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STUDIES IN SEPTATE GREGARINES (APICOMPLEXA : SPOROZOEA) FROM ORTHOPTERAN INSECTS OF WEST BENGAL: SEVEN NEW SPECIES OF *DIDYMOPHYES*, *HIRMOCYSTIS* AND *QUADRUSPINOSPORA*

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INTRODUCTION

The orthopteran insects in association with other arthropods cause immense damage to the field crops. Frequently these orthopterans are parasitized by eugregarines in their hepatic caeca and midgut. Occasionally the protozoans produce heavy destruction to the host gut epithelium and, as such, much attention is being paid on these parasites as possible agents for biocontrol of harmful insects (Lipa, 1967; Haldar and Chakraborty, 1975; Ghose, Sengupta and Haldar, 1986).

The present communication deals with the structure and life history of seven new species of septate gregarines (Apicomplexa : Sporozoea) infecting orthopteran insects. The information might help future investigators in using these protozoans for the biological control of insect pests.

Types are deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

MATERIAL AND METHODS

The different insect hosts were collected from various places in West Bengal and were brought alive to the laboratory for microscopic examination of protozoan parasites. The insects were decapitated, their guts and hepatic caeca were dissected out and gently pressed for the parasites to come out from their lumen. Thin smear preparations were made on glass slides and fixed in Schaudinn's fluid and subsequently stained with Heidenhain's haematoxylin. For observing the developmental stages of parasites, some heavily infected hosts' gut were fixed in Bouin's fluid, 5.0 μm thick sections were cut and stained as above. For sporulation, the cysts were cultured in moist chambers (Sprague, 1941).

OBSERVATIONS

The hosts examined and found parasitized by the eugregarines along with the information on the place of collection, number of hosts examined, number of hosts parasitized and percentage of infection are given in TABLE I.

Genus *Didymophyes* Stein, 1848

Pointed papilla-like epimerite; spherical cyst; dehiscence by simple rupture; ellipsoidal spores and satellite without septum.

TABLE – I

Showing names of the hosts, names of the parasites, places of collection, number of hosts examined, number of hosts parasitized and percentage of infection of seven new species of gregarines from orthopteran insects

Sl. Nos.	*Name of hosts*	*Name of the parasites*	*Place of collection*	*No. of hosts examined*	*No. of hosts parasitized*	*% of infection*
1	*Tridactylus* sp.	*Didymophyes tridactyli* n.sp.	Kalyani, W.B. India	80	35	44.0
2.	*Gesonula punctiformis*	*Hirmocystis murtii* n.sp.	Kalyani, w.B. India	150	60	40.0
3.	*Phleoba* antennata	*Hirmocystis antennatae* n. sp.	Kalyani, W.B. India	122	36	30.0
4.	*Oxya hyla*	*Quadruspinospora platyepimerita* n.sp.	Naihati, W.B. India	70	45	64.2
5.	*Phleoba antennata*	*Quadruspinospora adigitalis* n.sp.	Kalyani, W.B. India	65	16	24.6
6.	*Gesonula punctiformis*	*Quadruspinospora gesonulae* n.sp.	Kalyani, W.B. India	50	35	70.0
7	*Oxya sp.*	*Quadruspinospora jalpaiguriensis* n.sp.	Jalpaiguri, W.B., India	73	48	65.7

Didymophyes tridactyli n.sp.
(Figs. 1 - 6)

Development : Extracellular.

Trophozoite : Vase-shaped body with small semilunar epimerite. Protomerite somewhat rectangular, always broader than long. Deutomerite is more or less spherical in shape containing a spherical or ovoidal nucleus which may be situated at any place. Nucleus possesses a distinct nuclear membrane and a large endosome. Cytoplasm of deutomerite is more granulated than other parts of the body.

Sporadin and association : Sporadin is cylindro-conical with hemispherical protomerite. A straight septum divides the protomerite from the deutomerite that is rectangular in shape and always broader than long. The spherical nucleus is situated at the posterior portion of the deutomerite. Association is caudo-frontal. The deutomerite

of the primite has a broad posterior extremity. The satellite characteristically lacks a protomerite and its deutomerite has an ovoidal shape. A thick band of cytoplasm connects the primite with satellite.

Gametocyst and spore : Freshly collected gametocyst is opaque white in colour with prominent ectocyst. The ectocyst measures 33.3 µm in diameter. The gametocytes are equal in size. The cysts are more or less spherical in shape and measure 116.6 µm to 233.2 µm x 133.3 µm to 283.2 µm. The partition between the gametocytes disapper after 24 hours of development. The cyst dehisces by simple rupture after 48 hours. The spores are released in a mass through a pore that appears to one corner of the cyst.

Double walled, ovoidal spores are covered by a rectangular hyaline coat. The spores measure 5.0 µm × 3.3 µm and the thickness of the hyaline coat is 1.7 µm. Formation of eight sporozoites is completed after 24 hours of cyst rupture.

Measurements (in microns) :

Trophozoite

TL = 42.5 - 46.8 (44.7);

LE = 4.3 - 12.8 (8.6); WE = 12.8 - 14.9 (13.9);

LP = 6.4 - 17.0 (11.7); WP = 17.0 - 25.5 (21.3);

LD = 17.0 - 31.9 (24.5); WD = 19.1 - 29.8 (24.5);

Sporadin

TL = 34.0 - 157.0 (81.7);

LP = 8.5 - 85.0 (24.2); WP=8.5 - 106.3 (35.9);

LD = 23.4 - 125.4 (57.5); WD = 17.0 - 114.8 (50.1);

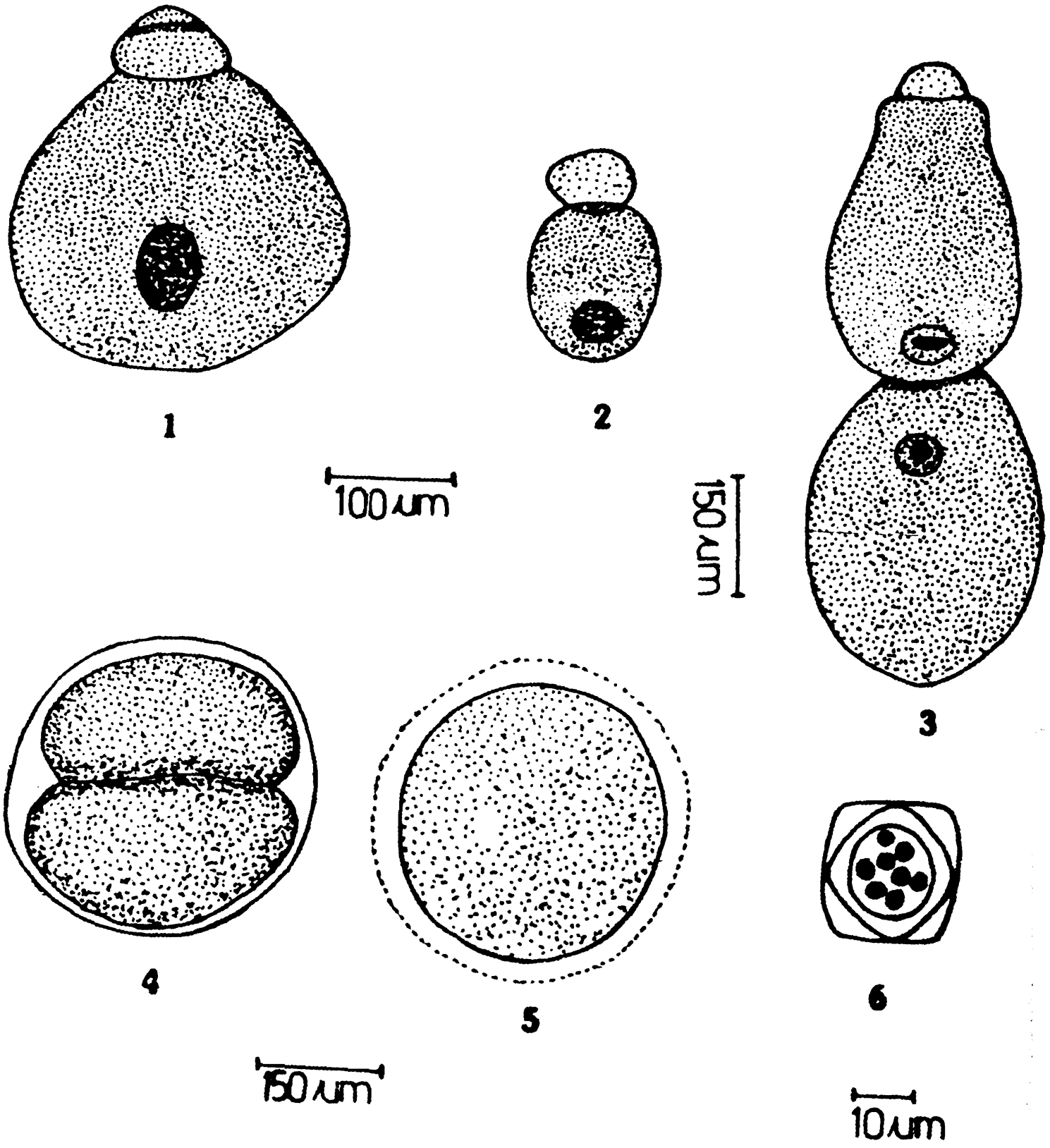
LN = 4.3 - 46.8 (14.2); WN = 4.3 - 46.8 (14.2);

LP : TL = 1 : 1.6 - 15.7 (5.8);

WP : WD = 1 : 0.5 - 2.8 (1.7).

Material : Holotype; Coll. No. X 15/4 S. C. Datta Coll. dated 8.9.1979. Type locality; Bidhan Chandra Krishi Viswa Vidyalaya, W B. Paratype; Coll. No. X 15/1 and others.

Affinities : In having sporadins in association and satellite without septum, the gregarine is at once placed in the genus *Didymophyes* Stein, 1848 under the family Didymophyidae Leger, 1892. It resembles *D. paradoxa* Stein, 1848 in ratios of LP : TL but differs from the latter in the ratios of WP and WD. It has an affinity with *D. leuckarti* Marshall, 1893 in ratios of WP and WD but their other features are different. The parasite under investigation has the following peculiarities of its own vase-shaped trophozoite and ovoidal spore surrounded by hyaline rectangular coat. In view of the above-mentioned features the present gregarine is given a new specific status and the name *Didymophyes tridactyli* n.sp. is given.



Figs. 1-6. Camera lucida drawings of different stages of life cycle of *Didymophyes tridactyli* n.sp. 1. Fully grown trophozoite. 2. Sporadin. 3. Syzygy. 4. Gametocyst. 5. Gametocyst prior to dehiscence. 6. Spore with rectangular coat.

Genus ***Hirmocystis*** Labbé, 1899

Sporadins in association of 2 to 12; epimerite conical or cylindrical knob, cysts spherical and ovoidal spores.

Hirmocystis murtii n. sp.
(Figs. 7 - 13)

Development : Intracellular.

Trophozoite : Elongated; knob-like epimerite, conical protomerite and cylindroconical deutomerite with rounded posterior extremity. An ovoidal nucleus is present at the centre of the deutomerite.

Sporadin and association : Elongated with dome-shaped protomerite and cylindrical deutomerite. The pellicle is thick in the anterior free margin of the protomerite. The nucleus is rounded. Cytoplasm is densely granulated in protomerite while in the deutomerite dense granules are scattered irregularly. Section through the nuclear region shows prominent dumbell-shaped chromatin bodies.

Syzygy caudo-frontal showing larger satellite than primite. Epicyteal striations are pronounced and the cytoplasm is densely granulated. The pellicle is thick in both primite and satellite.

Gametocyst and spore : Orange-coloured with thick cyst wall. Spherical in shape measuring 340.0 µm x 360.0 µm with transparent ectocyst. The ectocyst measures 16.0 µm in thickness. The gametocysts dehisce by simple rupture after 96 hours of development.

Spores are ovoidal, double-walled meeasuring 5.8 µm × 4.2 µm. On the fifth day of development eight sporozoites are formed in each spore and arranged linearly.

Measurements (in microns) :

Trophozoite

TL = 114.8;

IE = 10.6; WE = 8.5;

LP = 29.8; WP = 38.3;

LD = 74.4; WD = 55.3;

LN = 12.8; WN = 12.8;

Sporadin

TL = 93.5 - 383.2 (202.7);

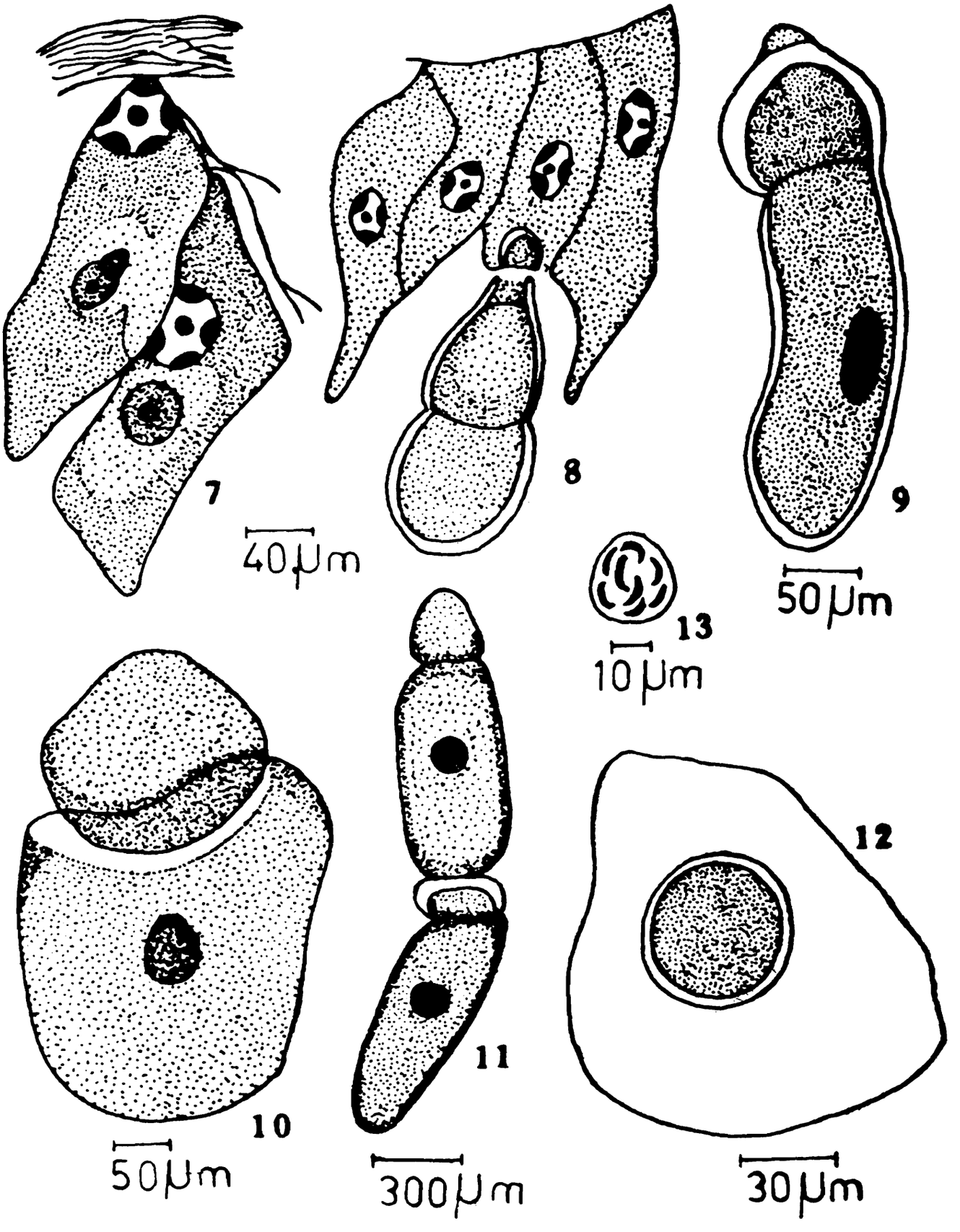
LP = 16.7 - 83.3 (46.9); WP = 33.3 - 116.6 (69.4);

LD = 63.8 - 299.9 (155.8); WD = 34.0 - 166.6 (109.4);

LN = 8.3 - 33.3 (19.7); WN = 8.5 - 33.3 (19.0);

LP : TL = 1 : 3.1 - 10.5 (4.9);

WP : WD = 1 : 1.0 - 1.5 (1.7).



Figs. 7-13. Camera lucida drawings of different stages of life cycle of *Hirmocystis murtii* n.sp. 7. Intracellular stages of development of the parasite. 8. Trophozoite attached to the gut wall. 9. Trophozoite. 10. Sporadin. 11. Sporadin in association. 12. Gametocyst with ectocyst. 13. Ovoidal spore with eight sporozoites.

Material : Holotype; Coll..No. B14/5 S. C. Datta Coll. dated 2.9.1979. Type locality; paddy fields of Bidhan Chandra Krishi Viswavidhalaya, Kalyani, W. B. Paratype; Coll. No. B10 and others.

Affinities : The parasite possesses close resemblances with *H. gryllotalpae* Labbé, 1899 in the shape of the cyst and spore but the two differ widely in other characters. The present form also shows similarities with *H. venticossa* Wellmer. 1911 and *H. pitcharis* Haldar and Chakraborty, 1979 in WP : WD value but the shape of the epimerite, general structure of the body, LP : TL and the presence of ectocyst in the gregarine separate in markedly from the other described and related species of *Hirmocystis* Labbé. The features justify the erection of a new species for the parasites for which the name *Hirmocystis murtii* n.sp. is proposed after the eminent gregarinologist, Prof. C. C. N. Murti.

Hirmocystis antennatae n. sp.
(Figs. 14 - 19)

Development : Intracellular.

Trophozoite : Elongated with tongue-shaped epimerite, subspherical protomerite and elongated deutomerite. The protomerite is always broader than long. The pellicle covering the protomerite and deutomerite is thick (4.3 µm). Epicyteal striations are not clearly observable. The endoplasm is orange-coloured in living condition.

Sporadin and association : Cylindrical with oval protomerite and dome-shaped deutomerite. The pellicle is thick in both proto and deutomerite. Nucleus is oval in shape and the cytoplasm is finely granulated.

Association is caudo-frontal; protomerite of the primite is hemispherical whereas in the satellite it is flat. The primite is always smaller than the satellite.

Gametocyst and spore : Orange-coloured, spherical cyst measuring 420 µm to 500 µm x 460 µm to 500 µm. An ectocyst of 340 µm x 620 µm is present surrounding the gametocyst. After 56 hours of development the cyst dehisces by simple rupture. At the time of dehiscence the spores are liberate by simple rupture at one point of the cyst wall and come out with great force in a mass giving the appearance of a long duct.

Ovoidal spores measure 5.8 µm × 4.2 µm. Eight sporozoites are arranged irregularly within each spore. Formation of sporozoites is completed at 72 hours inside the moist chamber.

Measurements (in microns) :

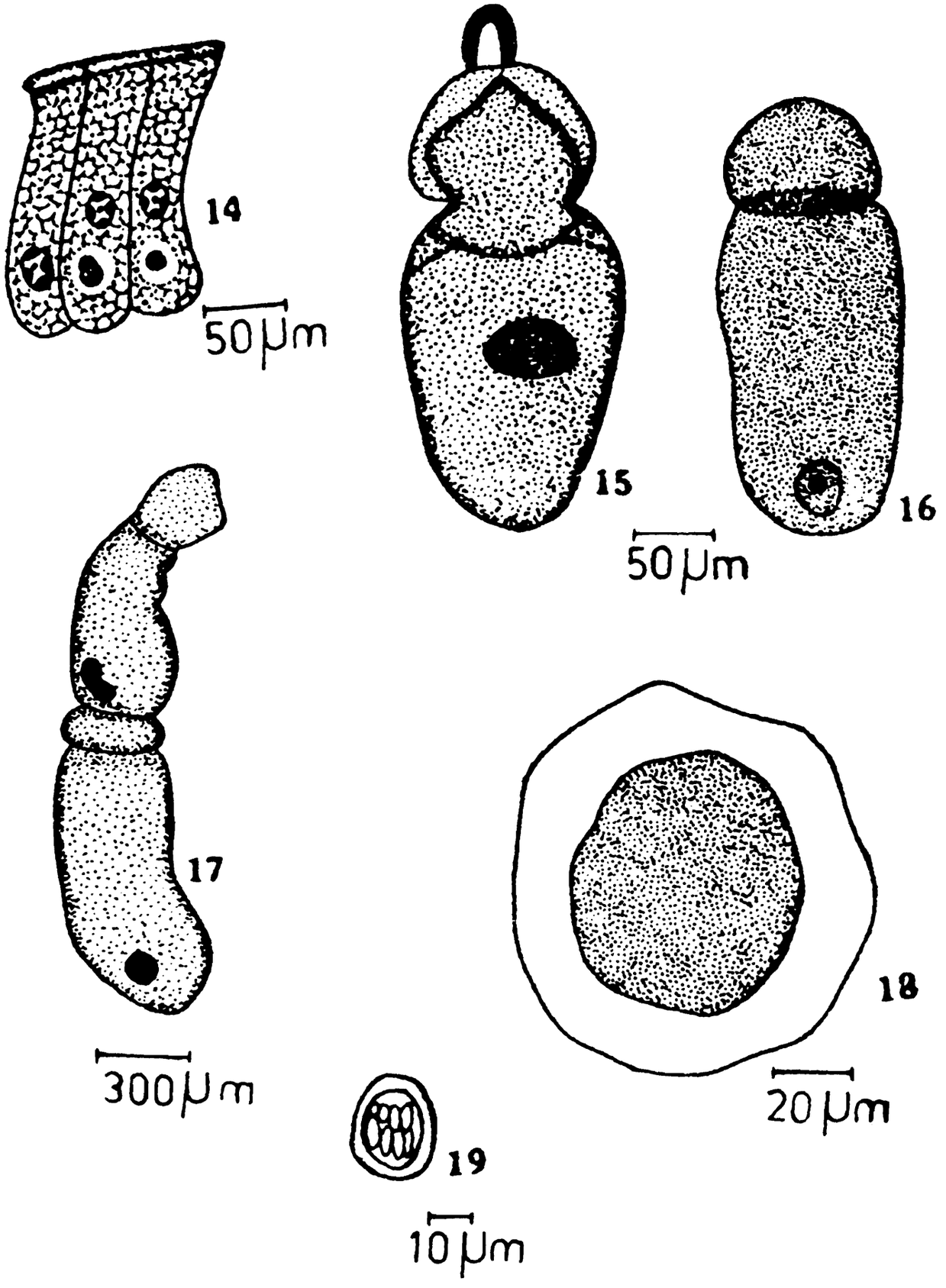
Trophozoite

TL = 166.6

LE = 8.3; WE = 16.7

LP = 33.3; WP = 50.0;

LD = 125.0; WD = 41.7;



Figs. 14-19. Camera lucida drawings of different stages of life cycly of *Hirmocystis antennatae* n.sp. 14. Section through hepatic caeca of the host showing intracellular stages of development. 15. Trophozoite. 16. Sporadin. 17. Syzygy. 18. Gametocyst. 19. Ovoidal spore with eight sporozoites.

Sporadin

TL = 150.0 - 516.5 (317.0);

LP = 33.3 - 100.0 (60.3); WP = 33.3 - 183.3 (100.4);

LD = 100.0 - 466.5 (256.3); WD = 33.2 - 216.6 (106.7);

LN = 16.7 - 41.7 (21.1); WN = 16.7 - 33.3 (20.3);

LP : TL = 1 : 2.2 - 10.3 (6.07);

WP : WD = 1 : 0.6 - 1.4 (1.26).

Material : Holotype; Coll. No. Ph/1 S. C. Datta Coll. dated 1.7.1979. Type locality; Kalyani University Campus, W. B. Paratype; Coll. No. Ph/2 and others.

Affinities : The gregarine under report has exceedingly thick pellicle and during association its satellite is always larger than primite. Early gametocysts are covered by an ectocyst, which later disappear. The dehiscence of the cyst in the present form is very characteristic as elaborated earlier. Its early development is intracellular. The ratios between length of protomerite and total length (1 : 6.07) as well as width of protomerite and width of deutomerite (1 : 1.26) are also specific in this particular gregarine. The combination of such characters are sufficient for the erection of a new species for this hirmocystid for which the name *Hirmocystis antennatae* n.sp. is proposed.

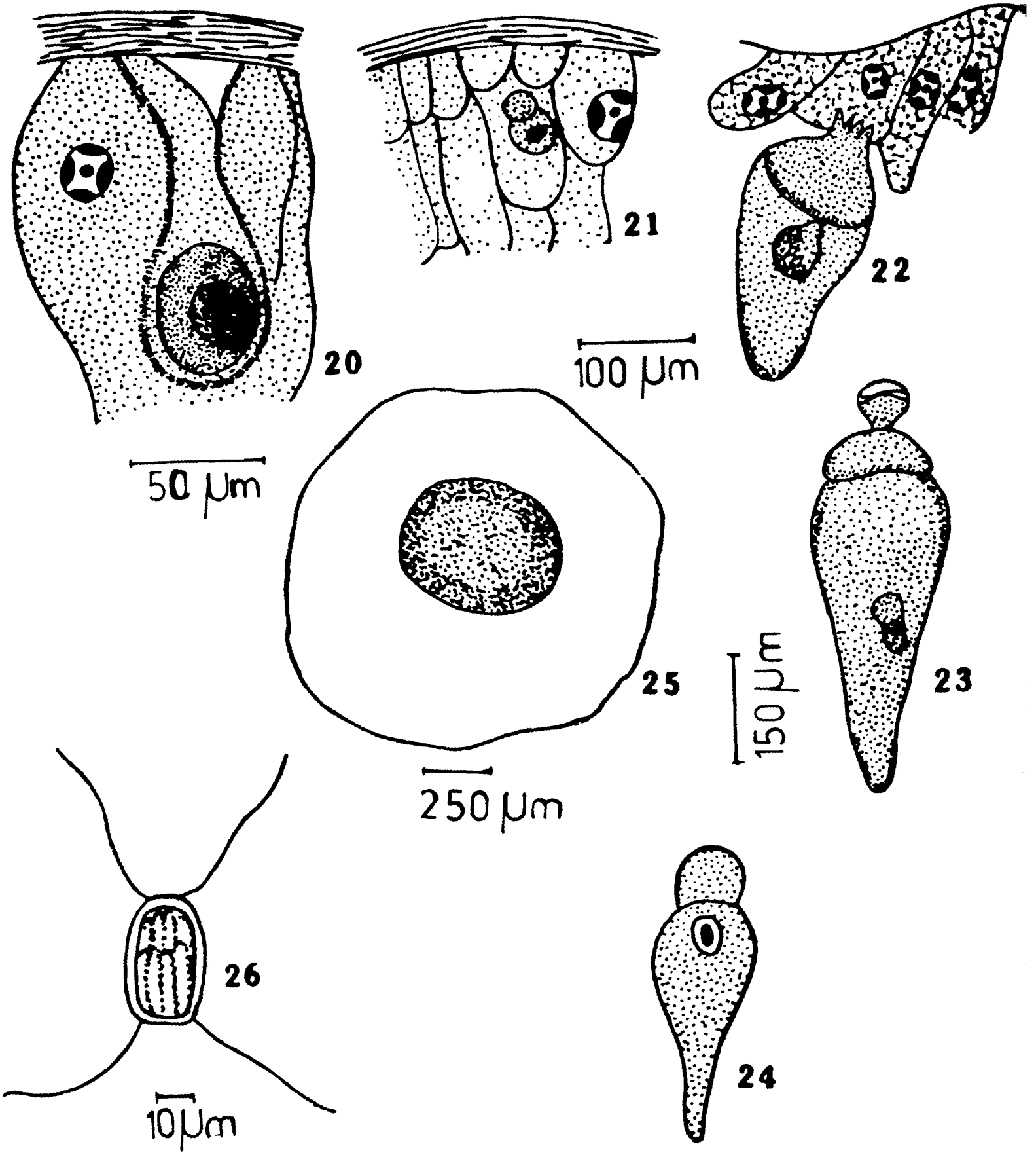
Genus ***Quadruspinospora*** Sarkar and Chakravarty, 1969, emend. Haldar and Chakraborty, 1975.

Solitary, elongated trophozoite with subspherical epimerite having a variable number of stumpy digitiform processes, hemispherical protomerite and granular deutomerite, spherical gametocysts dehiscing by simple rupture, oval spores with a pair of long spines, development intracellular.

Quadruspinospora platyepimerita n.sp.
(Figs. 20 - 26)

Development : Intracelluar.

Trophozoite : Elongated with the usual three segments. In the attached trophozoite epimerite possesses numerous short, stumpy digitiform processes. In the lumen-dwelling form epimerite is subspherical or knob like, broad at the free end and narrow at the base of attachment with the protomerite. The free end is devoid of any digitiform processes, their place being taken up by a characteristic flat disc-like structure. The protomerite is hemispherical in outline and is always broader than long. Elongated and cylindroconical deutomerite contains fine dense granules. The nucleus is oval in shape with clear nuclear membrane. The nuclear material is concentrated at the centre of the nucleoplasm.



Figs. 20-26. Camera lucida drawings of different stages of life cycle of *Quadruspinospora platyepimerita* n.sp. 20, 21. Intracellular development of the parasite. 22. A fully grown trophozoite attached with the epithelium of the hepatic caeca. 23. Trophozoite. 24. Sporadin. 25. A gametocyst with ectocyst. 26. Spore with spines and eight sporozoites.

Sporadin : Characteristically solitary with hemispherical protomerite. The deutomerite is conical in shape and broadest immediatly behind the protomerite deutomerite septum. The mature sporadins associate sidewise in pairs, move together and ultimately become enclosed within a cyst wall.

Gametocyst and spore : Opaque white in color, almost spherical measuring 420.0 µm x 400.0 µm. Each is enclosed by a prominent ectocyst, measuring 240.0 µm x 320.0 µm. The gametocyst dehisces by simple rupture at about 96 hours.

The spores are oval bodies measuring 8.3 µm × 5.0 µm. The length of the spines varies from 24.9 µm to 33.2 µm. Formation of sporozoites is completed at 24 hours of dehiscence. The eight sporozoites are arranged in a linear fashion inside the spore.

Measurements (in microns) :

Trophozoite

TL = 441.5;

LE = 33.3; WE = 58.3;

LP = 50.0; WP = 116.6;

LD = 358.2; WD = 116.6

Sporadin

TL = 83.3 - 699.7 (243.3);

LP = 16.7 - 116.6 (52.6); WP = 33.3 - 166.6 (85.5);

LD = 66.6 - 583.1 (190.7); WD = 33.3 - 249.9 (90.8);

LN = 25.0 - 50.0 (35.4); WN = 16.7 - 50.0 (25.0);

LP : TL = 1 : 2.0 - 10.0 (7.9);

WP : WD = 1 : 0.4 - 2.0 (1.06).

Material : Holotype; Coll. No. B6/1 S. C. Datta Coll. dated 5.9.1979. Type locality; Naihati, W. B. Paratype; Coll. No. B5/2 and others.

Affinities : Sarkar and Chakravarty (1969) first established the genus *Quadruspinospora*. Later, Haldar and Chakraborty (1975a) emended the generic characters of this genus. However, presence of four spines in the spore is sufficient for placement of the parasite under the genus *Quadruspinospora* Sarkar and Chakravarty, 1969, emend. Haldar and Chakraborty, 1975. The structure of the epimerite as well as the measurements and ratios of different body parts in the present form are not in agreement with previously described species of *Quadruspinospora* and for this reason it is described here as *Quadruspinospora platyepimerita* n.sp. The specific trivial name implies the presence of flat disc-like structure in the epimerite of the fully grown trophozoite.

Quadruspinospora adigitalis n. sp.
(Figs. 27 - 32)

Development : Intracellular.

Trophozoite : Elongated conical and possesses a sub-spherical epimerite, hemispherical protomerite and cylindroconical deutomerite. The septum separating the protomerite from deutomerite is inwardly curved. Younger trophozoites attach with host gut epithelial cells with distinct digitiform processes.

Sporadin : solitary with hemispherical protomerite and elongated deutomerite having a pointed extremity. An oval nucleus with a distinct nuclear membrane is present anteriorly in the deutomerite.

Gametocyst and spore : Freshly collected gametocysts enclosing two unequal gamtocytes are milky white in color. These are spherical measuring 320.0 µm to 660.0 µm in diameter. A prominent ectocyst, 180.0 µm to 270.0 µm × 180.0 µm to 200.0 µm, is present outside the gametocyst. After 48 hours of development the partition wall between the two gametocytes disappears. After 96 hours, the ectocyst disappears and one portion of the gametocyst bulges out. At about 112 hours the spores are liberated by simple rupture through this buldged point.

The spores are oval in shape with four spines. Each spore measures 8.3 µm x 5.0 µm and each spine is 13.3 µm long. Elongated sporozoites are arranged at two poles of the spore.

Measurements (in microns) :

Trophozoite

TL = 799.7;

LE = 133.3; WE = 116.6;

LP = 183.3; WP = 250.0;

LD = 483.1; WD = 283.2;

LN = 30.6; WN = 21.4;

Sporadin

TL = 100.0 – 949.6 (277.1);

LP = 16.7 – 299.9 (63.6); WP = 41.7 – 199.9 (82.4);

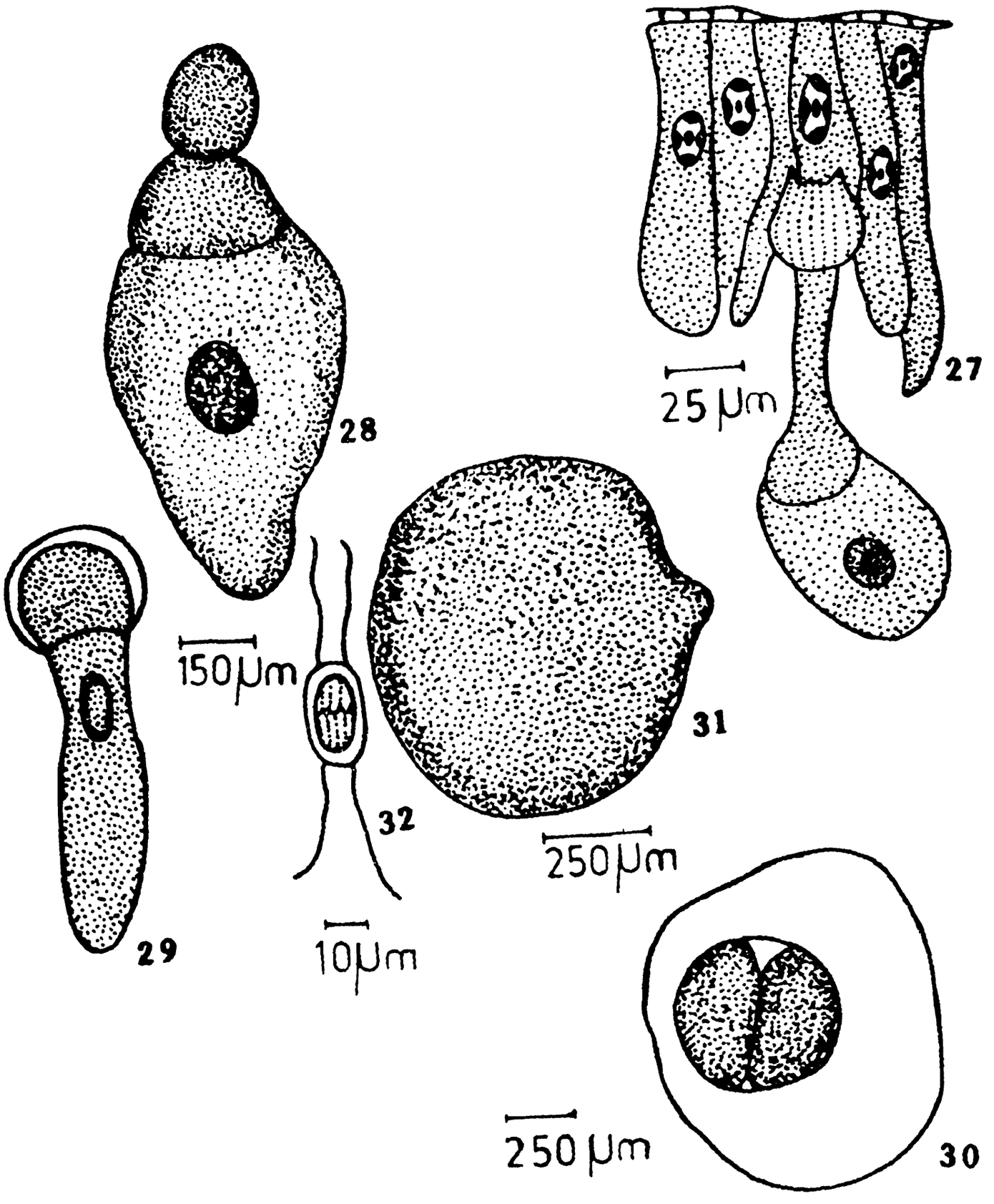
LD = 83.3 – 649.7 (216.1); WD = 33.3 – 249.9 (91.4);

LN = 16.7 – 50.0 (31.5); WN = 16.7 – 33.3 (24.1);

LP : TL = 1 : 2.2 – 21.5 (7.1);

WP : WD = 1 : 0.7 – 2.3 (1.2).

Material : Holotype; Coll. No. Ph/Q/1 S. C. Datta Coll. dated 4.1079. Type locality; Bidhan Chandra Krishi Viswa Vidyalaya, W B. Paratype; Coll. No. Ph/Q/3 and others.



Figs. 27-32. Camera lucida drawings of different stages of life cycle of *Quadruspinospora adigitalis* n.sp. 27. Showing attachment of trophozoite with its digitiform processes of epimerite. 28. Trophozoite. 29. sporadin. 30. Early gametocyst. 31. Mature gametocyst showing a bulge at one side. 32. Spore with spines at each pole and eight sporozoites.

Affinities : Presence of epimerite with stumpy, digitiform processes, solitary sporadins, dehiscence of cyst by simple rupture and ovoidal spores with spines confirm inclusion of the gregarine under the genus *Quadruspinospora*. Its LP : TL values closely resemble with *Q. megaspinosa* Haldar and Chakraborty, 1976 but all other characters like measurement of spore, spines and body structures are altogethere different. The present form also shows similarities with *Q. platyepimerita* in the size and shape of the spore but differs in all other respects. In view of these differences, the present form undoubtedly warrants erection of a new species for which the name *Quadruspinospora* adigitalis n.sp. for the absence of any digitiform process in the epimerite.

Quadruspinospora gesonulae n.sp.
(Figs. 33 - 38)

Development : Intracellular.

Trophozoite : Elongated, conical, the epimerite is subspherical, knob-like with fine thread like digitiform processes at the free surface. The protomerite is conical, broader than long while the deutomerite is elongated, tapering posteriorly. The pellicle is thin and epicyteal striations are not observable. Spherical nucleus with distinct nuclear membrane and an endosome is discernable. The nucleoplasm is filled with fine chromatin granules. The cytoplasm is densely granulated throughout the body.

Sporadin : Solitary. The protomerite is hemispherical while the deutomerite is elongated with gradually tapering posterior end. The septum separating the protomerite from deutomerite is thick.

Gametocyst and spore : Opaque white in color, ovoidal in shape and containing two equal gametocytes. The gametocyst measures 340.0 µm to 560.0 µm x 370.0 µm to 570.0 µm. A gelatinous transparent ectocyst encloses the cyst. After 24 hours of development the partition wall disappears and at 72 hours the cyst dehisces by simple rupture.

Oval spores measure 10.0 µm × 5.0 µm. The length of each spine is 24.9 µm. Sporozoites are arranged along the longitudinal axis of the spore.

Measurements (in microns):

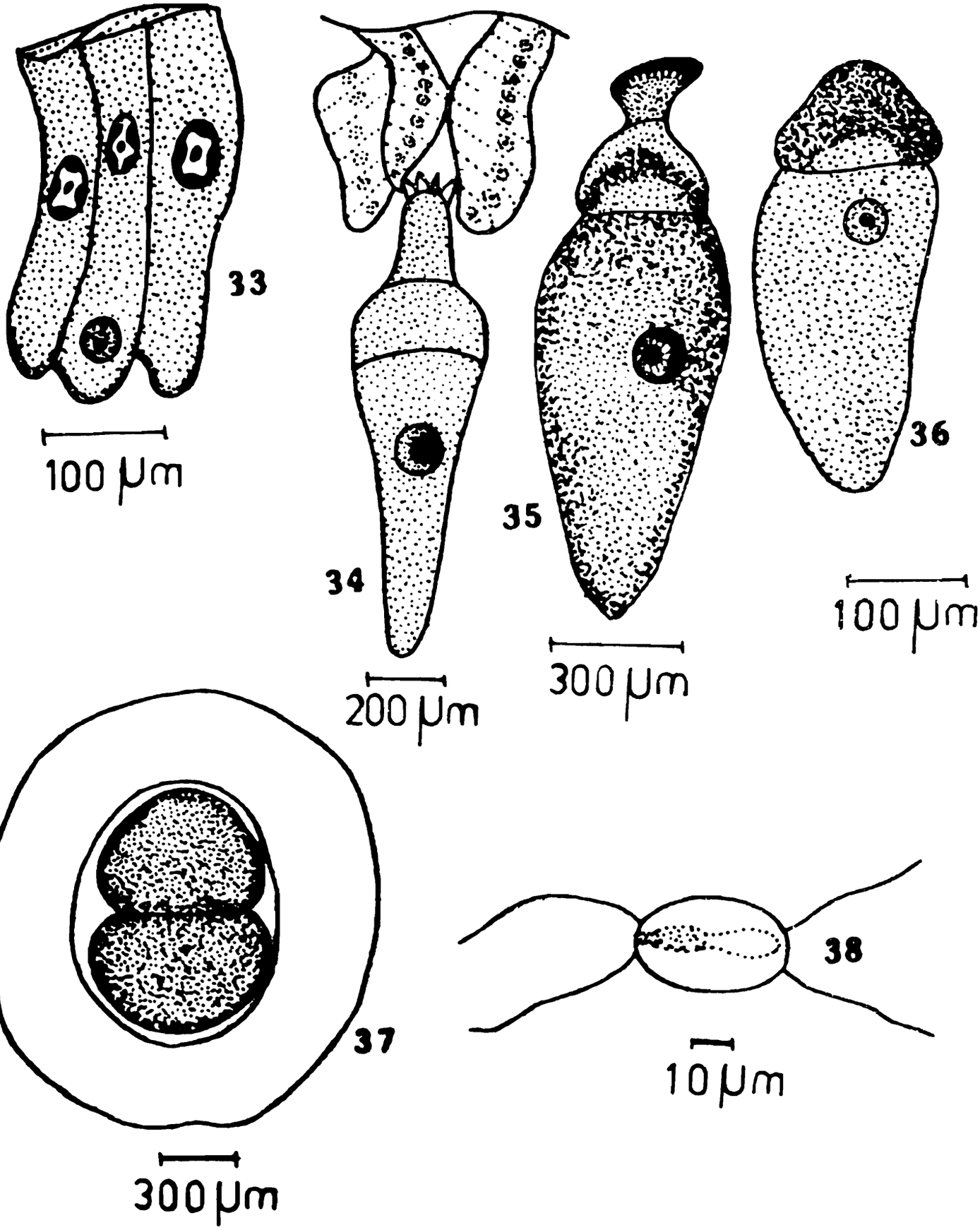
Trophozoite

TL = 316.5 - 649.7 (432.2);

LE = 16.7 - 50.0 (32.4); WE = 33.3 - 50.0 (44.4);

LP = 50.0 - 83.3 (66.6); WP = 83.3 - 183.3 (124.0);

LD = 249.9 - 533.1 (325.8); WD = 100.0 - 266.6 (167.5);



Figs. 33-38. Camera lucida drawings of different stages of life cycle of *Quadruspinospora gesnulae* n.sp. 33. Intracellular stages of development. 34. Showing trophozoite with characteristic epimerite attached with the epithelium of the hepatic caeca. 35. Trophozoite. 36. Sporadin. 37. A gametocyst with ectocyst. 38. Spore with spines.

Sporadin

TL = 299.9 - 733.0 (427.1);

LP = 50.0 - 100.0 (78.0); WP = 83.3 - 166.6 (123.4);

LD = 233.2 - 649.7 (349.1); WD = 83.3 - 183.3 (128.0);

LN = 25.0 - 33.3 (29.7); WN = 16.7 - 33.3 (26.2);

LP : TL = 1 : 4.0 - 10.0 (6.0);

WP : WD = 1 : 0.8 - 1.5 (1.2).

Material : Holotype; Coll. No. B/14/Q/1 S. C. Datta Coll. dated 4.10.1979. Type locality; Bidhan Chandra Krishi Viswa Vidyalaya. Paratype; Coll. No.B/14/Q/3 and others.

Affinities : The gregarine has a close similarity with *Q. chakravartyei* Chakraborty and Haldar, 1974 and *Q. indoaiolopii* Haldar and Chakraborty, 1976 in the ratios of LP : TL but differs from these two and the other described speices of the genus in total length, length of the spines in the spore and number of digitiform processes. It is, therefore, considered to be a new species for which the name *Quadruspinospora gesonulae* n.sp. after the generic name of its host.

Quadruspinospora jalpaiguriensis n. sp.
(Figs. 39 - 42)

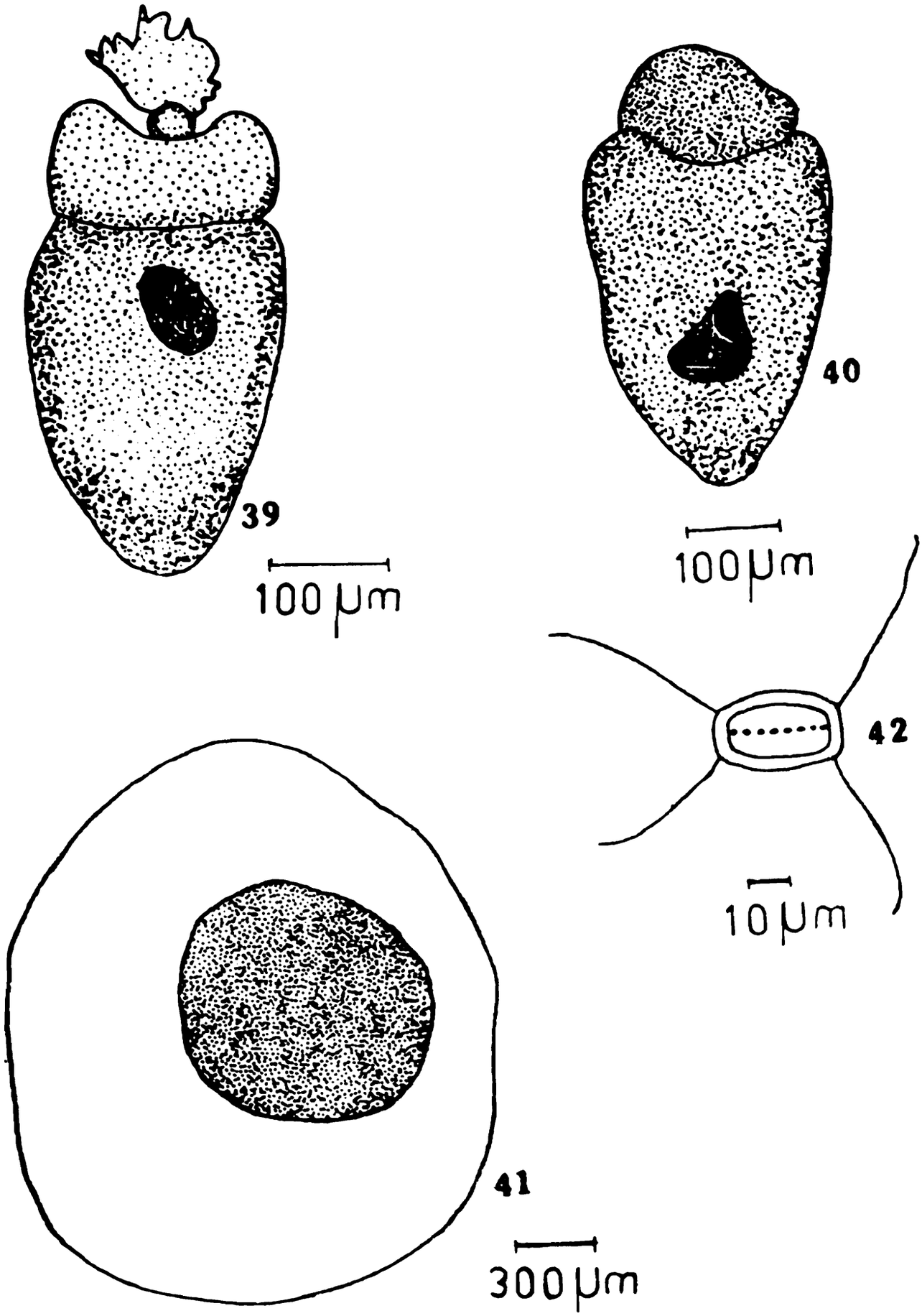
Development : Intracellular.

Trophozoite : Elongated, possesses a sub-spherical or knob-like epimerite with nine digitiform processes. The protomerite is hemispherical and broader than long. The deutomerite is elongated, conical and is separated from the protomerite by a thick septum. The nucleus is ovoidal with distinct nuclear membrane and several chromatin granules.

Sporadin : Solitary sporadins are found in the lumen of the hepatic caeca and midgut contents of the host. The protomerite is hemispherical and the deutomerite is conical in shape. The cytoplasm is uniformly granulated and epicyteal striations are lacking.

Gametocyst and spore : Spherical in shape, bright white in color with prominent ectocyst. The cysts measure 383.2 µm to 497.0 µm x 263.2 µm to 299.9 µm. The ectocyst disappears after 48 hours of development. After 96 hours the cyst dehisces by simple rupture liberating spores.

The spores are oval in shape measuring 6.6 µm x 5.0 µm. The spine measures 18.3 µm to 28.2 µm in length. 48 hours after the release of spores, sporozoites are formed which are arranged longitudinally.



Figs. 39-42. Camera lucida drawings of *Quadruspinospora jalpaiguriensis* n.sp. 39. Trophozoite. 40. Sporadin. 41. A gametocyst with prominent ectocyst. 42. Spore.

TABLE

Showing comparative characters of ten species of West Bengal to show the distinctiveness

Characters	*Q. aelopii* Sarkar and Chakravarty, 1969	*Q. chakra-vartyei* Chakraborty and Haldar, 1976	*Q. indoaio-lopii* Haldar and Chakraborty, 1976	*Q. acridii* Haldar and Chakraborty, 1976	*Q. megas-pinosa* Haldar and Chakraborty, 1976
Total length	92.5 µm 290.0 µm	52.5 µm - 457.5 µm	140.0 µm 600.0 µm	70.0 µm - 720.0 µm	90.0 µm - 630.0 µm
Epimerite	With 8-12 digitiform processes	With 20-24 digitiform processes	10 23 digitiform processes	10 - 13 digitiform processes	13 - 16 digitiform processes
Protomerite	Hemispherical	Dome-shaped	Rhomboidal	Hemispherical	Hemispherical
Nucleus	Spherical	Spherical to elliptical	Spherical, subspherical	Oval or elliptical	Spherical or slightly oval
Gametocyst	530.0 µm 590.0 µm; equal or unequal gametocytes	350.0 µm - 420.0 µm; unequal gametocytes	250 µm 440.0 µm; equal gametocytes	240.0 µm - 280.0 µm equal gametocytes	290.0 µm - 300.0 µm; equal gametocytes
Spore	8.0 µm x 4.0 µm; four spine measuring 36.0 µm	9.0 µm x 5.0 µm; length of each spine 30.0 µm	10.0 µm x 5.0 µm; length of each spine 40.0 µm	9.0 µm x 5.0 µm; length of each spine 30.0 µm	9.0 µm x 5.0 µm; length of each spine 43.0 µm
LP : TL	1 : 5.3	1 : 6.1	1 : 6.3	1 : 5.8	1 : 5.5
WP : WD	1 : 1.1	1 : 1.2	1 : 1.4	1 : 1.8	1 : 1.1
Host	*Aeolopus* sp.	*Spathos-ternum* sp.	*Aiolopus sp., Aiolopus thalassimus tumulus* (Fabr.)	*Acrida exaltata* (Walk.)	*Trilophidia annulata* Thumb.
Locality	Howrah	Kalyani	Kalyani, Naihati	Kalyani, Naihati	Kalyani, Naihati

- II

of *Quadruspinospora* described from grasshoopers of presently described four new species.

Q. attracto-morphii Haldar and Chakraborty, 1976	*Q. platyepi-merita* n. sp.	*Q. adigitalis* n. sp.	*Q. gesonulae* n. sp.	*Q. jalpaiguri-ensis* n. sp.
110.0 µm - 1020.0 µm	441.5 µm	799.7 µm	316.5 µm 649.7 µm	106.3 µm 533.1 µm
12 - 18 digitiform processes	Numerous short, stumpy brush-like digitiform processes	No distinct digiti-form processes in adult trophozoite	Subspherical knob-like with fine thread-like digitiform processes	Knob-like with nine digitiform processes
Rhomboidal	Hemispherical	Hemispherical	Conical	Hemispherical
Oval	Oval	Oval	Spherical	Ovoidal
300.0 µm - 440.0 µm; equal gametocytes	Spherical, 420 µm, equal or unequal gametocytes	320.0 µm 660.0 µm x 320.0 µm 660.0 µm; unequal gametocytes	340.0 µm 560.0 µm x 370.0 µm 570.0 µm; equal gametocytes	383.2 µm 497.0 µm x 263.2 µm 297.9 µm; equal or unequal gametocytes
10.0 µm x 5.0 µm; length of the spine 33.0 µm	Oval; 8.3 µm x 5.0 µm; length of the spine 24.9 µm to 33.2 µm	Oval; 8.3 µm x 5.0 µm; spine measures 13.3 µm in length	Oval; 10.0 µm x 5.0 µm; spine measures 24.9 µm in length	Oval; 6.6 µm x 5.0 µm; length of the spines 18.3 µm to 28.2 µm
1 : 7.09	1 : 2.0 10.0 (7.9)	2.2 21.5 (7.1)	1 : 4.0 10.0 (6.0)	1 : 2.7 9.3 (5.8)
1 : 1.17	1 : 0.4-2.0 (1.06)	0.7 2.3 (1.2)	1 : 0.8 1.5 (1.2)	1 : 0.8 1.4 (1.2)
Attracto-morpha crenulata Fabr.	Oxya hyla Serville	Phleoba antennata	Gesonula punctiformes (Stal.)	Oxya sp.
Kalyani, Naihati	Naihati	Kalyani	Kalyani	Jalpaiguri

The comparative characters of the different species of Quadruspinospora are compiled in Table II.

Measurements (in microns) :

Trophozoite

TL = 106.3 - 533.1 (284.2);

LE = 12.8 - 33.3 (20.6); WE = 17.0 - 66.6 (36.9);

LP = 17.0 - 83.3 (46.4); WP = 46.8 - 133.3 (98.2);

LD = 72.3 - 416.5 (217.3); WD = 53.1 - 144.5 (106.7);

LN = 17.0 - 34.0 (25.4); WN = 12.8 - 34.0 (24.9);

Sporadin

TL = 85.0 - 766.4 (372.1);

LP = 21.3 - 133.3 (65.5); WP = 38.3 - 233.2 (133.2);

LD = 63.0 - 683.2 (307.9); WD = 42.5 - 249.9 (158.3);

LN = 12.8 - 41.7 (28.6); WN = 12.8 - 50..0 (27.9);

LP : TL = 1 : 2.7 - 9.3 (5.8);

WP : WD = 1 : 0.8 - 1.4 (1.2).

Material : Holotype; Coll. No. B1/1 S. C. Datta Coll., dated 3.3.1979. Type locality; Alipurduar, Jalpaiguri, W. B. India. Paratype; Coll. No. B1/3 and others.

Affinities : The gregarine possesses close similarities with *Q. acridii* Haldar and Chakraborty, 1976 and *Q. megaspinosa* Haldar and Chakraborty, 1976 in having hemispherical protomerite and the values of LP : TL and WP : WD, however, differs in all other respects. The combination of characters like epimerite with 9 digitiform processes and size of the gametocyst and spore are altogether new and for this reason the present form is described as a new species and the name *Quadruspinospora jalpaiguriensis* n.sp. is given for it, as this is the first report of a gregarine species from this locality in West Bengal.

SUMMARY

The present paper deals with seven new species of cephaline gregarines (Apicomplexa : Sporozoea) from Orthopteran insects.

REFERENCES

Chakraborty, N. & Haldar, D. P. 1974. Morphology and life-history of a new cephaline gregarines from grasshopper. Proc. 61st Sci. Cong. Pt. III (Abst.), 51.

Ghose, S., Sengupta, T. & Haldar, D. P. 1986. Two new septate gregarines (Apicomplexa : Sporozoea), *Gregarina basiconstrictonea* n.sp. and *Hirmocystis oxeata* n.sp. from *Tribolium castaneum*. Acta Protozool., **25** (1) : 93-108.

Haldar, D. P. & Chakraborty, N. 1975. The genus. *Quadruspinospora* (Protozoa : Sporozoa). A new definition. Curr. Sci., **44**(15) : 558.

Haldar, D. P. & Chakraborty, N. 1976. Observations on the morphology and life history of three new speies of cephaline gregarines (Protozoa : Sporozoa) from grasshoppers in Kalyañi, Proc. Zool. Soc., **29**(1) : 73-81.

Haldar, D. P. & Chakraborty, N. 1979. Observations on three new species of cephaline gregarines (Protozoa : Sporozoa) of the genus *Hirmocystis* Labbé from coleopteran insects. Z. Parasitenkd., **59** : 121-130.

Labbé, A. 1899. Sporozoa. In "Das Tierreich", Friedlander. Berlin Leif, **5**(20) : 1-180.

Lipa, J. J. 1967. Studies on gregarines (Gregarinomorpha) of arthropods in Poland. Acta Protozool., **5**(8) : 97-179.

Marshall, W. S. 1890. Beitrage Zur Kenntuis der Gregarinen. Arch. Naturg., **59** : 25-44.

Sarkar, A. & Chakravarty, M. 1969. Gregarines (Protozoa : Sporozoa) from insects. I. New cephaline gregarines of the family Actinocephalidae. Proc. Zool. Soc., **22** : 17-29.

Sprague, V 1941. Studies on *Gregarin. blattarum* with particular reference to the chromosome cycle. Univ. Ill., **18**(2) : 7-57.

Stein, F. 1848. Uber die Nature der Gregarinen. Arch. Anat. Physiol., 182-223.

Wellmer, L. 1911. Sporozoan Ostprussischer Arthropoden. Sch. Physik. Okonom. Ges. Konigsb., **52** : 102-164.