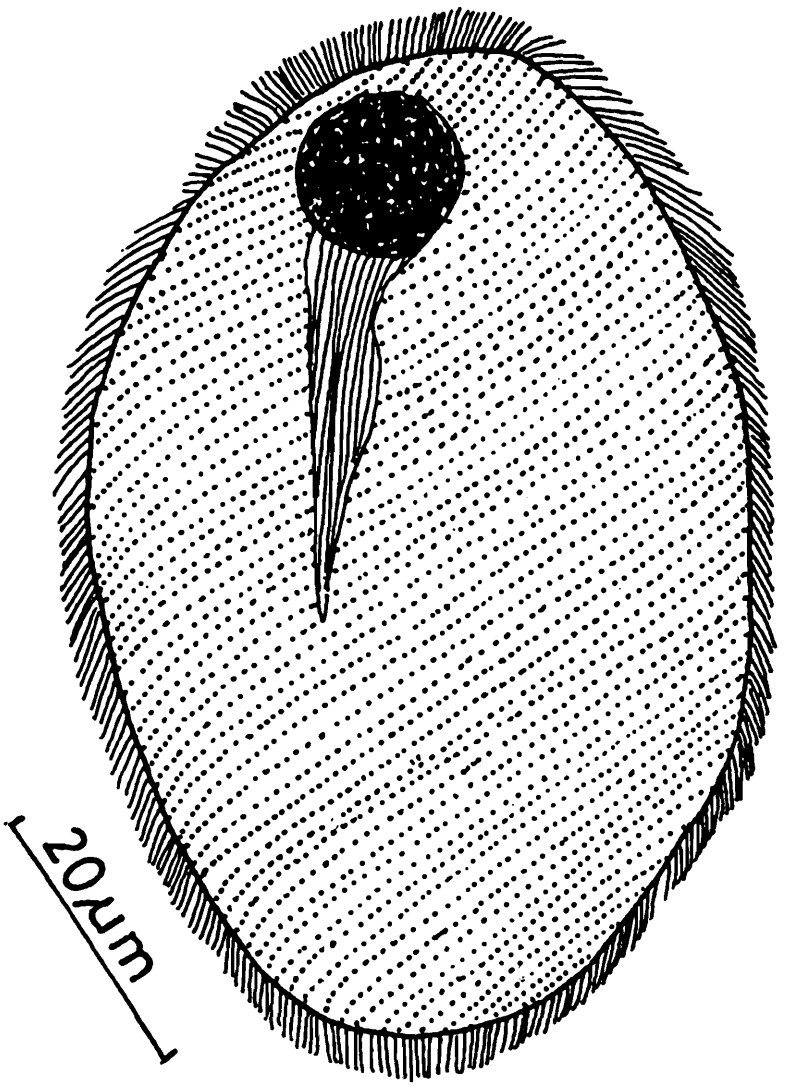

Fig. 29 : *Holomastigotoides globosus* De Mello from *Heterotermes indicola.*

31. ***Holomastigotoides hollandei*** Das
(Fig. 30)

1976. *Holomastigotoides hollandei* Das, *Acta. Protozool.*, 15 : 103-104, fig.1.

Type host : *Heterotermes indicola* (Wasmann), Barrackpur, West Bengal, India

Diagnosis : Body almost round in shape with a finger like elevation at the anterior end, generally bearing an apical pit and subround at the posterior end; first type of flagella (5 µm) covering almost the entire body in 35-45 dexiotropic rows, while the second type (11 µm) being much longer and occupying the posterior extremity; nucleus ovoidal in shape occupying the anterior portion of the body; axostyle well developed, made up of many fibers forming a bundle and running obliquely then gradually tapering towards the posterior end; prenuclear zone very conspicuous and seen as a dense homogenous mass.

Table 31 : Comparison of measurements of *Holomastigotoides hollandei* Das as recorded by different Indian workers (in µm).

	Type specimens (Das, 1921)		Specimens studied in the present work	
	From *Heterotermes indicola*, Barrackpur, West Bengal, India		From *Heterotermes indicola*, Chandannagar, West Bengal, India	
	Range	Mean	Range	Mean
Length of body	45.9-96	71	72-120	96
Width of body	30.6-73.1	51.4	54-84	69
Length of nucleus	10.1-14.4	13.3	8.4-14	11.2
Width of nucleus	6.8-11.9	9.5	7-12	9.5
Length of shorter flagella	8.5-15	12	4-6	5
Length of longer flagella	17-25.5	21.5	10-12	11
Body ratio (body length/body width)	1.2-1.7	1.4	1.3-1.4	1.35
Body nuclear ratio (body length/ nuclear length)	4.8-9.2	6.8	8.5-10	9.2

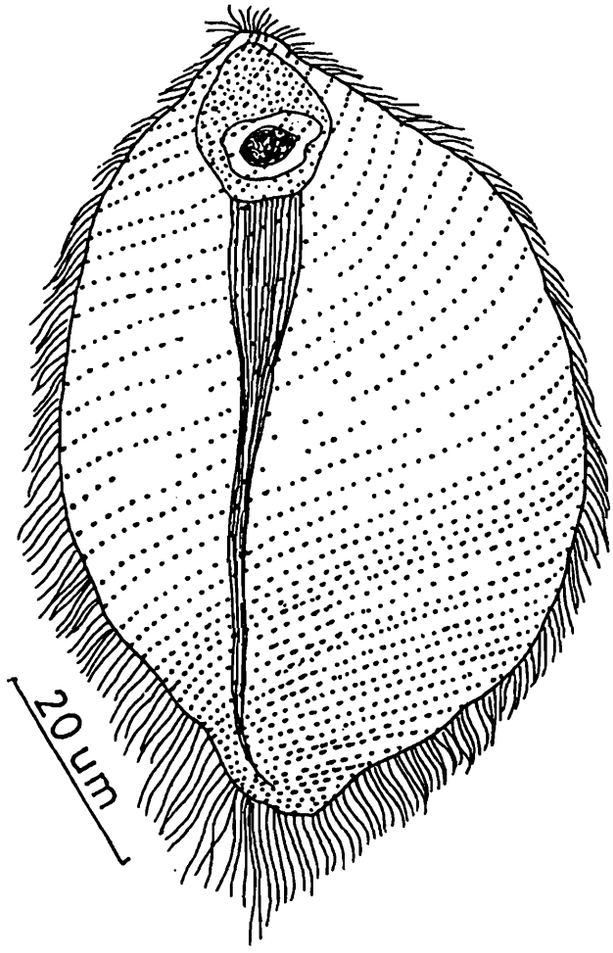

Fig. 30 : *Holomastigotoides hollandei* Das from *Heterotermes indicola.*

Remarks : The species recorded from *Heterotermes indicola* of Chandannagar, West Bengal, India, shows much greater body dimension than that originally described from the same host but of different locality.

32. *Holomastigotoides magnus* Uttangi
(Fig. 31)

1962. *Holomastigotoides magnus* Uttangi, *J. Karnatak. Univ. Sci.*, **7** : 188-190, fig. 4.

Type host : *Heterotermes indicola* (Wasmann), Gujarath, India.

Diagnosis : Body typically oval in shape, widest generally on the posterior third but with anterior and posterior ends narrowly rounded; shorter flagella covering major portion of the body in about 42 dexiotropic spiral rows, except the glabrous posterior fifth of the body; nucleus ovoidal in shape and placed at the anterior portion of the body; axostyle well developed, somewhat conical running obliquely through the endoplasm terminating in the posterior half of the body; prenuclear zone occurring as a dense narrow strip.

Table 32 : Comparison of measurements of *Holomastigotoides magnus* Uttangi as recorded by different Indian workers (in μm).

	Type specimens (Uttangi, 1952)	Type specimens (Das, 1976)	Specimens studied in the present work	
	From *Heterotermes indicola*, Gujrat, India	From *Heterotermes indicola*, Barrackpur, West Bengal, India	From *Heterotermes indicola*, Kolkata and Chandannagar, West Bengal, India	From *Coptotermes travians*, Jorhat, Assam, India
Length of body	165	125.1 (100.3-170)	145 (100-190)	87.5 (85-90)
Width of body	110	87.7 (74.8-102)	92.5 (65-120)	49.9 (47-53)
Length of nucleus	–	–	20 (10-30)	6.6 (6-7.2)
Width of nucleus	–	–	15 (6-24)	5.5 (5-6)
Length of flagella	Not given	9-12	11 (8-14)	6-8
Body ratio (body length/body width)	1.5	1.4 (1.3-1.6)	1.55 (1.5-1.6)	1.7 (1.6-1.8)
Body nuclear ratio (body length/nuclear length)	–	10.5 (9-12.4)	8.1 (10-6.3)	13.3 (12.5-14.1)

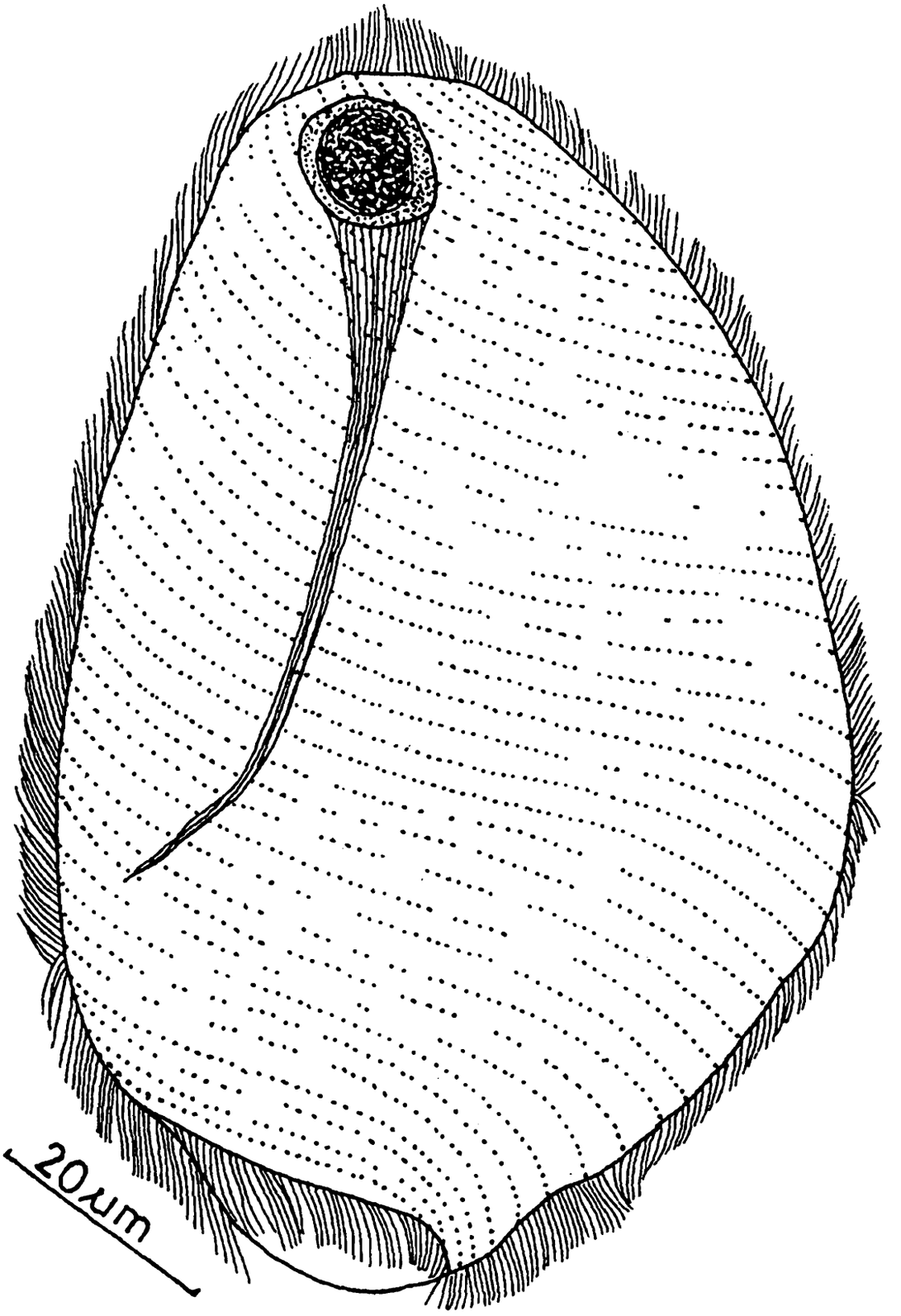

Fig. 31 : *Holomastigotoides magnus* Uttangi from *Heterotermes indicola.*

Remarks : The individuals from *Coptotermes travians* (Sjöstedt) are much smaller than those from *Heterotermes indicola* (Wasmann), which have only 22 dexiotropic flagellar rows with contrast to 42 in those from *H. indicola.*

33. ***Holomastigotoides ogivalis*** De Mello
(Fig. 32)

1937. *Holomastigotoides ogivalis* De Mello, *C. R. 12th. Cong. Int. Zool.*, 1935, **2** : p. 1373.

Type host : *Coptotermes* sp., Daman, India.

Diagnosis : Body looking like an inverted cup with anterior surface outcurved into a blunt median finger-like elevation and with incurved or substraight posterior surface; shorter flagella (6-8 µm) running almost all over the body in about 23-36 spiral rows and longer flagella (9-12 µm) densely occupying the posterior surface; nucleus oval in shape and occupying the anterior portion of the body, a little behind the apical elevation; axostyle a fibrous cone-shaped well marked body, extending posteriorly from the nucleus upto the anterior half of the body with tapering extremity; prenuclear zone distinct but irregularly visible.

Table 33 : Comparison of measurements of *Holomastigotoides ogivalis* as recorded by different workers (in µm).

	Type specimens (De Mello, 1937)	Specimens studied in the present work	
	From *Coptotermes* sp., Daman, India	From *Heterotermes indicola*, Kolkata, West Bengal, India	
		Range	Mean
Length of body	44-49	54-108	81
Width of body	44-99	38.4-84	61.2
Length of nucleus	–	7.2-16	11.6
Width of nucleus	–	6-12	9
Length of shorter flagella	–	6-8	7
Length of longer flagella	–	9-12	10.5
Body ratio (body length/body width)	0.4-1	1.2-1.4	1.3
Body nuclear ratio (body length/nuclear length)	–	6.7-7.5	7.1

Remarks : In its major morphological features, the species largely agrees with the typical species, except some variations noted from the specimens occurring in another host, ***Heterotermes indicola***. Among such variations the globular body-shape with much more body dimension, relatively widely spaced flagellar rows and more extended axostyle are worth noting here.

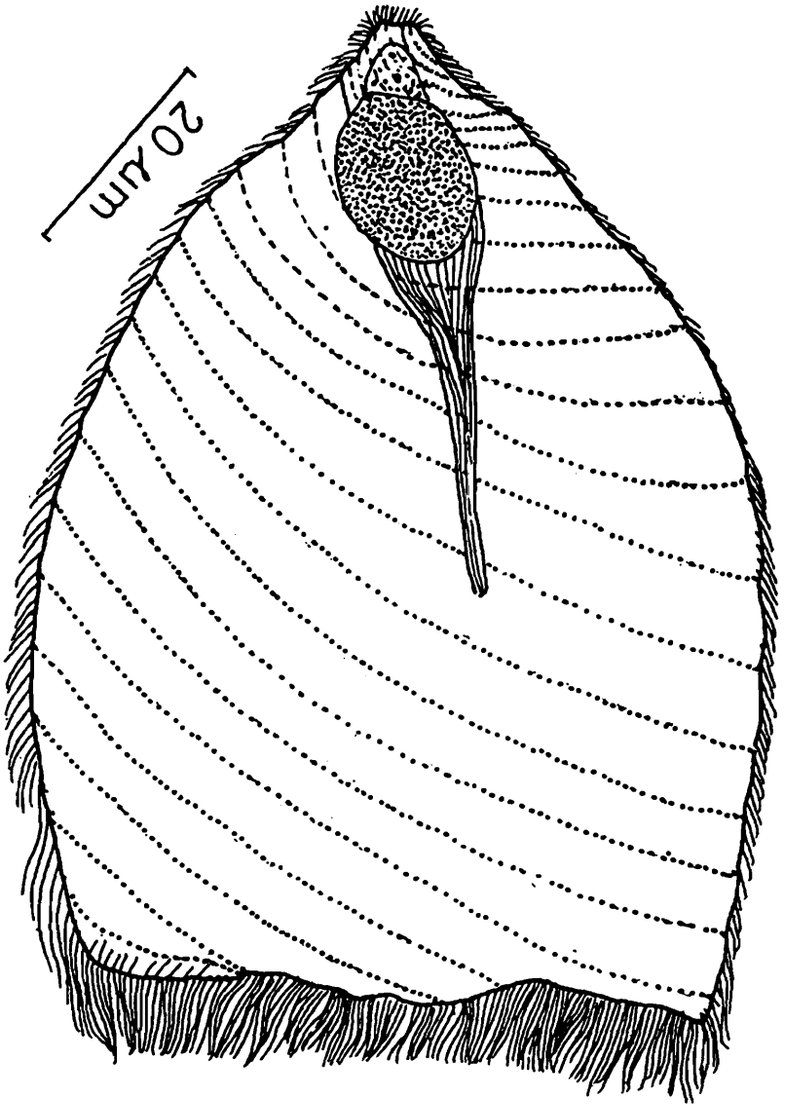

Fig. 32 : *Holomastigotoides ogivalis* De Mello from *Heterotermes indicola.*

34. ***Holomastigotoides rayi*** Karandikar and Vittal
(Fig. 33)

1937. *Holomastigotoides rayi* Karandikar and Vittal, *J. Univ. Bombay.*, **23**(3B) : 18-19, Fig. 18.

Type host : *Coptotermes heimi* (Wasmann), Dharwar, Karnataka, India

Diagnosis : Body elongately oval, always projected anteriorly into a small median conical process with a feeble depression known as apical pit; shorter flagella covering the major portion of body in about 30 well marked and equally spaced dexiotropically spiral rows; much more longer flagella arranged in compact irregular fashion around the glabrous area occupying posterior fifth of the body; nucleus ovoidal in shape and occupying the anterior pole of the body; axostyle prominent and consisting of several fibers gradually aggregated into a conical bundle extended almost upto the posterior extremity of the body; prenuclear zone seen as a irregular mass of dense protoplasm extended a little distance.

Table 34 : Comparison of measurements of *Holomastigotoides rayi* Karandikar and Vittal as recorded by different Indian workers (in µm).

	Type specimens (Karandikar & Vittal, 1954)	Specimens studied in the present work	
	From *Coptotermes heimi*, Dharwar, Karnataka, India	From *Heterotermes indicola*, Chandannagar, West Bengal, India	
		Range	Mean
Length of body	200	78-120	99
Width of body	125	42-60	51
Length of nucleus	–	12-17	14.5
Width of nucleus	–	10-12	11
Length of shorter flagella	12-16	4-10	7
Length of longer flagella	–	14-16	15
Body ratio (body length/body width)	1.6	1.8-20	10.9
Body nuclear ratio (body length/nuclear length)	–	6.5-7.05	6.7

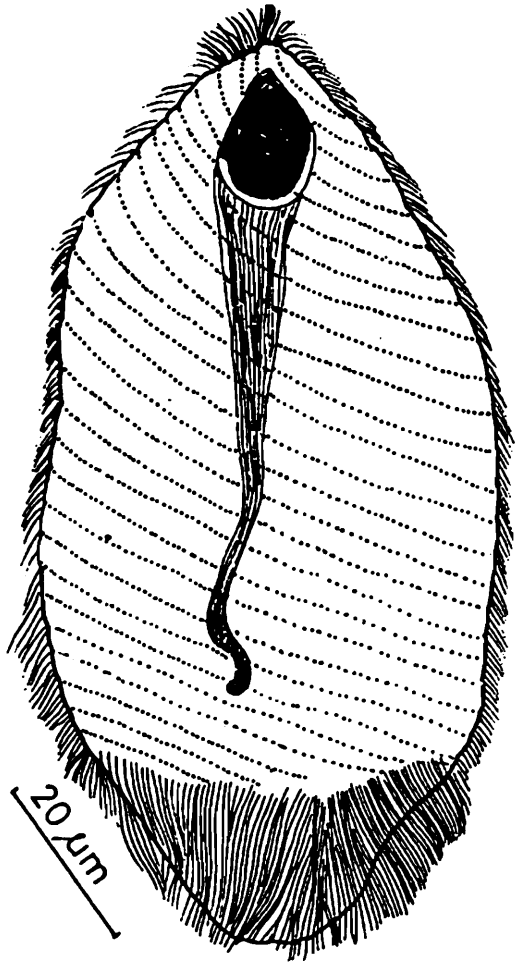

Fig. 33 : *Holomastigotoides rayi* Karandikar and Vittal from *Heterotermes indicola.*

Remarks : The only variation noted in specimens studied is distinctly visible axostyle, which had been reported as to be faintly seen in earlier records. The individuals studied are generally much smaller in body dimension than it is known before.

35. ***Holomastigotoides saccusiformis*** Uttangi
(Fig. 34)

1962. *Holomastigotoides saccusiformis* Uttangi, *J. Karnataka. Univ. Sci.*, **7** : 194-196, Fig. 7.

Type host : *Heterotermes indicola* (Wasmann), Gujrath, India.

Diagnosis : Body somewhat balloon-shaped with broadly rounded anterior and narrowly rounded posterior ends; except the extreme posterior end entire body covered with 32-50 closed and equally spaced spirally coiled flagellar rows; posterior glabrous area covered by flagella of greater length (9 µm); apical pit in some specimens thumb like and quite distinct at the anterior pole of the body; nucleus large located at the anterior pole; axostyle fibrous, cord-like, conical and composed of a number of slender fibers, extending beyond the middle of the body.

Table 35 : Comparison of measurements of *Holomastigotoides saccusiformis* Uttangi as recorded by different Indian workers (in µm).

	Type specimens (Uttangi, 1962)	Specimens studied in the present work	
	From *Heterotermes indicola*, Gujarath, India	From *Heterotermes indicola*, Chandannagar, West Bengal, India	
		Range	Mean
Length of body	115	84-162	123
Width of body	70	64-108	86
Length of nucleus	–	12-26	19
Width of nucleus	–	10-15	12.5
Length of flagella	5-8	4-9	6.5
Body ratio (body length/body width)	1.6	1.3-1.5	1.4
Body nuclear ratio (body length/ nuclear length)	–	3.8-6.2	5

Remarks : The specimens studied possess all the essential characters of typical *H. saccusiformis* except their unusual large size.

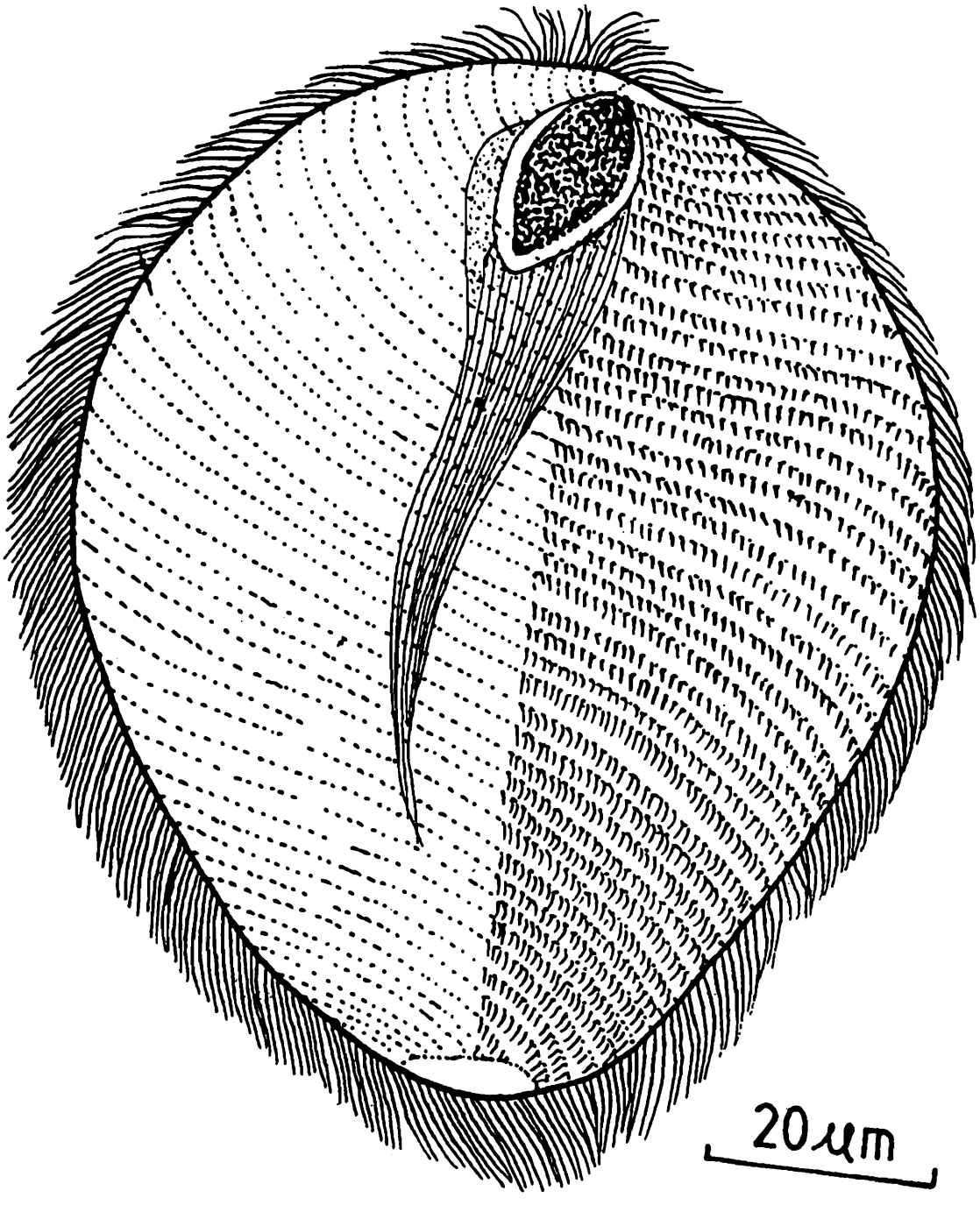

Fig. 34 : *Holomastigotoides saccusiformis* Uttangi from *Heterotermes indicola.*

36. ***Holomastigotoides sphaeroidalis*** De Mello
(Fig. 35A)

1937. *Holomastigotoides sphaeroidalis* De Mello, *C. R. 12th Cong. Int. Zool.* 1935, **2** : p. 1373.

Type host : *Coptotermes* sp., Daman, India.

Diagnosis : Body spherical in shape; only single type of flagella arranged in many close dexiotropic rows which seemed to converge round a small spot on the body probably making the anterior end of body; nucleus irregular in shape and placed very close to so-called anterior

spot; axostyle fibrous and almost indistinct, but seen as a conical bundle tapering posteriorly and terminating a little behind the nucleus within endoplasm.

Table 36 : Comparison of measurements of *Holomastigotoides sphaeroidalis* De Mello as recorded by different workers (in µm).

	Type specimens (De Mello, 1937)	**Type specimens (Das, 1976)**		**Specimens studied in the present work**
	From *Coptotermes* sp., India	**From *H. indicola*, Kolkata, West Bengal, India**		**From *H. indicola*, Chandannagar, West Bengal, India**
	Range	**Range**	**Mean**	**Mean**
Length of body	41-49	67.5-86.2	76.8	46
Width of body	39-47	–	–	48
Length of nucleus	–	–	–	15
Width of nucleus	–	Diameter 7.5-9.4	7.8	18
Length of flagella	–	–	–	6
Body ratio (body length/body width)	1.04-1.05	9-11	9.9	0.9
Body nuclear ratio (body length/nuclear length)	–	–	–	3.06

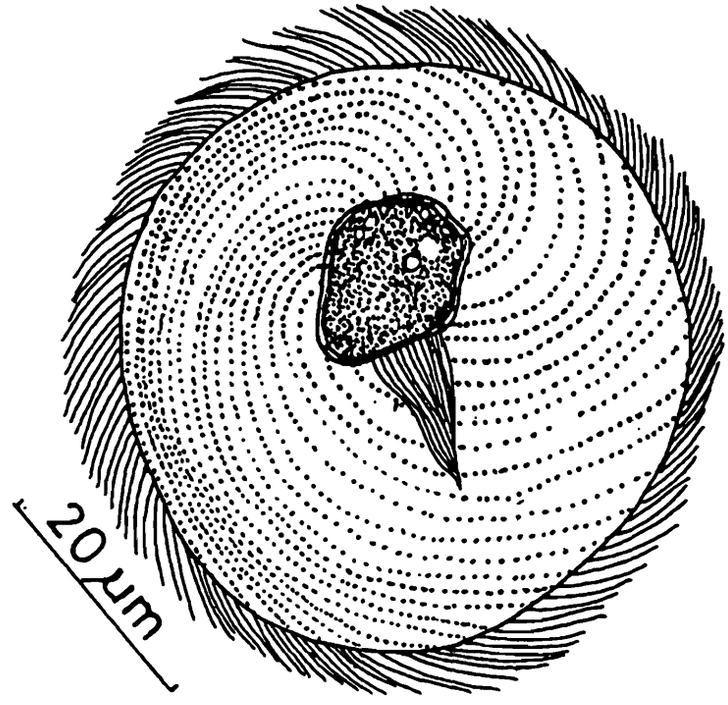

Fig. 35A : *Holomastigotoides sphaeroidalis* De Mello from *Heterotermes indicola.*

Remarks : The most noteworthy variation is the absence of prenuclear zone in the specimens studied, which is reported to be present in the specimens studied by Das from the same host, ***Heterotermes indicola.***

37. ***Holomastigotoides turboformis*** Uttangi
(Fig. 35B)

1962. *Holomastigotoides turboformis* Uttangi, *J. Karnataka Univ. Sci.*, **7** : 192-194, fig. 6.

Type host : *Coptotermes heimi* (Wasmann), Karnataka, India

Diagonosis : Body resembling a top with two distinct poles on either ends; it attaining maximum width at posterior third whence suddenly constricted posteriorly and terminating into a comparatively narrow end; anterior end provided with a blunt finger-like projection having a distinct apical pit; flagella of two types; those of first type longer (10 μm) and arranged in about 40 dexiotropic rows covering the major portion of body leaving the posterior most area; flagella of second type shorter (8 μm) present on the posterior glabrous area; nucleus transversely oval in shape and placed near the anterior pole; axostyle conical and fibrous extending beyond the middle of the body.

Table 37 : Comparison of measurements of *Holomastigotoides turboformis* Uttangi as recorded by different Indian workers (in μm).

	Type specimens (Uttangi, 1962)	Specimens studied in the present work	
	From *Coptotermes heimi*, Gujarath and Karnataka, India	From *Coptotermes heimi*, Kolkata, West Bengal, India	
		Range	Mean
Length of body	50	100-150	125
Width of body	45	50-90	70
Length of nucleus	–	8-14	11
Width of nucleus	–	10-16	13
Length of shorter flagella	4	6-8	7
Length of longer flagella	10	8-10	9
Body ratio (body-length/body-width)	1.1	1.6-2	1.8
Body-nuclear ratio (body-length/nuclear length)	–	10.7-12.5	11.6

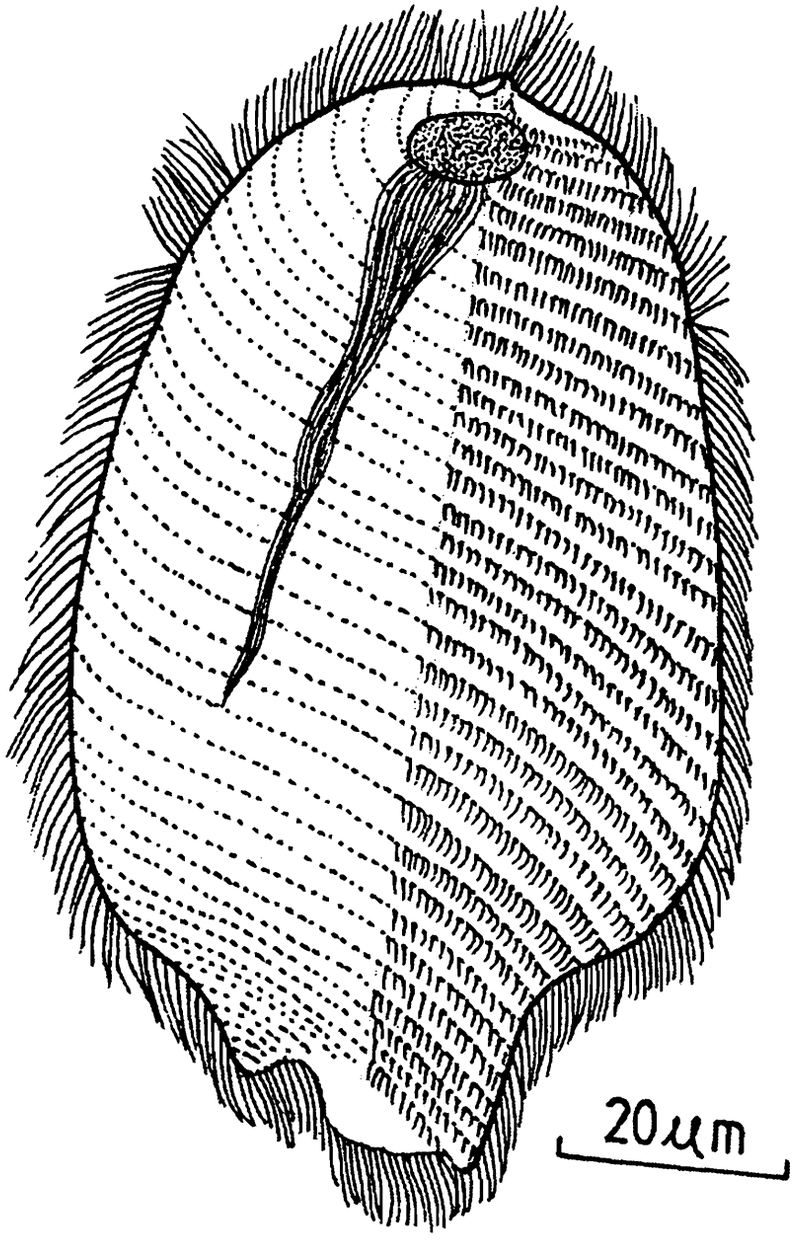

Fig. 35B : *Holomastigotoides turboformis* Uttangi from *Coptotermes heimi.*

Remarks : The specimens studied in the present work are three times longer, but much slender than those described in original publication.

Genus ***Spirotrichonympha*** Grassi and Foa

Diagnosis : Body small or large; spiral bands of flagella extending posteriorly or only on anterior half of the body.

Key to the species

1(8). Prenuclear zone and axostyle present

2(5). Axostyle indistinct and never protruding out of the posterior end of the body

3(4). Body pyriform in shape ..... *S. roonwali*

4(3). Body ovoidal in shape ..... *S. ovalis*

5(2). Axostyle distinct and sometimes protruding out of the posterior end of the body

6(7). Body conical in shape ..... *S. froilanoi*

7(6). Body pyriform in shape ..... *S. porteri*

8(1). Prenuclear zone and axostyle absent

9(10). Body entirely covered with flagellar rows, axial tubule either extremely short or indistinct and occypying the extreme anterior end of the body ..... *S. rotunda*

10(9). Body largely covered with flagellar rows except on posterior portion, axial tubule relatively long and extending far below the anterior end of the body ..... *S. pyriformis*

38. ***Spirotrichonympha froilanoi*** Karandikar and Vittal
(Fig. 36)

1954. *Spirotrichonympha froilanoi* Karandikar and Vittal, *J. Univ. Bombay*, **23**(3B) : 20-21, fig. 20.

Type host : ***Coptotermes heimi*** (Wasmann), Dharwar, Karnataka, India and ***Heterotermes malabaricus*** Snyder, Dharwar Karnataka, India.

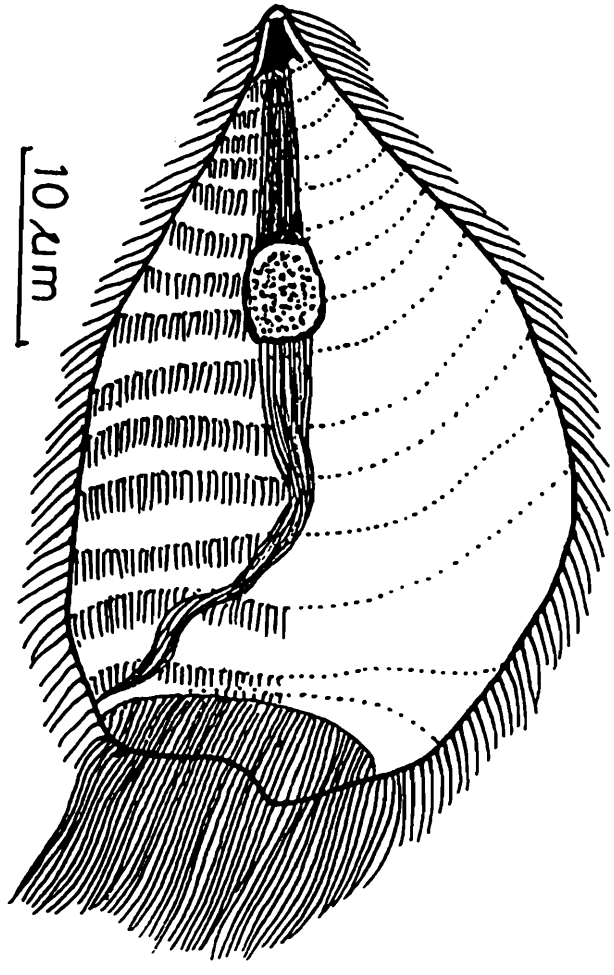

Fig. 36 : *Spirotrichonympha froilanoi* Karandikar and Vittal from *Coptotermes heimi*.

Diagnosis : Body somewhat conical, gradually becoming narrowed anteriorly to a blunt finger-like elevation and with broadened posterior end; the posterior surface depressed, or sometimes slightly protruded out; anterior end bearing a hyaline cap or operculum; axial tubule originating from the anterior tip of the body and extended upto certain distance; entire body covered with two types of flagella; a bunch of very long flagella (25-30 µm) thickly studded in the wide posterior surface; dexiotropic rows of shorter flagella (15 µm) emerged out from the anterior end of the body in the form of four flagellar bands covering the rest of the body; nucleus almost round in shape and placed in anterior half of the body; prenuclear mass of endoplasm very distinctly seen as a heavily stained thickened band running from the nucleus forwardly upto the anterior end; axostyle seen as a prominent band running obliquely and becoming slender gradually towards the posterior end of the body.

Table 38 : Comparison of measurements of *Spirotrichonympha froilanoi* Karandikar and Vittal as recorded by different Indian workers (in µm).

	Type specimens (Karandikar and Vittal, 1954)	**Type specimens (Das, 1976)**		**Specimens studied in the present work**	
	From *Heterotermes malabaricus*, Dharwar, India	**From *Coptotermes heimi*, Kolkata, India**		**From *Coptotermes heimi*, Kolkata, India**	
		Range	**Mean**	**Range**	**Mean**
Length of body	50	20.4-42.5	29	32.4-48	40.2
Width of body	25	11.9-27.2	16.8	20.4-25.2	22.8
Length of nucleus	–	3.4-5.1	4.5	6.2-8.4	7.3
Width of nucleus	–	3-4.6	4.2	4-8.4	6.2
Body ratio (body-length/body-width)	2	1.4-2.1	1.7	1.5-1.9	1.7
Body nuclear ratio (body length/nuclear length)	–	5.2-8.5	6.4	5.2-5.7	5.4
Length of shorter flagella	15	9-10	–	5-15	10
Length of longer flagella	25	15-20	–	18-24	21

Remarks : Presence of brush-like long flagella on the posterior surface of the body is the distinctive feature of the species, as also defined by its original authors. This character is very pronounced in the series of specimens studied, in addition to the axostyle protruded out of the posterior end of the body which is said to be absent in typical *S. froilanoi*.

39. ***Spirotrichonympha pyriformis*** Chakravarty and Banerjee (Fig. 37)

1956. *Spirotrichonympha pyriformis* Chakravarty and Banerjee, *Proc. Zool. Soc., Calcutta,* **9** : 40-42, fig. 2.

Type host : *Heterotermes indicola* (Wasmann), Kolkata, India.

Diagnosis : Body typically pyriform in shape with the anterior end narrowed into a finger-like elevation and posterior end broadly rounded; axial tubule hardly extending upto nucleus; entire body covered with spirally coiled flagellar rows except on a narrow portion of the posterior end; nucleus spherical in shape and placed in anterior third of the body.

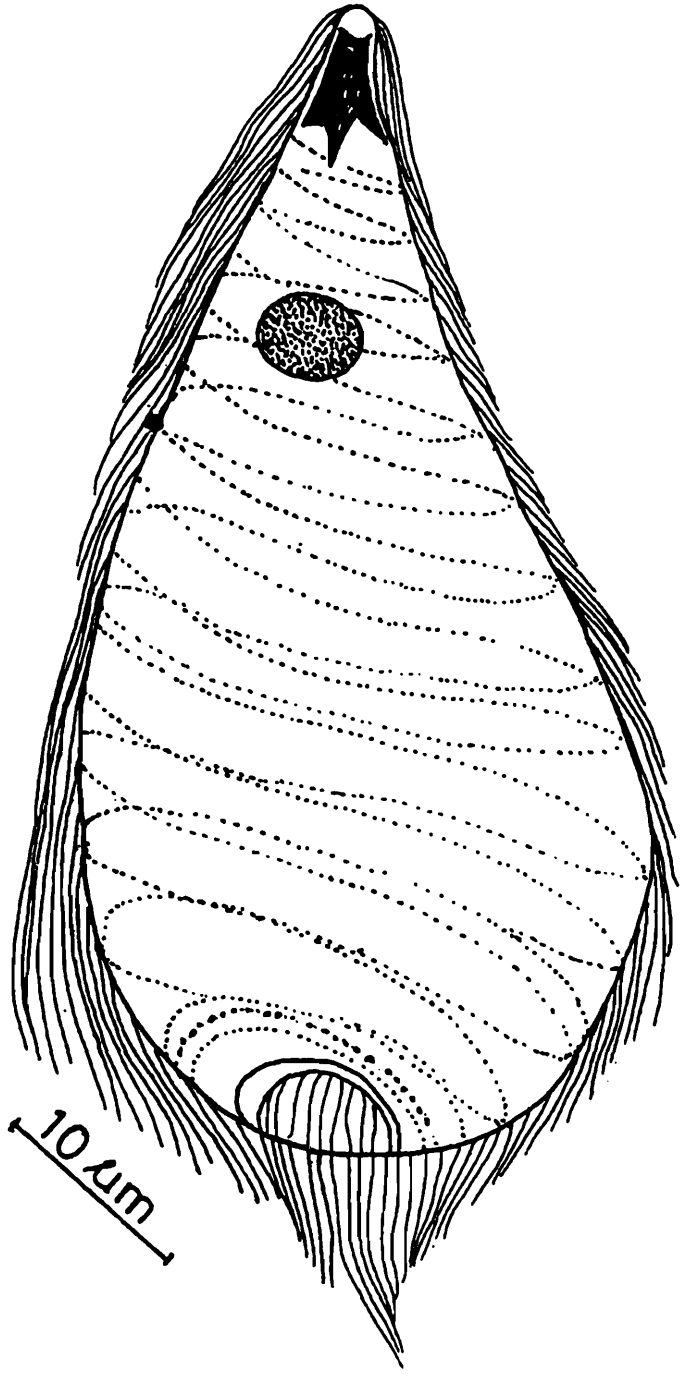

Fig. 37 : *Spirotrichonympha pyriformis* Chakravarty and Banerjee from *Heterotermes indicola.*

Table 39 : Comparison of measurements of *Spirotrichonympha pyriformis* Chakravarty and Banerjee as recorded by different Indian workers (in µm).

	Type specimens (Chakravarty and Banerjee, 1966)			Specimens studied in the present work	
	From *Heterotermes indicola*, Kolkata, India	From *Heterotermes indicola*, Kolkata, India		From *Coptotermes heimi*, Kolkata, India	
		Range	Mean	Range	Mean
Length of body	10.70-55.6	12-54	33	20.4-66	43.2
Width of body	8.56-23.54	9.6-30	19.8	15.6-33.6	24.6
Length of nucleus	5.35-8.56 (Diameter)	2-3.6	2.8	3.6-8.4	6
Width of nucleus	–	2-5	3.5	2.4-6	4.2
Body ratio (body-length/body-width)	1.25-2.36	1.2-1.8	1.7	1.3-1.9	1.6
Body nuclear ratio (body length/nuclear length)	–	6-15	10.5	5.6-7.8	6.7

Remarks : The specimens studied from *Coptotermes heimi* show greater dimension of body than those from *Heterotermes indicola* from earlier record, yet length-breath ratio remains almost same. The species is very much common in both the hosts studied in the present work.

40. *Spirotrichonympha roonwali* Das

(Fig. 38)

1976. *Spirotrichonympha roonwali* Das, *Acta protozool,* **15** : 116-117, fig. 10, pl. 1, fig. 3-4.

Type host : *Coptotermes heimi* (Wasmann), Falta, West Bengal, India.

Diagnosis : Body somewhat pyriform with finger-like projection on anterior end and broadly rounded posterior end; anterior end bearing a hyaline apical cap or operculum; axial tubule distinctly seen originating from the anterior tip of the body and extended upto certain distance; body covered with one type of flagella; these arranged in spirally coiled four flagellar bands originating at the anterior tip of the body and running all over the body; nucleus round and situated in the middle of the body; prenuclear mass of endoplasm distinctly seen as a narrow, dense and conical band extending from the nucleus anteriorly upto the axial tubule; axostyle consisting of many fine fibers and very faintly seen.

Table 40 : Comparison of measurements of *Spirotrichonympha roonwali* Das as recorded by different Indian workers (in μm).

	Type specimens (Das, 1976)		Specimens studied in the present work	
	From *Coptotermes heimi*, Falta, West Bengal, India		From *Coptotermes heimi*, Kolkata, West Bengal, India	
	Range	Mean	Range	Mean
Length of body	35-42	39	40-80.4	60.2
Width of body	18-22.4	20.4	30-42	36
Length of nucleus	4.8-5.7	5.1	3.6-7.2	5.4
Width of nucleus	4.2-5	4.5	3-6.9	4.9
Body ratio (body-length/body-width)	1.8-1.9	1.85	1.3-1.9	1.6
Body nuclear ratio (body length/nuclear length)	7.2-7.3	7.25	11.1-11.2	11.15
Length of flagella	13-16	14.2	5-15	10

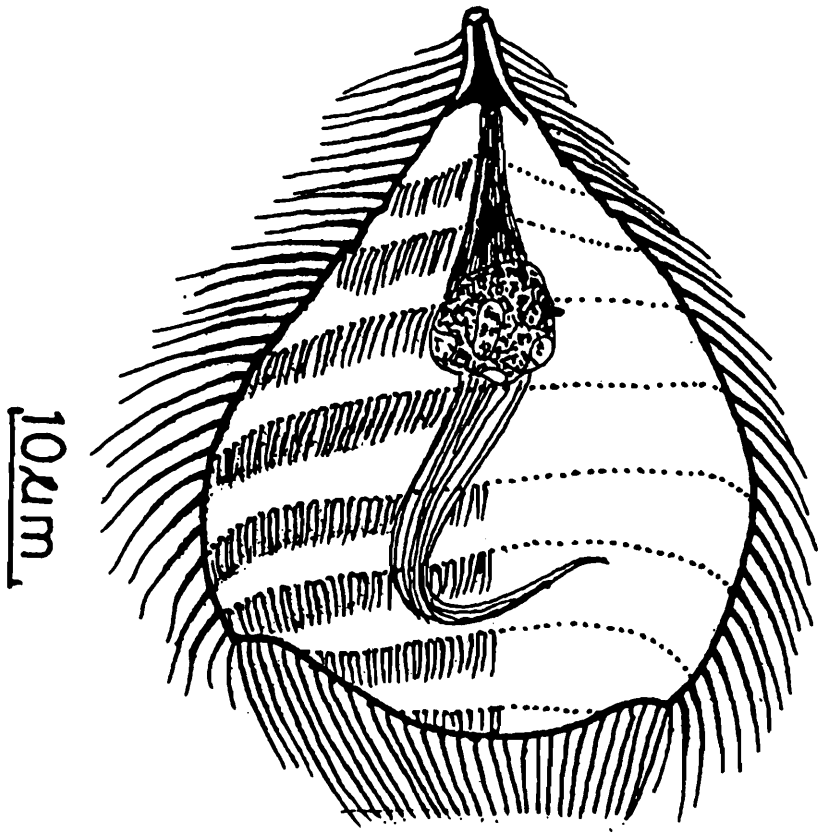

Fig. 38 : *Spirotrichonympha roonwali* Das from *Coptotermes heimi.*

Remarks : The specimens studied are much more longer and wider than type specimens, although maintaining similar length-width ratio.

41. *Spirotrichonympha rotunda* De Mello
(Fig. 39)

1928. *Spirotrichonympha rotunda* De Mello, *Arqu. Eac. Med.–Cirurg., Nova. Goa*, (A) **3** : p. 260.

Type host : Undetermined termite of India.

Diagnosis : Body spheroidal in shape with a prominent finger-like elevation at the anterior end and broadly rounded posterior end, having maximum width at the middle; hyaline apical cap or operculum covering the extreme anterior end of the body; axial tubule very minute; nucleus rounded in shape, placed almost at the anterior end; one type of flagella covering the entire body surface; flagella arranged in four bands arising from the anterior tip, turning spirally around the body dexiotropically and reaching upto the posterior end.

Table 41 : Measurements of *Spirotrichonympha rotunda* De Mello (in µm) from *Reticulitermes tirapi* Chhotani and Das, Namdhapa, Arunachal Pradesh, India.

	Range	Mean
Length of body	15.6-30	22.8
Width of body	12-28	20
Body ratio (body-length/body-width)	1.1-1.3	1.2
Length of nucleus	3.6-5	4.3
Width of nucleus	2.4-4.8	3.6
Body nuclear ratio (body-length/nuclear length)	4.3-6	5.15
Length of flagella	6-9	7.5

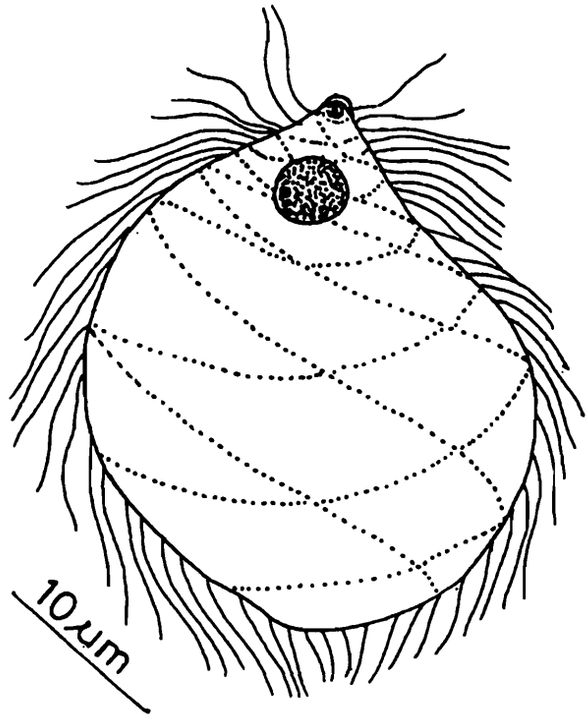

Fig. 39 : *Spirotrichonympha rotunda* De Mello from *Reticulitermes tirapi.*

Remarks : The individuals studied are exactly identical with the specimens described as *S. rotunda* De Mello. No striking variation could be observed in the long series of material studied except the frequent occurrence of broadly ovoidal forms with truncated posterior surface.

42. *Spirotrichonympha ovailis* (Brown)
(Fig 40)

1931. *Spirotrichonympha ovailis* (Brown), *J. Morph. Phy.*, **51** : 295-296, pl. 1, figs. 1 and 5, pl. 2, figs. 6, 7 and 9.

Type host : *Reticulitermes hesperus* Banks, California.

Diagnosis : Body typically ovoidal in shape; axostyle gradually tapering and its posterior portion being mostly incurved within endoplasm, rarely fixed to posterior end of the body; flagella arranged in four flagellar bands originating from the anterior tip and spirally coiled around the anterior portion of the body; nucleus spherical; it remaining connected with the anterior tip of the body by a tubular organ.

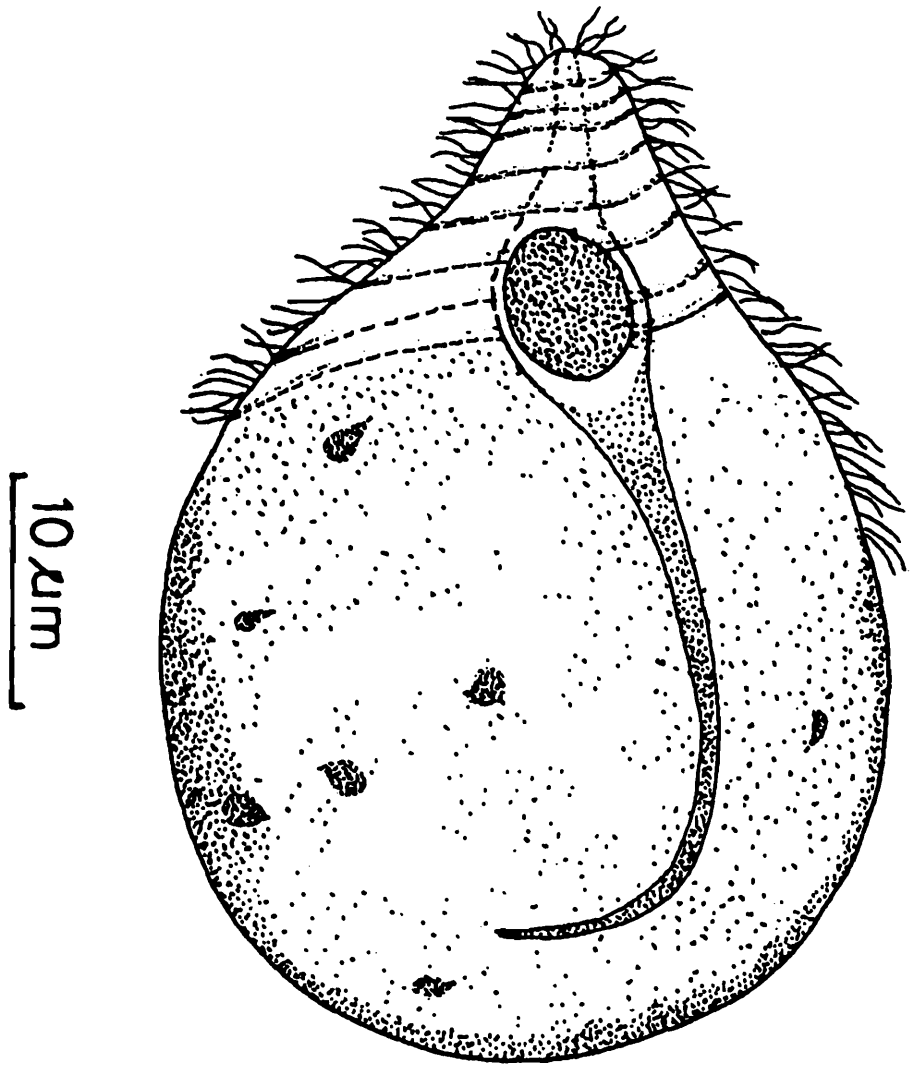

Fig. 40 : *Spirotrichonympha ovalis* (Brown) from *Reticulitermes tirapi.*

Table 42 : Comparison of measurements of *Spirotrichonympha ovalis* (Brown) as recorded by different workers (in µm).

	Type specimens (Brown, 1931)		Specimens studied in the present work	
	From *Reticulitermes hesperus*, California		From *Reticulitermes tirapi*, India	
	Range	Mean	Range	Mean
Length of body	36-48	42	10.8-48	29.4
Width of body	32-52	42	9.6-33.6	21.6
Length of nucleus	–	–	3.6-6	4.8
Width of nucleus	–	–	2.4-8.4	5.4
Body ratio (body-length/body-width)	0.9-1.1	1	1.1-1.4	1.2
Nuclear ratio (nuclear length/nuclear width)	–	–	0.7-1.5	1.1

Remarks : Except in some characters which are not clearly visible, the individual studied at present remains otherwise in full conformity with the type specimen described by Brown (1931). Moreover, the specimens recovered in the present work have much less body dimension than type specimen.

43. ***Spirotrichonympha porteri*** (Koidzumi)
(Fig 41)

1917. *Spirotrichonympha porteri* (Koidzumi), *Ann. Rep. Inst. Sci.* Govt. Formosa, **6** : p. 93.

Type host : *Leucotermes* (= *Reticulitermes*) *flaviceps* (Oshima), Formosa.

Diagnosis : Body somewhat top-like or pyriform in shape with an elongated cone anteriorly and posterior end sometimes broadly rounded; axostyle slender, rod-like and protruding posteriorly out of the body to some extent; 6-8 narrow flagellar bands observed to occupy the anterior cone-like portion of the body; four of these originating at the anterior tip of the body, then turning around spirally towards the posterior portion in dexiotropic parallel lines; flagella arising from spiral bands very conspicuous, shortest anteriorly increasing in length toward the posterior portion; nucleus round, or oval in shape and placed near the anterior end of the body; it being connected with the anterior tip of the body by means of a transparent rod-like tubular organ.

Remarks : Since the species *Spirotrichonympha porteri* and *S. ovalis* are found in plenty in the gut contents from the present hosts, their isolation becomes a problem based on their recognisable characters. In case of *S. porteri* as pointed out by Brown that the flagella being

Table 43 : Comparison of measurements of *Spirotrichonympha porteri* (Koidzumi) as recorded by different workers (in μm).

	Type specimens (Koidzumi, 1921)	**Specimens studied in the present work**	
	From *Reticulitermes flaviceps*, Formosa	**From *Reticulitermes tirapi*, India**	
		Range	**Mean**
Length of body	20-55	12-50	31
Width of body	10-30	8.4-25	16.7
Body ratio (body-length/body-width)	1.8-2	1.4-2.3	1.8
Length of nucleus	4-7 (Diameter)	2.4-4.8	3.6
Width of nucleus	–	2-3.6	2.8
Nuclear ratio (nuclear length/nuclear width)	–	1.2-1.3	1.25

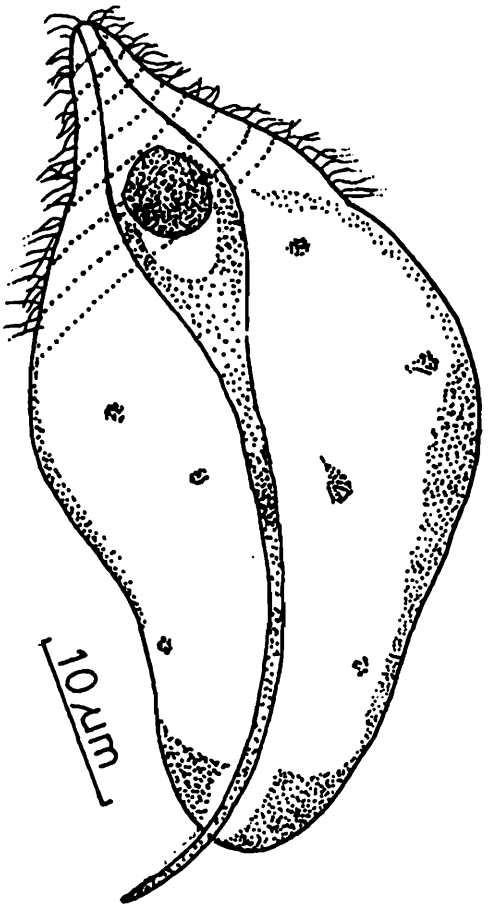

Fig. 41 : *Spirotrichonympha porteri* (Koidzumi) from *Reticulitermes tirapi.*

extended beyond the nucleus, which remains restricted in anterior end in *S. ovalis*. In *S. porteri* posterior end of the body is found frequently prolonged with bluntly pointed end and very often drawn out into a slender tail like appendage.

Genus ***Pseudotrichonympha*** Grassi and Foa

Diagnosis : Body mostly entirely covered with flagella; flagellar rows slightly obliquely arranged on the bell; bell composed of two layers of ectoplasm; nucleus lodged anywhere within endoplasm.

Key to the species

1(2). Campanula subapically placed, rostral tube not visible in its longer axis .... *P. subapicalis*

2(1). Campanula apically placed, rostral tube visible in its longer axis

3(4). Body heart-shaped ..... *P. cardiformis*

4(3). Body much elongated ..... *P. indica*

44. ***Pseudotrichonympha cardiformis*** Karandikar and Vittal (Fig 42)

1954. *Pseudotrichonympha cardiformis* Karandikar and Vittal, *J. Univ. Bombay.*, **23**(3B) : 2-6, Fig. 1-4.

Type host : *Heterotermes malabaricus* Snyder and *Coptotermes heimi* (Wasmann), Dharwar, Karnataka, India

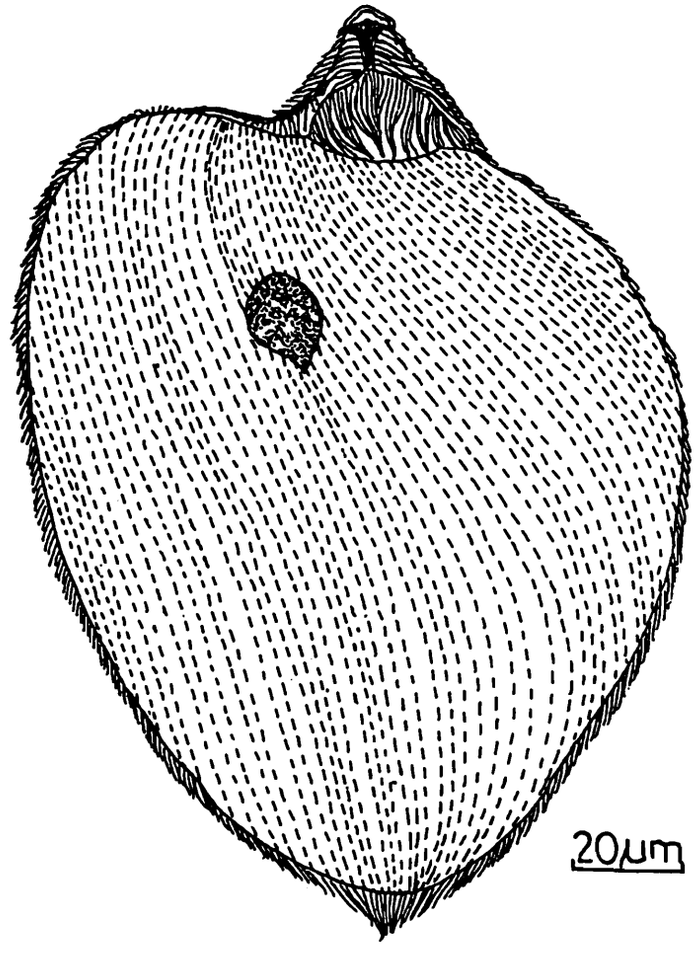

Fig. 42 : *Pseudotrichonympha cardiformis* Karandikar and Vittal from *Heterotermes indicola.*

Diagnosis : Body typically heart-shaped with anterior portion comparatively greatly swollen and posterior portion gradually narrowed to rounded end; campanula, a bell-shaped structure medially placed in the anterior portion of the body; it consisting of a centrally placed darkly stained and somewhat dumb-bell shaped rostral tube; the tube enlarging anteriorly into a transparent, lightly stained, hemispherical hollow bulb covered by another transparent helmet-shaped hyaline structure, the apical cap; ectoplasm occupying all round the rostal tube distinguishable into an outer lighter area and an inner darker one; three types of flagella covering the campanular surface; flagella of first type shorter, immobile and restricted to the rostral tube region; flagella of second type longest, extremely mobile and set in a thick circular band just below the first one; flagella of third type having medium length, lying just posterior to the second type, arranged in leiotropic longitudinal rows and extended beyond the campanula, but thickly in many rows over the body region except sometimes in the small glabrous posterior extremity; nucleus spherical and situated generally above the middle of the body.

Table 44 : Comparison of measurements of *Pseudotrichonympha cardiformis* Karandikar and Vittal as recorded by different Indian workers (in μm).

	Type specimens (Karandikar and Vittal, 1954)	**Specimens studied in the present work**	
	From *Heterotermes malabaricus* and *Coptotermes heimi*, Dharwar, India	**From *Heterotermes indicola*, Kolkata, West Bengal, India**	
		Range	**Mean**
Length of body	100-225	150-306	228
Width of body	50-150	132-150	141
Length of nucleus	14-18 (Diameter)	18-25.2	21.6
Width of nucleus	–	16-19.2	17.6
Body ratio (body length/body width)	1.5-2	1.1-2	1.5
Body nuclear ratio (body length/nuclear length)	–	8.3-12.1	10.2
Length of 1st type of flagella	6-8	6-8	7
Length of 2nd type of flagella	18-20	18-20	19
Length of 3rd type of flagella	12-14	12-14	13

Remarks : The result of studying a long series of material indicates that *Pseudotrichonympha cardiformis* is least variable species in different hosts, although much more abundant in *Heterotermes indicola* than in *Coptotermes heimi*. The latter host is thought to be most favoured, since in remote different parts of the country the species is associated with this host. Comparatively a much more wide range of variation in body size has been found in the material studied from *H. indicola* than that from *C. heimi*.

45. *Pseudotrichonympha indica* Chakravarty and Banerjee (Fig 43)

1956. *Pseudotrichonympha indica.* Chakravarty and Banerjee, *Proc. Zool. Soc. Calcutta*, **9** : 42-44, Fig. 3.

Type host : *Heterotermes indicola* (Wasmann), West Bengal, India.

Diagnosis : Body much elongated, more or less cone-shaped anteriorly, gradually tapering posteriorly and terminating with truncated extremity; campanula much shorter in comparison to body-length; rostral tube bearing the hyaline cap or operculum; body covered as usual with flagella of three types arranged obliquely in spiral rows; nucleus somewhat spherical and placed a little above the middle of the body.

Table 45 : Comparison of measurements of *Pseudotrichonympha indica* Chakravarty and Banerjee as recorded by different Indian workers (in µm).

	Type specimens (Chakravarty and Banerjee, 1956)	Type specimens (Das, 1976)		Specimens studied in the present work		
	From *Heterotermes indicola*, Kolkata, India	From *Coptotermes heimi*, Falta and *Heterotermes indicola*, Kolkata, West Bengal, India		From *Heterotermes indicola*, Chandannagar, West Bengal, India	From *Coptotermes heimi*, Kolkata, West Bengal, India	From *Coptotermes travians*, Jorhat, Assam, India
	Range	Range	Mean	Mean	Mean	
Length of body	220-300	165-221.2	193.8	260	250	216-312
Width of body	38-55	22.5-52.5	38.2	50	48	50.4-54
Length of nucleus	10.26-11.4	10.2-18.7	15.1	20	28.8	24
Width of nucleus	10.26-11.4	10.2-15	13.5	18	15.6	18
Body ratio (body-length/ body-width)	–	4.2-7.3	5	5.2	5.2	4.2-5.7
Body-nuclear ratio (body-length/ nuclear length)	–	11.5-15.9	13.5	13	8.6	13
Length of 1st type of flagella	–	5-6	–	12	10	12
Length of 2nd type of flagella	–	11-12	–	20	1	20
Length of 3rd type of flagella	–	7-8	–	14	12	16

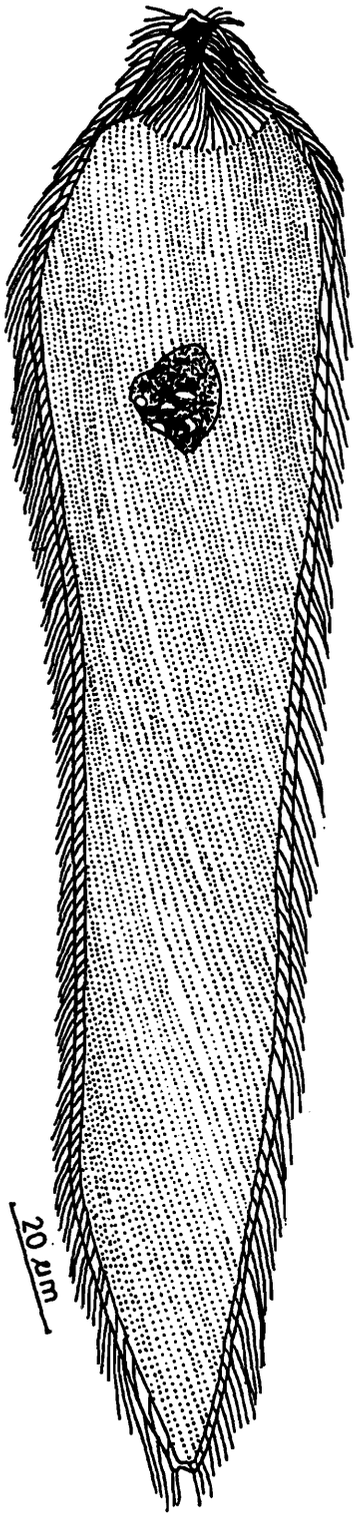

Fig. 43 : *Pseudotrichonympha indica* Chakravarty and Banerjee from *Heterotermes indicola.*

Remarks : Considering the morphological variations among the individuals from different hosts, it has been found that the specimens from *Heterotermes indicola*, and *Coptotermes heimi* are more or less similar in their morphological characters to the type specimens except in body dimensions. The individuals from *C. travians* show some variations in the orientation of rostral tube. It is directed to lateral side a little in comparison to exactly mid-apical position of rostral tube in the individuals from other hosts in present and all previous records also. Further, in

the same host along with typical forms, some atypical forms are observed, having much more elongated body constricted at the middle with round posterior end. Otherwise the forms are in quite conformity with the specimens originally designated in having elongated body form with round posterior end, comparatively shorter rostral tube as well as medially placed nucleus.

46. ***Pseudotrichonympha subapicalis*** Karandikar and Vittal
(Fig. 44)

1954. *Pseudotrichonympha subapicalis* Karandikar and Vittal, *J. Univ. Bombay*, **23**(3B) : 8-9, Fig. 8, 9.

Type host : *Coptotermes heimi* (Wasmann) and *Heterotermes malabaricus* Snyder, Dharwar, Karnataka, India.

Diagnosis : Body typically oval in shape with broadly rounded anterior end and gradually narrowing posteriorly to terminate in broadly rounded end; campanula subapical in position, consisting of two to three circular areas, placed one within the other; outer circle almost indistinct representating the peripheral margin of campanula; middle circle distinctly seen representating the rim of second type of flagella; inner circle disc-like with a central tiny aperture; flagella of third type covering the whole body in longitudinal rows; nucleus spherical and occupies variable position within the endoplasm.

Table 46 : Ciomparison of measurements of *Pseudotrichonympha subapicalis* Karandikar and Vittal as recorded by different Indian workers (in µm).

	Type specimens (Karandikar and Vittal, 1954)	**Specimens studied in the present work**			
	From *Coptotermes heimi*, and *Heterotermes malabaricus*, Dharwar, India	**From *Heterotermes indicola*, Chandannagar, West Bengal, India**		**From *Coptotermes heimi*, Kolkata, West Bengal, India**	**From *Coptotermes travians*, Jorhat, Assam, India**
	Range	**Range**	**Mean**	**Mean**	
Length of body	200-300	160-252	206	192	208-240
Width of body	100-210	60-90	75	84	72-90
Length of nucleus	15-25 (Diameter)	18-24	21	24	20.4
Width of nucleus	–	10-15	12.5	20.4	18
Body ratio (body-length/body-width)	–	2.6-2.8	2.75	2.2	2.6-2.8
Body-nuclear ratio (body-length/ nuclear length)	–	8.8-10.5	9.6	8	10.1

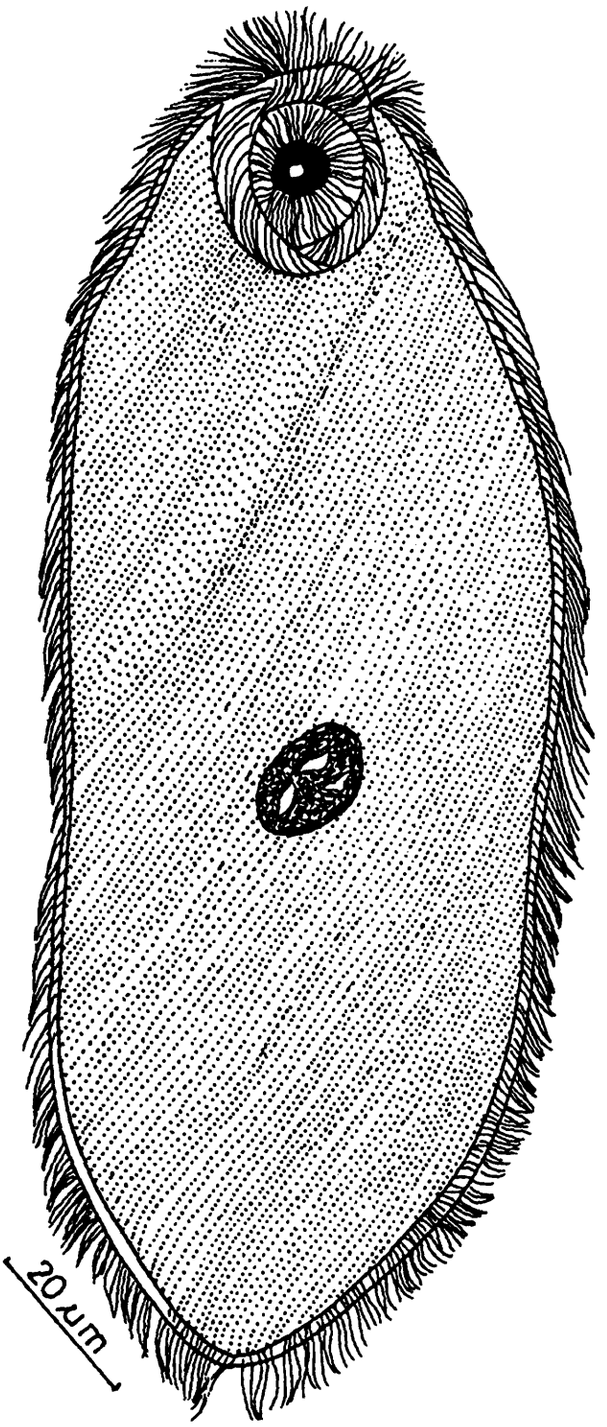

Fig. 44 : *Pseudotrichonympha subapicalis* Karandikar and Vittal from *Heterotermes indicola.*

Remarks : Detailed study indicates that the species is predominantly found in both the species of the genus *Coptotermes*, rather than in any other host, the reason which is difficult to presume. Further, the material from these hosts generally have the truncated posterior end of the body, which is somewhat round in the specimens from *Heterotermes indicola.* The specimens from *Coptotermes travians* are usually much more elongated than those found from the other hosts.

Genus *Trichonympha* Leidy

Diagnosis : Body entirely covered with flagella except on the posterior portion; flagellar rows longitudinally arranged on the bell; body, the nipple and bell composed of two layers of ectoplasm; nucleus lodged centrally within endoplasm.

47. *Trichonympha agilis* Leidy
(Fig 45)

1877. *Trichonympha agilis* Leidy, *Proc. Accad. Nat. Sci., Philadelphia,* **29** : p. 147.

Type host : *Reticulitermes flavipes* (Kollar), United states.

Diagnosis : Body spindle or lanceolate shaped, slightly narrowed anteriorly and evenly rounded posteriorly; it divisible into three regions-the anterior rostral region, the middle flagellated body region and the posterior non-flagellated glabrous region; anterior region of the body provided with a distinct cone-shaped nipple-like elevation covering one-forth of the whole body and consistinhg of a tubular hollow ectoplasmic structure called rostral tube; rostral tube narrow in the middle, comparatively wider at either end, thus looking like an hour-glass; it covered anteriorly by a helmet-like cap or "Operculum"; nucleus oval or rounded in shape and placed just above the middle of the body along the median line, suspended by a basket-like "cestello" or "little basket" by Grassi and "Corbule" by Koidzumi; body covered with three types of flagella; flagella of first type shorter, covering over the body of the rostral tube; flagella of second type longer, thickly distributed on both the nipple and the bell; flagella of third type longest and placed over the body in many longitudinally or slightly obliquely disposed flagellar rows running leiotropically, regularly and closely as parallel stripes.

Table 47 : Measurements of *Trichonympha agilis* Leidy (in µm) from *Reticulitermes tirapi* Chhotani and Das, Namdhapa, Arunachal Pradesh, India.

	Range	Mean
Length of body	100-150	125
Width of body	40-48	44
Body ratio (body-length/body-width)	2.5-3.15	2.8
Length of nucleus	10-14.4	12.2
Width of nucleus	9-14	11.5
Body-nuclear ratio (body-length/nuclear length)	10-10.4	10.2
Length of rostral tube	8-18	13

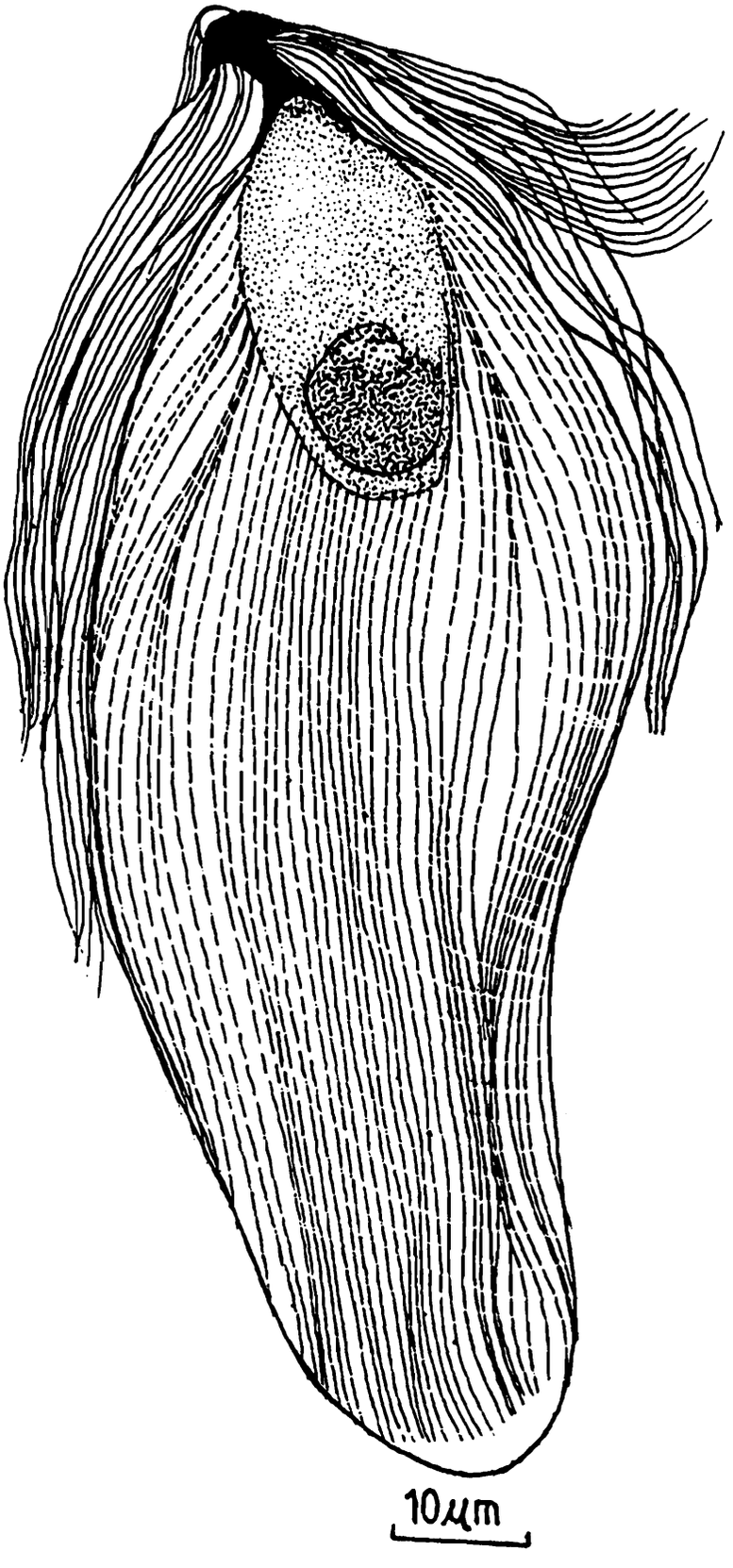

Fig. 45 : *Trichonympha agilis* Leidy from *Reticulitermes tirapi.*

Remarks : The individuals of present study are exactly similar to type specimens described by Koidzumi (1921). Spindle or lanceolate shaped individuals with distinct "corbule" and shoulder-like projection, are also met in present study.

Genus *Teranympha* Koidzumi, 1921

Diagnosis : Body large in size and elongated in shape; body with many transverse ridges showing some what segmented appearance; each transverse ridge with a single row of flagella; anterior end complex containing a single nucleus.

48. *Teranympha mirabilis* Koidzumi
(Fig. 46)

1921. *Teranympha mirabilis* Koidzumi, *Parasitology,* **13** : 260-267, pl. XII, figs. 16-31.

Type host : *Leucotermes* (= *Reticulitermes*) *speratus* Holmgren, Japan.

Diagnosis : Body roughly club-shaped, broadly rounded anteriorly and gradually tapering posteriorly, then terminating into a truncated end; anterior portion of the body termed as the head and maximum in width; it consisting of two parts-a thick axial column or cylinder and a peripheral layer traversed by numerous flagella arising at the surface of the column; peripheral layer encircling axial column and becoming gradually thinner towards the sides; nucleus larger, transversely oval in shape and placed at the short distance behind the axial column; posterior portion of the body looking very peculiar, consisting of numerous (13-25) prominent and sharp transverse ridges; these ridges arranged in regular metameric fashion appearing as proglottids of a tapeworm and giving the entire body apparently a segmented outlook like a cestode larva and becoming inclined backwards; individually each ridge drawn out and flattened into a fold, thus giving a prominent groove formed under it; larger flagella distributed closely at the head and the flagella on the surface of the body arranged in distinct transverse rows and becoming free at the edge of each of the transverse ridge.

Table 48 : Measurements of *Teranympha mirabilis* Koidzumi as recorded by different workers (in µm).

	Type specimens (Koidzumi, 1921)		**Specimens studied in the present work**	
	From *Reticulitermes speratus*, Japan		**From *Reticulitermes tirapi*, Arunachal Pradesh, India**	
	Range	**Mean**	**Range**	**Mean**
Length of body	200-300	250	132-180	156
Width of body	40-50	45	40-48	44
Length of nucleus	–	–	6-12	9
Width of nucleus	–	–	8.4-12	10.2
Body ratio (body-length/body-width)	5-6	5.5	3.3-3.7	3.5
Nuclear ratio (nuclear length/nuclear width)	–	–	0.7-1	0.8

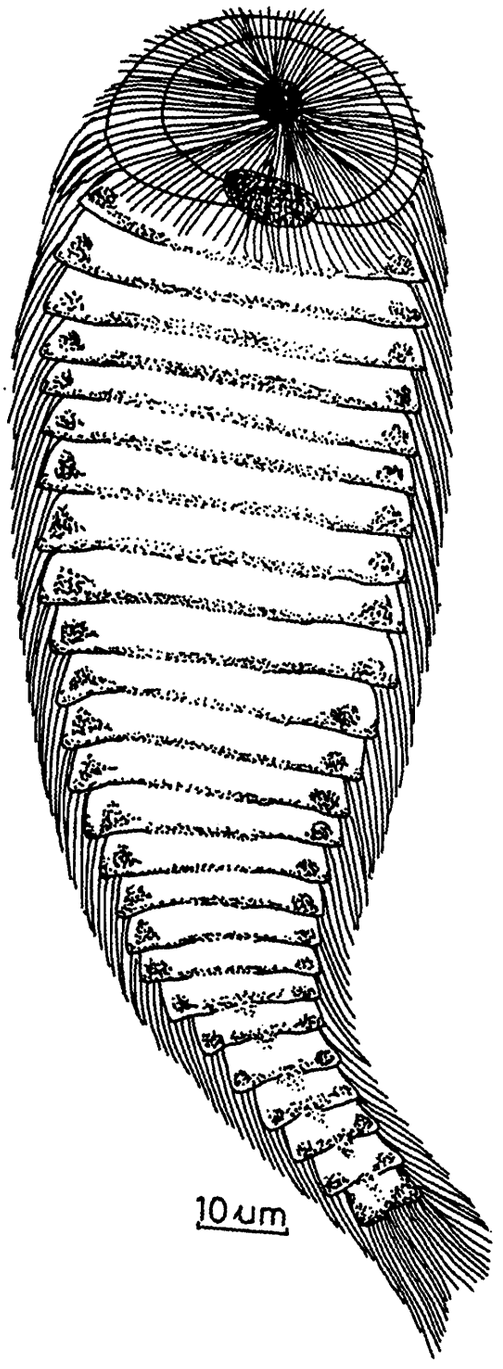

Fig. 46 : *Teranympha mirabilis* Koidzumi from *Reticulitermes tirapi.*

Remarks : The individuals of present study are very much identical with those of earlier reports. 18-30 ridges had been reported in originally described specimens, whereas the individuals generally consist of 13-25 ridges as indicated in the present study. A horizontal flange like extension of nuclear sac is being sometimes observed in the vicinity of the nucleus but becoming gradually indistinct towards the body. Axial column sometimes circular in outline and often looking barrel-shaped and slightly narrowed towards the tip and the base.

SUMMARY

Detailed taxonomic account of symbiotic flagellate protozoa collected from the gut contents of wood-eating termites from different parts of India has been dealt with. This includes 48 species of symbiotic flagellates belonging to 3 orders, 9 families and 13 genera. 9 species of termite hosts belonging to 2 families and 5 genera, have been studied in details for these symbiotic protozoa.

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