

FAUNA OF ANDHRA PRADESH

**PART - 6
Protozoa**

ZOOLOGICAL SURVEY OF INDIA



FAUNA OF ANDHRA PRADESH

(PART-6)

Protozoa

Edited by
The Director, Zoological Survey of India, Kolkata



Zoological Survey of India
Kolkata

CITATION

Editor–Director, 2004. *State Fauna Series 5 : Fauna of Andhra Pradesh, Part-6 (Protozoa)*, 1-466 (Published–Director, *Zool. Surv. India*, Kolkata)

Published : September, 2004

ISBN 81-8171-048-7

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PRICE

India : Rs. 700.00

Foreign : \$ 50; £ 40

Published at the Publication Division by the Director, Zoological Survey of India, 234/4, AJC Bose Road, 2nd MSO Building, (13th Floor), Nizam Palace, Kolkata-700 020 and printed at Calcutta Repro Graphics, Kolkata-700 006.

STATE FAUNA SERIES
FAUNA OF ANDHRA PRADESH
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Part-6	2004	1-466

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PARASITIC PROTOZOA

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INTRODUCTION

The protozoa literally means first animal. It includes amazingly diverse group of organisms which are mostly microscopic, generally unicellular, and sometimes appear to be simple. But, these are the most complex cells known because all the biological and biochemical mechanisms for a complex life-style are contained within these single cells (Sleigh, 1991). Some protozoa are quite large, and are often multinucleate or have polyploid nuclei. They have different morphology and physiology at different stages of complex life cycle, especially among parasitic forms. Goldfuss (1817) introduced the term protozoa (in Greek, *proto* means first, and *zoon* means animal) and included in it a variety of simple organisms, including unicells, sponges, cnidarians, rotifers, and bryozoans. After the cellular nature of living organisms was discovered and the distinction between unicellular and multicellular organisms was clarified, von Siebold (1845) delimited the protozoa to only the "one celled animals". Being diverse organisms with divergent life-styles, morphologies, habits, and reproductive cycles, debate still continues on the phylogenetic relationships among unicellular organisms and about their evolutionary relationship to multicellular plants, animals and fungi. Some scientists consider unicellular eukaryotes to be classes in the phylum Protozoa (Hickman *et al.*, 1979), while others treat them as phyla in a kingdom Protista (Whittaker, 1977; Margulis and Schwartz, 1988), and still others distribute them among multiple, newly created kingdoms (Leedale, 1974; Dillon, 1981; Lipscomb, 1989; Hausman and Huelsman, 1996).

In India, Andhra Pradesh which lies between 12°37' and 19°54' N latitudes and between 76°46' and 84°46' E longitudes, is the fourth largest state (275068 sq. km.) and also has the fifth biggest population in the country. It is the biggest and most populous state in south India, comprising of 23 districts as follows with state capital in Hyderabad :

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1. Adilabad (Adilabad)	13. Medak (Medak)
2. Anantapur (Anantapur)	14. Nalgonda (Nalgonda)
3. Chittoor (Chittoor)	15. Nellore (Nellore)
4. Cuddapah (Cuddapah)	16. Nizamabad (Nizamabad)
5. East Godavari (Kakinada)	17. Prakasam (Ongale)
6. Guntur (Guntur)	18. Rangareddy (Hyderabad)
7. Hyderabad (Hyderabad)	19. Srikakulam (Srikakulam)
8. Karimnagar (Karimnagar)	20. Visakhapatnam (Visakhapatnam)
9. Khammam (Khammam)	21. Vizianagaram (Vizianagaram)
10. Krishna (Machilipatnam)	22. Warangal (Warangal)
11. Kurnool (Kurnool)	23. West Godavari (Eluru)
12. Mahbubnagar (Mahbubnagar)	

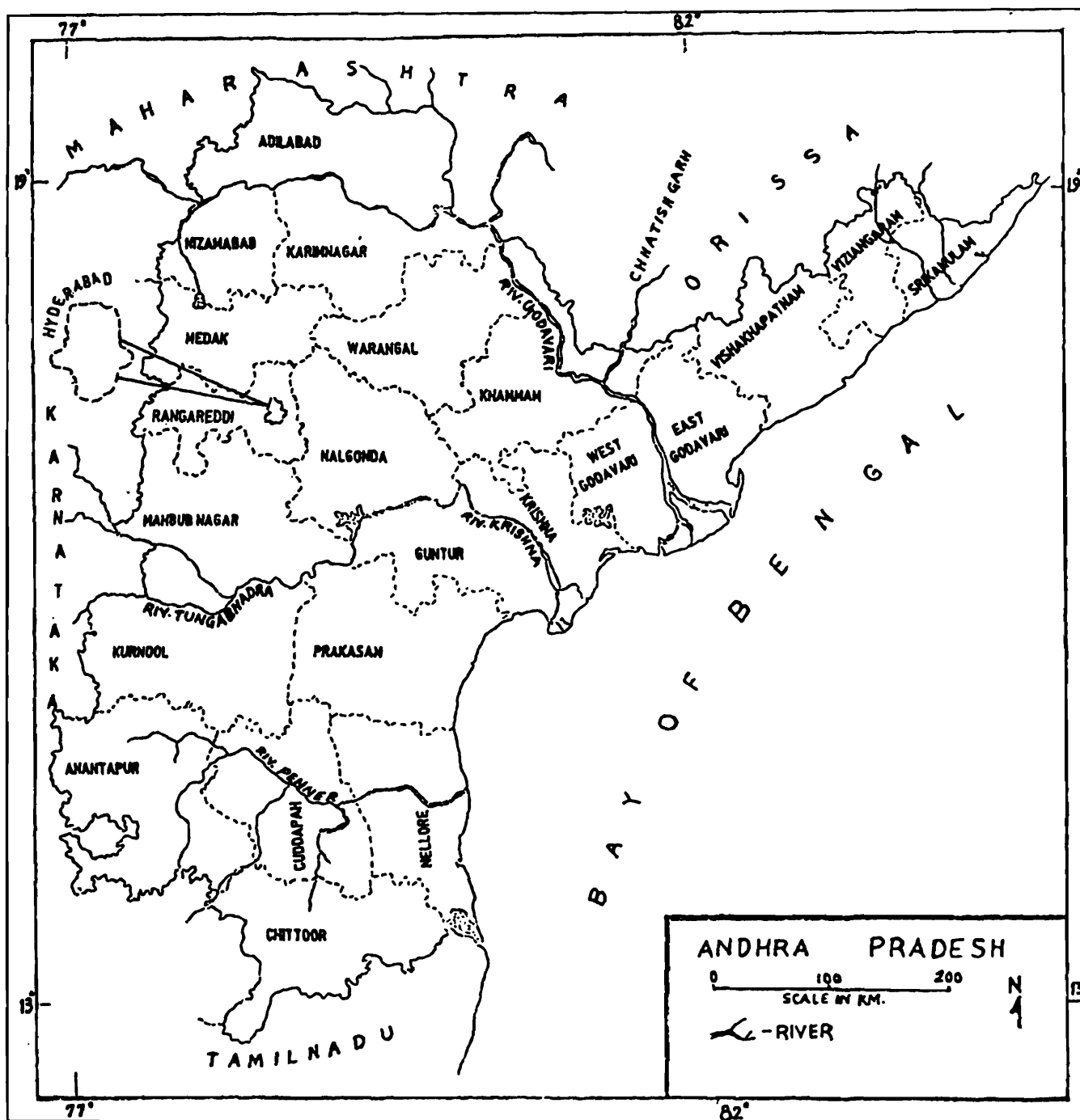
Physiographically, the state is situated on the eastern sea board of Indian peninsula with a vast coastline of about 1000 km, two major river systems (Godavari and Krishna) and three mountain chains (Eastern Ghats, Deccan plateau and Horsley and other hills). As such, this state offers suitable habitats for freeliving as well as parasitic protozoa and their hosts.

It is worth mentioning that extensive studies on protozoa, particularly the parasitic ones have been made from Andhra University, Osmania University, Kakatiya University, *etc.*, of this state. As a result more than 400 species have been reported comprising of various parasitic groups. It is in this respect Andhra Pradesh is the only state in India which represents six phyla, *viz.*, Sarcomastigophora, Apicomplexa, Microspora, Ascetosporea, Myxozoa and Ciliophora out of seven phyla in the classification scheme of Levine *et al.* (1980) which is adopted herein. The number of species of parasitic protozoa so far recorded from this state represents the second highest in India, being next to West Bengal (Das *et al.*, 1993).

The present communication includes 433 species of parasitic protozoa out of which 156 belong to the phylum Sarcomastigophora, while 122, 33, 3, 76 and 43 species represent the phyla Apicomplexa, Microspora, Ascetosporea, Myxozoa and Ciliophora respectively. Amongst these, five species of gregarines are new to science, two species of gregarines comprise new host parasite records, one species of gregarine is redescribed and 9 species of coccidian parasites constitute first report from this state.

A glimpse of earlier works

Studies on the parasitic protozoa of Andhra Pradesh were initiated by the last decade of the Nineteenth Century. Sir Ronald Ross was probably the first to examine the protozoan



Map of Andhra Pradesh showing 23 districts.

parasites from Andhra Pradesh. During 1890s he was posted from place to place in India. While in Secunderabad in 1895, he elucidated the exflagellation of human *Plasmodium* species in the stomach of mosquito, *Anopheles stephensi*, demonstrating the active role of a vector insect in the transmission of malarial parasite. Since then as many as 433 species of parasitic protozoa from 208 species of both vertebrate and invertebrate hosts have been recovered from this state till date. So far Indian states are concerned this species number is next to West Bengal from where 596 species of parasitic protozoa have been reported from 351 species of hosts (Das *et al.*, 1993).

During the first half of the twentieth century no work could be cited on parasitic protozoa from this state. In the post independence period there has been significant contributions in this field made by Ganapati and his co-workers (1954-1974), Qadri and his co-workers (1951-1973), Narasimhamurti and his associates (1985-1991), Krishnamurthy and Bhaskar Rao in 1960s and 1970s, Kalavati 1968 onwards and their fellow researchers from Andhra University, Osmania University and Kakatiya University have contributed much on flagellates, gregarines, myxosporidians and microsporidians of Andhra Pradesh.

Flagellate parasites particularly haemoflagellates/ trypanosomes have been studied by Qadri (1962), Todd (1963), Mandal and his co-workers (1977-1984), Narasimhamurti and Saratchandra (1980) and, Saratchandra and Jayaramaraju (1981). Intestinal flagellates of insects, arachnids, amphibians, reptiles, birds and mammals were investigated by Abraham (1961-1962), Janakidevi (1961-1962), Bhaskar Rao (1963-1970), Krishnamurthy (1963-1970), Navarathnam (1970, 1971), Bhaskar Rao *et al.* (1976, 1978) and Saratchandra (1978-1982).

A parasitic amoeba, namely, *Malamoeba indica* was reported from Andhra Pradesh as early as 1980 from an insect host, *Poecilocera picta* by Narasimhamurti and Ahmed (1980). Subsequently, two species of *Rosculus* were reported by Kalavati and Lakshminarayana (1982) and, Aravindan *et al.* (2002) from the hosts freshwater snake and shrimps respectively. An opalinid protozoa, *Cepedea hylae* was also reported by Khan (1962) from amphibian host *Hyla arborea*.

Extensive researches on septate gregarines were made by Ganapati and his co-workers (1954-1974), Narasimhamurti and his co-researchers (1961-1984), Bhusana Rao (1962), Kalavati and her associates (1978 onwards) from Andhra University. Subba Rao *et al.* (1978), Kalavati (1979) and Sailaja (1995) studied aseptate gregarines of Andhra Pradesh.

Narasimhamurti and Kalavati (1960, 1968), Kalavati (1977) and Narasimhamurti (1977) made valuable contributions in the field of adeline coccidia from termites and centipedes of Andhra Pradesh. Narasimhamurti (1979) reported a single species of aggregatine coccidia from a cephalopod host. Saratchandra (1979, 1981) reported two new species of haemogregarines and made two new host records from reptilian hosts. Although many workers have contributed much to our knowledge of eimeriid coccidia from India (Mandal (1987), little attention was

paid on this important parasites from this state. However, Satyanarayanacharulu *et al.* (1969) encountered a new species of *Isospora* from avian hosts. Sivanarayan and Venkataratnam (1969) reported a new species, *Eimeria tirupatiensis* from a domestic goat, Narasimhamurti (1980) reported *Eimeria mecistophori* from centipede host and Aravindan *et al.* (2002) reported a new species, *Montonella macrobrachii* from shrimps..

Little attention was also paid to the study of haemosporidian parasites from this state. Narasimhamurti and Saratchandra (1980) recorded an unnamed species of *Plasmodium* from *Hemidactylus prashadi*. Bhaskar Rao and Bhaskar Rao (1980) made their preliminary survey reports and dealt with seasonal dynamics of avian *Plasmodium* from Andhra Pradesh. Shortt *et al.* (1961) and Anantaraman (1980) studied the simian malaria parasites from Hyderabad. Nandi and Mandal (1984) reported several species of avian haemosporidians from middle stretches of Godavari River Basin, Adilabad and Warangal districts, Andhra Pradesh.

Padmavathi *et al.* (1974) studied a piroplasmid parasite of cattle, while Raghavachari and Reddy (1959) reported acute theileriasis in sheep. However, Colonel H.E. Shortt in 1960s (cited from Garnham, 1966) studied the piroplasms of small mammals. He had inoculated a species of *Babesia*, from an Indian Gerbil, into a *Macaca radiata* which he had trapped in the adjacent forests. Interestingly, a few days later, Shortt and his colleagues at the Osmania University were surprised to find not only the piroplasm, but a malaria parasite in the monkey's blood, and soon afterwards they discovered natural infection of a new malaria parasite (*Plasmodium osmaniae* Shortt, Rao, Qadri and Abraham, 1961) from the same locality.

Microsporean parasites were studied by Narasimhamurti and Kalavati (1972-1978), Kalavati and Ganapati (1974), Kalavati (1976), Weiser *et al.* (1981), Kalavati and Lakshiminarayana (1982), Sandeep and Kalavati (1985) and Narasimhamurti *et al.* (1985), while haplosporidian parasites were reported by Ganapati *et al.* (1964) and Narasimhamurti and Kalavati (1976).

Myxozoan parasites of freshwater, estuarine and marine fishes were studied by several investigators like Qadri (1965-1970), Lalitha Kumari (1965-1969), Narasimhamurti (1970), Narasimhamurti and Kalavati (1979-1986), Narasimhamurti *et al.* (1980-1990), Kalavati *et al.* (1981), Kalavati and Narasimhamurti (1983-1984), Kalavati and Anuradha (1992-1995), Padma Dorothy and Kalavati (1987-1998) and Padma Dorothy *et al.* (1998). From this state a single species of myxozoan parasites, viz., *Parazschokkella melanosticti* was reported so far from amphibian host by Kalavati and Narasimhamurti (1987).

Abraham (1962) and Kalavati *et al.* (1991) reported balantid ciliates from mammals and amphibians. Mahmood and Khan (1980) and, Jamadar and Choudhury (1988) studied endocommensal ciliates from molluscan hosts. Naidu (1961) and, Joseph and Rao (1980) recorded astomatid ciliates from oligochaetes. Kalavati *et al.* (1991) reported several peritrichid ciliates from anuran hosts.

Coverage

The present communication deals with six phyla, viz., Sarcomastigophora, Apicomplexa, Microspora, Ascetospora, Myxozoa and Ciliophora. Accordingly, several specialists were entrusted to write up different chapters of this document as detailed below :

- N. C. Nandi : Introductory and concluding parts as well as Phyla Sacomastigophora and Apicomplexa (except Coccidia and Gregarina).
- C. Kalavati : Phyla Microspora, Ascetospora and Myxozoa as well as Gregarina.
- A. K. Das : Phylum Ciliophora and editing of the entire text.
- R. Nandi : Order Coccidia, survey works in the state and library work.

A systematic list of parasitic species of protozoa occurring in the state is provided for quick reference to host and locality (district). A host parasite list is also provided for reference to parasites occurring in the respective host in addition to authors. A bibliography of references as many as available is incorporated at the end for the convenience of the readers, which include research papers, articles, Ph. D. and M. Phil. theses so that one may know the extent of work done on this subject from this state.

It is needed to mention here that collection locality of several parasitic species of Protozoa has been mentioned as Andhra Pradesh in the concerned literature. In such cases it has not been possible to ascertain from which district those parasites were recorded.

MATERIALS AND METHODS

Protozoa collections from Andhra Pradesh present in the National Zoological Collections of Zoological Survey of India (ZSI) and in the Division of Protozoology, Department of Zoology, Andhra University as well as parasitic protozoan species published so far from this state form the basis of this document. The explorations by ZSI scientists were conducted during 1970s, 1980s and in 2002-2003, while the investigations by scholars of Andhra University were made since 1950s. The host specimens, both invertebrates and vertebrates, as well as sample smears and histological sections were mostly examined in the Division of Protozoology of Andhra University where these were dissected and studied. Methodology followed for parasitological investigations over the years, in general, are as follows :

- Gut contents were examined after diluting them with Ringer's solution or Normal saline (0.56% for invertebrates and 0.8% for vertebrate hosts) on clean slides, wet-fixed in Schaudinn's fluid and stained with Heidenhain's iron haematoxylin.
- Organ-imprints and blood smears were drawn on clean grease-free slides, air-dried, fixed and / or stained with suitable stains (Geimsa, Wright or Leishman's stain).
- Faecal samples were kept in 2.5% aqueous potassium dichromate solution for subsequent sporulation and study of the coccidial oocysts for about a week.

- Portargal staining or dry silver impregnation technique was employed for some endocommensal ciliates to study the ciliary lines.
- Materials for histological study were fixed in alcoholic Bouin's fluid, sectioned at 6 μ m thickness and stained with Heidenhain's iron haematoxylin or Ehrlich's acid haematoxylin.
- Live temporary preparations were made using a drop of dilute neutral red, methylene blue, Lugol's iodine, ink, *etc.*, for the detection of different organelles and vacuoles.
- Extrusion of polar filaments was observed using 5-10% KOH solution.
- Drawings were made with the aid of a camera lucida.

The details on the collection and preservation of parasitic protozoa were used following Mandal and Nandi (1980), Mandal *et al.* (1990) and Das *et al.* (1993). For reference and diagnostic characters Wenyon (1920), Bhatia (1936, 1938), Garnham (1966), Kudo (1966), Levine (1967, 1988), Kreier (1978, 1994) and Corliss (1979) were consulted.

In this connection this is to mention here that types of five new taxa are deposited with Andhra University, Protozoology Laboratory in the custody of Prof. C. Kalavati as mentioned in respective places.

CLASSIFICATION

The parasitic protozoa, like freeliving ones, are comprised of a large and highly heterogenous taxonomic groups. They are of much interest to mankind because they produce disease in man and his livestock. There are others, which seldom produce disease, and still others, which live as commensals or symbionts in the animal body and thus, they all, must be recognized to avoid misdiagnosis as well as to understand their functional relationship in the animal's economy.

Classification of Protozoa is still in an unsettled stage. In fact, there is no generally accepted classification of this group. In the classical scheme which was mainly based on their locomotory organelles, Protozoa was treated as a phylum, but in one of the revised schemes it is considered as a kingdom (Cavelier-Smith, 1993, 1998).

In 1980, the Society of Protozoologists (Levine *et al.*, 1980) published a newly revised classification which recognized seven phyla : Sarcomastiphora, Labyrinthomorpha, Apicomplexa, Microspora, Ascetospora, Myxozoa and Ciliophora. Most of the parasitic protozoa were assigned to the phyla Sarcomastigophora, Apicomplexa, Microspora and Myxozoa. There are also some parasitic and commensalistic protozoa in the phyla Ascetospora and Ciliophora. This 1980 classification, though mostly followed in this document for convenience and wide acceptance, was realized to be unsatisfactory by the Society of Protozoologists (Lee *et al.*, 1985). The classification proposed by Sleight (1989) has shown a starting point of further revision (Table 1).

Table 1 : Comparative outline classification of Levine et al. (1980) and Sleigh (1989)

Levine et al. (1980)	Sleigh (1989)
Subkingdom Protozoa	Kingdom Protista
Phylum Sarcomastigophora	–
Subphylum Mastigophora	Flagellated protozoa
Class Zoomastigophora	–
Order Kinetoplastida	Phylum Kinetoplasta
–	Phylum Metamonada
Order Retortamonadida	Order Retortamonadida
Order Diplomonadida	Order Diplomonadida
Order Oxymonadida	Order Oxymonadida
–	Phylum Parabasalia
Order Trichomonadida	Order Trichomonadida
Order Hypermastigida	Order Hypermastigida
Subphylum Opalinata	Phylum Opalinata
Subphylum Sarcodina	Amoeboid Protozoa
Superclass Rhizopoda	Phylum Rhizopoda
Order Amoebida	Order Euamoebida
Phylum Apicomplexa	Phylum Sporozoa
Class Sporozoea	–
Subclass Gregarina	Class Gregarinea
Order Eugregarinida	Order Eugregarinida
Subclass Coccidea	Class Coccidea
Subclass Piroplasmia	Class Piroplasma
Phylum Myxozoa	Phylum Myxosporidia
Class Myxosporea	Class Myxosporea
Phylum Microspora	Phylum Microspora
Phylum Ciliophora	Phylum Ciliophora

The outline classifications of the parasitic protozoa as proposed by Cox (1991) and, Hausman and Huelsman (1996) are shown in Table 2 to orientate the reader about the turmoil, transition and revision of the higher taxa.

Table 2 : Outline classification of the parasitic Protozoa

Cox (1991)	Hausman and Huelsman (1996)
Kingdom Protista	–
Group 1. The flagellated protozoa	Kingdom Mastigota
–	Phylum Caryoblasta
Phylum Metamonada	Phyla Retortamonada and Axostylata (Superphylum Tetramastigota)
Order Retortamonadida	Superclass Retortamonadea
Order Diplomonadida	Superclass Diplomonadea
Order Oxymonadida	Superclass Oxymonadea (Phylum Axostylata)
Phylum Parabasalia	Superclass Parabasalea (Phylum Axostylata)
Order Trichomonadida	Order Trichomonadida
–	Order Polymonadida
Order Hypermastigida	Order Hypermastigida
–	Phylum Euglenozoa
Phylum Kinetoplasta	Subphylum Kinetoplasta
Order Bodonida	Superclass Bodonea
Order Trypanosomatida	Superclass Trypanosomatidea
Phylum Opalinata	Superclass Opalineae (Phylum Chromista)
<i>Incertae sedis</i>	–
Class Heterolobosea	Phylum Heterolobosa
Order Schizopyrenida	Superclass Schizopyrenidea
Group 2. The amoeboid protozoa	<i>Incertae sedis</i> (Superphylum Metakaryota : Kingdom Mastigota)
Phylum Rhizopoda	–
Class Lobosea	Superclass Lobosea (Subphylum Amoebozoa)
Order Euamoebida	Order Gymnamoebia
Order Acanthopodida	Order Gymnamoebia
Group 3. The Sporozoans	Subphylum Apicomplexa (Phylum Alveolata)
Phylum Sporozoa	Subphylum Apicomplexa
Class Gregarineae	Superclass Gregarineae
Order Archigregarinida	Superclass Gregarineae
Order Eugregarinida	Superclass Gregarineae
Order Neogregarinida	Superclass Gregarineae
Class Coccidea	Superclass Coccidea
Order Protococcida	Order Coelotrophiida

Table 2 Contd.

Cox (1991)	Hausman and Huelsman (1996)
Order Adeleida	Order Adeleida
Order Eimeriida	Order Eimeriida
Class Haemosporidea	Superclass Haematozoa
Order Haemosporida	Order Haemosporida
Class Piroplasmea	Superclass Haematozoa
Order Piroplasmida	Order Piroplasmida
Order Dactylosomida	Order Piroplasmida
Group 4. The microsporidians	Kingdom Microspora
Phylum Microspora	Phylum Microspora
Class Rudimicrosporea	Superclass Rudimicrosporea
Order Metchnikovellida	Class Rudimicrosporea
Class Microsporea	Superclass Microsporea
Order Minisporida	—
Order Microsporida	Superclass Microsporea
Group 5. The haplosporidians	Superphylum Metakaryota <i>incertae sedis</i>
Phylum Haplosporidia	Subphylum Ascetospora; Superclass Haplosporea
Order Balanosporida	—
Group 6. The myxosporidians	Subphylum Myxozoa (Superphylum Metakaryota <i>incertae sedis</i>)
Phylum Myxozoa	Subphylum Myxozoa
Class Myxosporea	—
Order Bivalvulida	—
Order Multivalvulida	—
Group 7. The ciliated protozoa	Subphylum Ciliophora (Phylum Alveolata)
Phylum Ciliophora	Subphylum Ciliophora
Subphylum Postciliodesmatophora	Superclass Postciliodesmatophora
Class Karyorelictea	Class Karyorelictea
Class Spirotrichea	Class Spirotrichea
Subclass Heterotrichia	Subclass Heterotrichia
Order Clevelandellida	Order Clevelandellida
Subphylum Rhabdophora	Superclass Rhabdophora
Class Prostomatea	Class Prostomatea
Class Litostomatea	Class Litostomatea
Subclass Trichostomatia	Order Trichostomatia
Order Vestibuliferida	—
Subphylum Cyrtophora	Superclass Cyrtophora

Table 2 Contd.

Cox (1991)	Hausman and Huelsman (1996)
Class Phyllopharyngea	Class Phyllopharyngea
Class Nassophoria	Superclass Nassophorea
Class Oligohymenophorea	Class Oligohymenophorea
Subclass Peritrichia	Subclass Peritrichia
Order Mobilina	Order Mobilida
Subclass Astomatia	Subclass Astomatia
Class Colpodea	Superclass Colpodea

All these classification with diagnostic characters are made only up to order and suborder level. The characteristic features are mostly ultrastructural or based on argentophilic studies, while majority of old protozoan taxa are based on classical characters. In view of above, it is often very difficult to place those taxa particularly the families and the genera under a particular order or suborder. Perhaps, therefore, no classification is generally accepted to the workers who deal with taxonomy of lower protozoan taxa. To avoid this difficulty they often do not mention higher taxonomic hierarchy during their taxonomic works.

In the present communication, the classification of Levine *et al.* (1980) has been mostly followed for the convenience and keeping continuity with the earlier State Fauna Series published by the Zoological Survey of India. However, some other classifications have also been used in this paper for some protozoan phyla as mentioned in the respective portion in the text.

SYSTEMATIC LIST OF PARASITIC PROTOZOA

The systematic list of parasitic protozoa along with locality (district) of occurrence hitherto known/ recorded from the state of Andhra Pradesh is as follows :

Parasite	Host	Locality (District)
Kingdom	PROTISTA	
Subkingdom	PROTOZOA	
Phylum	SARCOMASTIGOPHORA	
Subphylum	MASTIGOPHORA	
Class	ZOOMASTIGOPHOREA	
Order	KINETOPLASTIDA	
Suborder	BODONINA	
Family	CERCOBODONIDAE	
Genus	<i>Alexeiefella</i> Janakidevi, 1961	
1. <i>A. cheloni</i> Janakidevi, 1961	<i>Lissemys punctata granosa</i>	Hyderabad

Suborder TRYPANOSOMATINA		
Family TRYPANOSOMATIDAE		
Genus <i>Leishmania</i> Ross, 1903		
2. <i>L. donovani</i> (Laveran and Mesnil, 1903)	<i>Homo sapiens</i>	Hyderabad, Krishna and West Godavari
Genus <i>Trypanosoma</i> Gruby, 1843		
A. <i>Trypanosoma</i> of fishes		
3. <i>T. batrachi</i> Qadri, 1962	<i>Clarias batrachus</i>	Hyderabad
4. <i>T. channai</i> Narasimhamurti and Saratchandra, 1980	<i>Channa punctatus</i>	Visakhapatnam and Srikakulam
5. <i>T. danilewskyi saccobranchi</i> Qadri, 1962	<i>Heteroneustes fossilis</i>	Hyderabad
6. <i>T. godavariensis</i> Saratchandra and Jayaramaraju, 1981	<i>Channa punctata</i>	East Godavari
7. <i>T. qadrii</i> Narasimhamurti and Saratchandra, 1980	<i>Clarias batrachus</i>	Visakhapatnam and Srikakulam
8. <i>T. striati</i> , Qadri, 1955	<i>Channa striatus</i> (= <i>Ophicephalus striatus</i>) <i>Channa punctatus</i> (= <i>Ophicephalus punctatus</i>)	Hyderabad Hyderabad
B. <i>Trypanosoma</i> of reptiles		
9. <i>T. lissemysi</i> Saratchandra, 1980	<i>Lissemys punctata granosa</i>	Visakhapatnam
C. <i>Trypanosoma</i> of birds		
10. <i>T. avium</i> Danilewsky, 1885	<i>Dicrurus macrocercus</i>	Warangal
11. <i>T. sp.</i>	<i>Eudynamis scolopacius</i>	Andhra Pradesh
12. <i>T. sp.</i>	<i>Streptopelia chinensis</i>	Andhra Pradesh
D. <i>Trypanosoma</i> of mammals		
13. <i>T. bandicotti</i> Lingard, 1904	<i>Nesocia</i> (= <i>Nesokia</i>) <i>bandicota</i>	Hyderabad
14. <i>T. evansi</i> (Steel, 1885)	Cattle Buffaloe Dog	Krishna, Guntur, East Gadavari

15. <i>T. indicum</i> Luhe, 1906	<i>Sciurus palmarum</i>	Hyderabad
16. <i>T. lewisi</i> Kent, 1880	<i>Rattus rattus frugivorus</i>	Hyderabad
17. <i>T. theileri</i> Laveran, 1902	Buffaloe	Guntur
18. <i>T. sp.</i>	<i>Vulpes bengalensis</i>	Hyderabad
19. <i>T. sp.</i>	Cow (<i>Bos indicus</i>)	Andhra Pradesh
20. <i>T. sp.</i>	Buffalo (<i>Bubalus bubalis</i>)	Andhra Pradesh
21. <i>T. sp.</i>	Dog (<i>Canis familiaris</i>)	Andhra Pradesh
22. <i>T. sp.</i>	Pony (<i>Equus caballus</i>)	Andhra Pradesh
23. <i>T. sp.</i>	Tiger, <i>Panthera tigris</i>	Andhra Pradesh
24. <i>T. sp.</i>	Puma, <i>Puma concolor</i>	Andhra Pradesh
25. <i>T. sp.</i>	Jackal, <i>Canis aureus</i>	Andhra Pradesh
Genus <i>Leptomonas</i> Kent, 1880		
26. <i>L. bakeri</i> Prasad and Kalavati, 1987	<i>Lygaeus militaris</i>	Visakhapatnam
27. <i>L. indica</i> Prasad and Kalavati, 1987	<i>Lygaeus hospes</i>	Visakhapatnam
Order PROTEROMONADIDA Family PROTEROMONADIDAE Genus <i>Proteromonas</i> Kunstler, 1883		
A. <i>Proteromonas</i> in reptiles		
28. <i>P. chameleoni</i> Krishnamurthy, 1963	<i>Chameleon zeylanicus</i>	Hyderabad
29. <i>P. ganapatii</i> Saratchandra, 1981	<i>Hemidactylus giganteus</i>	Visakhapatnam
30. <i>P. grassei</i> Saratchandra and Narasimhamurti, 1980	<i>Hemidactylus prashadi</i>	Srikakulam
31. <i>P. hemidactyli</i> Krishnamurthy, 1968	<i>Hemidactylus brooki</i>	Hyderabad
32. <i>P. kakatiyae</i> Bhaskar <i>et al.</i> , 1978	<i>Hemidactylus sp.</i>	Warangal
33. <i>P. krishnamurthyi</i> , Saratchandra and Babu, 1982	<i>Calotes versicolor</i>	Visakhapatnam

34. <i>P. lacertae-viridis</i> (Grassi, 1879)	<i>Hemidactylus giganteus</i>	Hyderabad
35. <i>P. mabuiae</i> , Saratchandra <i>et al.</i> , 1984	<i>Mabuya beddomii</i>	Visakhapatnam
36. <i>P. waltirensis</i> Saratchandra and Narasimhamurti, 1980	<i>Hemidactylus prashadi</i>	Visakhapatnam
37. <i>P. warangalensis</i> Bhaskar Rao <i>et al.</i> , 1978	<i>Mabuya carinata</i>	Warangal
38. <i>P. sp.</i>	<i>Chameleon zeylanicus</i>	Hyderabad
B. <i>Proteromonas</i> in mammals		
39. <i>P. hystrixi</i> Todd, 1963	<i>Hystrix leucura</i>	Hyderabad
40. <i>P. rattusi</i> Kalavathi, Saratchandra and Sambasivarao, 1986	<i>Rattus rattus</i>	Visakhapatnam
Order RETORTAMONADIDA Family RETORTAMONADIDAE Genus <i>Retortamonas</i> Grassi, 1879		
A. <i>Retortamonas</i> in insects		
41. <i>R. blattae</i> (Bishop, 1931)	<i>Blatta orientalis</i>	Hyderabad
	<i>Corydia petiveriana</i>	Hyderabad
	<i>Cryptocercus</i> sp.	Hyderabad
	<i>Leucophaea sinninamensis</i>	Hyderabad
	<i>Periplaneta americana</i>	Hyderabad
42. <i>R. toddi</i> Bhaskar Rao, 1968	<i>Laccotrephes maculatus</i>	Hyderabad
43. <i>R. wenrichi</i> Stabler, 1944	<i>Gryllotalpa africana</i>	Hyderabad
B. <i>Retortamonas</i> in reptiles		
44. <i>R. cheloni</i> Janakidevi, 1962	<i>Geochelone elegans</i> (= <i>Testudo elegans</i>)	Hyderabad
45. <i>R. sp.</i>	<i>Varanus</i> sp.	Hyderabad
46. <i>R. sp.</i>	<i>Zamenis mucosus</i>	Hyderabad
Genus <i>Chilomastix</i> Alexeieff		
A. <i>Chilomastix</i> in amphibians		
47. <i>C. qadrii</i> Krishnamurthy, 1970	<i>Rana tigrina</i>	Hyderabad

B. <i>Chilomastix</i> in reptiles		
48. <i>C. hemidactyli</i> Bhaskar Rao <i>et al.</i> , 1976	<i>Hemidactylus</i> sp.	Warangal
49. <i>C. kudo</i> Saratchandra and Narasimhamurti, 1980	<i>Hemidactylus prashadi</i>	Visakhapatnam
50. <i>C. wenyoni</i> Janakidevi, 1961	<i>Calotes nimericola</i>	Hyderabad
51. <i>C. sp.</i>	<i>Varanus sp</i>	Hyderabad
C. <i>Chilomastix</i> in birds		
52. <i>C. graecae</i> Navarathnam, 1971	<i>Alectoris graeca</i>	Hyderabad
53. <i>C. osmaniae</i> Navarathnam, 1971	<i>Gallus gallus domesticus</i>	Hyderabad
D. <i>Chilomastix</i> in mammals		
54. <i>C. bandicooti</i> Todd, 1963	<i>Nesocia bandicota</i>	Hyderabad
55. <i>C. equi</i> Abraham, 1961	<i>Equus caballus</i>	Hyderabad
56. <i>C. hyderabadensis</i> Todd, 1963	<i>Rattus rattus frugivorus</i>	Hyderabad
57. <i>C. indica</i> Todd, 1963	<i>Gerbillus indicus</i>	Hyderabad
58. <i>C. megamorpha</i> Abraham, 1962	<i>Cavia cutleri</i>	Hyderabad
59. <i>C. nigricollisi</i> Todd, 1963	<i>Lepus nigricollis</i>	Hyderabad
60. <i>C. palmari</i> Todd, 1963	<i>Sciurus palmarum</i>	Hyderabad
Order DIPLOMONADIDA		
Suborder ENTEROMONADINA		
Family ENTEROMONADIDAE		
Genus <i>Enteromonas</i> Da Fonseca, 1915		
61. <i>E. ratti</i> Navarathnam, 1970	<i>Rattus rattus frugivorus</i>	Hyderabad
Genus <i>Caviomonas</i> Nie, 1950		
62. <i>C. frugivori</i> Navarathnam, 1970	<i>Rattus rattus frugivorus</i>	Hyderabad
Suborder DIPLOMONADINA		
Family HEXAMITIDAE		
Subfamily HEXAMITINAE		
Genus <i>Hexamita</i> Durjardin, 1841		

A. <i>Hexamita</i> in insects		
63. <i>H. gryllotalpae</i> Bhaskar Rao, 1968	<i>Gryllotalpa africana</i>	Hyderabad
64. <i>H. honigbergi</i> Bhaskar Rao, 1968	<i>Gryllotalpa africana</i>	Hyderabad
B. <i>Hexamita</i> in fishes		
65. <i>H. sp.</i>	<i>Gobius giuris</i>	Andhra Pradesh
C. <i>Hexamita</i> in amphibians		
66. <i>H. hoarei</i> Krishnamurthy, 1967	<i>Rana tigrina</i>	Hyderabad
D. <i>Hexamitus</i> in reptiles		
67. <i>H. kakatiyae</i> Bhaskar Rao, 1975	<i>Calotes versicolor</i>	Warangal
68. <i>H. sp</i>	<i>Chameleon zeylanicus</i>	Hyderabad
69. <i>H. sp.</i>	<i>Varanus sp.</i>	Hyderabad
E. <i>Hexamita</i> in birds		
70. <i>H. singhi</i> Navarathnam, 1970	<i>Anas sp.</i>	Hyderabad
F. <i>Hexamita</i> in mammals		
71. <i>H. nesocium</i> Todd, 1963	<i>Nesocia (=Nesokia) bandicota</i>	Hyderabad
72. <i>H. pigmentatus</i> Todd, 1963	<i>Rattus rattus frugivorous</i>	Hyderabad
73. <i>H. spinulus</i> Todd, 1963	<i>Gerbillus indicus</i>	Hyderabad
Subfamily GIARDIINAE Genus <i>Giardia</i> Kunstler, 1882		
74. <i>G. dasi</i> Abraham, 1962	<i>Paradoxurus hermaphroditus hermaphroditus</i>	Hyderabad
75. <i>G. indica</i> Saratchandra, Sambasiva Rao and Kalavathi, 1982	<i>Rattus rattus</i>	Visakhapatnam
76. <i>G. intestinalis</i> (Lambl, 1859)	<i>Homo sapiens</i>	All districts
77. <i>G. qadrii</i> Navarathnam, 1969	<i>Capra hircus</i>	Hyderabad
78. <i>G. wenyoni</i> Abraham, 1962	<i>Loris tardigradus lydekkerianus</i>	Andhra Pradesh (Eastern Ghats)

Genus <i>Octomitus</i> Prowazek, 1904		
79. <i>O. rattusi</i> Saratchandra, Sambasiva Rao and Kalavathi, 1982	<i>Rattus rattus</i>	Visakhapatnam
Order OXYMONADIDA Family POLYMASTIGIDAE Genus <i>Polymastix</i> , Butschli, 1884		
80. <i>P. periplanetae</i> Qadri and Bhaskar Rao, 1963	<i>Periplaneta americana</i>	Hyderabad
Genus <i>Monocercomonoides</i> Travis, 1932		
A. <i>Monocercomonoides</i> in insects		
81. <i>M. ganapatii</i> Bhaskar Rao, 1969	<i>Gryllotalpa africana</i>	Andhra Pradesh
82. <i>M. garnhami</i> Bhaskar Rao, 1969	<i>Periplaneta americana</i>	Andhra Pradesh
83. <i>M. qadrii</i> Bhaskar Rao, 1969	<i>Oryctes rhinoceros</i>	Andhra Pradesh
B. <i>Monocercomonoides</i> in reptiles		
84. <i>M. filamentum</i> Janakidevi, 1962	<i>Geochelone elegans</i>	Hyderabad
85. <i>M. singhi</i> Krishnamurthy, 1967	<i>Chameleon zeylanicus</i>	Hyderabad
C. <i>Monocercomonoides</i> in mammals		
86. <i>M. indica</i> Navarathnam, 1970	<i>Gerbillus indicus</i>	Hyderabad
87. <i>M. lepusi</i> Todd, 1963	<i>Lepus nigricollis</i>	Hyderabad
88. <i>M. sayeedi</i> Abraham, 1961	<i>Capra hircus</i>	Hyderabad
89. <i>M. shortti</i> Navarathnam, 1970	<i>Rattus rattus frugivorus</i>	Hyderabad
Superorder PARABASALIDEA Order TRICHOMONADIDA Family MASTIGAMOEBIDAE Genus <i>Dientamoeba</i> Jepps and Dobell, 1918		
90. <i>D. dobelli</i> Bhaskar Rao, 1970	<i>Oryctes rhinoceros</i>	Hyderabad
Family MONOCERCOMONADIDAE Subfamily MONOCERCOMONADINAE Genus <i>Monocercomonas</i> Grassi, 1879		

A. <i>Monocercomonas</i> in insects		
91. <i>M. corydiae</i> Bhaskar Rao, 1970	<i>Corydia petiveriana</i>	Andhra Pradesh
92. <i>M. laccotrephis</i> Bhaskar Rao, 1970	<i>Laccotrephis maculatus</i>	Hyderabad
93. <i>M. leucophaeae</i> Bhaskar Rao, 1970	<i>Leucophaea sinninamensis</i>	Andhra Pradesh
94. <i>M. osmaniae</i> Bhaskar Rao, 1970	<i>Cryptocercus</i> sp.	Andhra Pradesh
B. <i>Monocercomonas</i> in reptiles		
95. <i>M. calotesi</i> Saratchandra, 1979	<i>Calotes versicolor</i>	Visakhapatnam
96. <i>M. colubrorum</i> (Hammerschmidt, 1844)	<i>Zamenis mucosus</i>	Hyderabad
97. <i>M. eryxi</i> Krishnamurthy, 1968	<i>Eryx johnii</i>	Hyderabad
98. <i>M. ganapatii</i> Saratchandra and Narasimhamurti, 1982	<i>Hemidactylus prashadi</i>	Visakhapatnam
99. <i>M. garnhami</i> Krishnamurthy, 1968	<i>Lycodon aulicus</i>	Hyderabad
100. <i>M. gopali</i> Krishnamurthy, 1967	<i>Dryophis mycterizans</i>	Hyderabad
101. <i>M. kakatiyae</i> Dayakar <i>et al.</i> , 1978	<i>Varanus indica</i>	Warangal
102. <i>M. prashadi</i> Saratchandra, 1981	<i>Hemidactylus prashadi</i>	Visakhapatnam
103. <i>M. rayi</i> Saratchandra and Narasimhamurti, 1982	<i>Hemidactylus prashadi</i>	Visakhapatnam
104. <i>M. srikakulamensis</i> Saratchandra and Narasimhamurti, 1979	<i>Calotes versicolor</i>	Srikakulam
105. <i>M. varani</i> Krishnamurthy, 1968	<i>Varanus</i> sp.	Hyderabad
106. <i>M. waltirensis</i> Narasimhamurti and Saratchandra, 1980	<i>Hemidactylus prashadi</i>	Visakhapatnam
107. <i>M. sp.</i>	<i>Hemidactylus giganteus</i>	Hyderabad
108. <i>M. sp.</i>	<i>Varanus</i> sp.	Hyderabad

C. <i>Monocercomonas</i> in birds		
109. <i>M. anasae</i> Navarathnam, 1971	<i>Anas</i> sp.	Andhra Pradesh
110. <i>M. qudrii</i> Navarathnam, 1971	<i>Gallus gallus domesticus</i>	Andhra Pradesh
D. <i>Monocercomonas</i> in mammals		
111. <i>M. andhrae</i> Kalavathi, Saratchandra and Sambariva Rao, 1983	<i>Rattus rattus</i>	Visakhapatnam
112. <i>M. cutleri</i> Navarathnam, 1971	<i>Cavia cutleri</i>	Hyderabad
113. <i>M. gerbilli</i> Todd, 1963	<i>Gerbillus indicus</i>	Hyderabad
114. <i>M. hoare</i> Navarathnam, 1970	<i>Rattus rattus frugivorus</i>	Hyderabad
115. <i>M. lori</i> Abraham, 1962	<i>Loris tardigradus lydekkerianus</i>	Andhra Pradesh Eastern Ghats
Genus <i>Hexamastix</i> Alexeieff 1912		
A. <i>Hexamastix</i> in insects		
116. <i>H. periplanetae</i> Bhaskar Rao, 1970	<i>Periplaneta americana</i>	Andhra Pradesh
117. <i>H. singhi</i> Bhaskar Rao, 1970	<i>Gryllotalpa afriacana</i>	Andhra Pradesh
B. <i>Hexamastix</i> in reptiles		
118. <i>H. dobelli</i> Janakidevi, 1961	<i>Testudo elegans</i>	Hyderabad
C. <i>Hexamastix</i> in mammals		
119. <i>H. gerbilli</i> Navarathnam, 1970	<i>Gerbillus indicus</i>	Hyderabad
120. <i>H. gopali</i> Navarathnam, 1970	<i>Rattus rattus frugivorus</i>	Hyderabad
121. <i>H. hyderabadensis</i> Navarathnam, 1971	<i>Cavia cutleri</i>	Hyderabad
122. <i>H. sciuri</i> Todd, 1963	<i>Sciurus palmorum</i>	Hyderabad
123. <i>H. spheroides</i> Todd, 1963	<i>Nesocia bandicota</i>	Hyderabad
Subfamily HYPOTRICHOMONADINAE		
Genus <i>Hypotrichomonas</i> Lee, 1960		
A. <i>Hypotrichomonas</i> in reptiles		
124. <i>H. hemidactyli</i> Bhaskar Rao et al., 1976	<i>Hemidactylus</i> sp.	Warangal

125. <i>H. osmaniae</i> Krishnamurthy, 1967	<i>Varanus</i> sp.	Hyderabad
126. <i>H. venkataramiahii</i> Dayakar et al., 1977	<i>Varanus</i> sp.	Warangal
B. <i>Hypotrichomonas</i> in birds		
127. <i>H. avium</i> Navarathnam, 1970	<i>Cryptoplectron erythrorhynchum</i>	Hyderabad
Family TRICHOMONADIDAE Subfamily TRICHOMONADINAE Genus <i>Trichomonas</i> Donne, 1836		
A. <i>Trichomonas</i> in birds		
128. <i>T. bramae</i> Sambasivarao and Narasimhamurti, 1982	<i>Athene brama</i>	Visakhapatnam
129. <i>Trichomonas gallinae</i> Rivolta, 1878	<i>Budgerigars</i> (= Love bird)	Hyderabad
130. <i>T. sp.</i>	<i>Budgerigars</i>	Hyderabad
B. <i>Trichomonas</i> in mammals		
131. <i>T. caballi</i> Abraham, 1961	<i>Equus caballus</i>	Hyderabad
132. <i>T. frugivori</i> , Todd, 1963	<i>Rattus rattus frugivorous</i>	Hyderabad
133. <i>T. leucuri</i> Todd, 1963	<i>Hystrix leucura</i>	Hyderabad
134. <i>T. singhi</i> Todd, 1963	<i>Gerbillus indicus</i>	Hyderabad
Genus <i>Trichomitus</i> Swezy, 1915 (Syn. <i>Tritrichomonas</i>)		
A. <i>Trichomitus</i> in insects		
135. <i>T. corydiae</i> Bhaskar Rao and Todd, 1968	<i>Corydia petiveriana</i>	Hyderabad
B. <i>Trichomitus</i> in amphibians and reptiles		
136. <i>T. batrachorum</i> (Perty, 1852) Honigberg, 1968	<i>Eryx johnii</i> <i>Varanus</i> sp.	Hyderabad Hyderabad
137. <i>T. hyderabadensis</i> Krishnamurthy, 1968	<i>Rana tigrina</i>	Hyderabad
138. <i>T. sp.</i>	<i>Chameleon zeylanicus</i>	Hyderabad

<i>C. Trichomitus</i> in mammals		
139. <i>T. honigbergi</i> Navarathnam, 1971	<i>Cavia cutleri</i>	Hyderabad
Genus <i>Tetratrichomonas</i> Parisi, 1910		
140. <i>T. garnhami</i> Navarathnam, 1971	<i>Coturnix coturnix</i>	Andhra Pradesh
Genus <i>Pentatrichomonas</i> Mesnil, 1914		
A. <i>Pentatrichomonas</i> in birds		
141. <i>P. capellae</i> Navarathnam, 1970	<i>Capella gallinago</i>	Hyderabad
142. <i>P. centropi</i> Navarathnam, 1970	<i>Centropus sinensis</i>	Hyderabad
B. <i>Pentatrichomonas</i> in mammals		
143. <i>P. smithi</i> Navarathnam, 1970	<i>Herpestes smithi</i>	Hyderabad
144. <i>P. tardigradi</i> Navarathnam, 1970	<i>Loris tardigradus</i>	Hyderabad
145. <i>P. vulpi</i> Todd, 1963	<i>Vulpes bengalensis</i>	Hyderabad
Subfamily TRITRICHOMONADINAE		
Genus <i>Tritrichomonas</i> Kofoid, 1920		
A. <i>Tritrichomonas</i> in reptiles		
146. <i>T. lissemyi</i> Janakidevi, 1961	<i>Lissemys punctata granosa</i>	Hyderabad
B. <i>Tritrichomonas</i> in Birds		
147. <i>T. gigantea</i> Navarathnam, 1970	<i>Coturnix coturnix</i>	Hyderabad
Incertae sedis		
Family ?		
Genus <i>Rhizomastix</i> Alexeieff, 1911		
A. <i>Rhizomastix</i> in insects		
148. <i>R. gryllotalpae</i> Bhaskar Rao, 1970	<i>Gryllotalpa africana</i>	Hyderabad
149. <i>R. periplanetae</i> Bhaskar Rao, 1963	<i>Periplaneta americana</i>	Hyderabad

B. <i>Rhizomastix</i> in amphibians		
150. <i>R. ranae</i> Krishnamurthy, 1969	<i>Rana tigrina</i>	Hyderabad
Genus <i>Spheromonas</i> Liebetanz, 1910		
151. <i>S. anteronucleatus</i> Todd, 1963	<i>Lepus nigricollis</i>	Hyderabad
Subphylum	OPALINATA	
Class	OPALINATEA	
Order	OPALINIDA	
Family	OPALINIDAE	
Genus <i>Cepedea</i> Metcalf, 1920		
152. <i>C. hylae</i> Khan, 1962	<i>Hyla arborea</i>	Medak
Subphylum	SARCODINA	
Class	LOBOSEA	
Subclass	GYMNAMOEBIA	
Order	AMOEBIDA	
Suborder	TUBULINA	
Family	ENDAMOEBIDAE	
Genus <i>Entamoeba</i> Casagrandi and Barbagallo (1895)		
153. <i>E. histolytica</i> Schaudinn, 1903	<i>Homo sapiens</i>	All districts
Suborder	FLABELLINA	
Family	?	
Genus <i>Rosculus</i> Hawes, 1963		
A. <i>Rosculus</i> in crustaceans		
154. <i>R. macrobrachii</i> Aravindan Kalavati and Sheeja	<i>Macrobrachium rosinbergii</i>	Visakhapatnam
B. <i>Rosculus</i> in reptiles		
155. <i>R. tropidonoti</i> Kalavati and Lakshminarayana, 1982	<i>Tropidonotus piscatar</i>	Krishna
<i>Incertae sedis</i>		
Genus <i>Malomoeba</i> Taylor and King, 1937		
156. <i>M. indica</i> Narasimhamurti and Ahmed, 1980	<i>Poecilocera picta</i>	Visakhapatnam
Phylum	APICOMPLEXA	
Class	SPOROZOEAE	
Subclass	GREGARINIA	

Order EUGREGARINIDA Suborder ASEPTATINA Family MONOCYSTIDAE Subfamily MONOCYSTINAE Genus <i>Monocystis</i> Stein, 1848		
157. <i>M. odontotermitis</i> Kalavati, 1979	<i>Odontotermes obesus</i>	Visakhapatnam
158. <i>M. pontodrilli</i> Subba Rao, Kalavati and Narasimhamurti, 1978	<i>Pontodrilus bermudensis</i>	Visakhapatnam
Subfamily STOMATOPHORINAE Genus <i>Chakravartiella</i> Misra and Raychaudhury, 1973		
159. <i>C. krishnamurthyi</i> Sailaja, 1995	<i>Thyropagus</i> sp.	Visakhapatnam
Family DIPLOCYSTIDAE Genus <i>Diplocystis</i> Kunstler, 1887		
160. <i>D. horni</i> Kalavati, 1977	<i>Odontotermes horni</i>	Visakhapatnam, Vizianagaram and East Godavari
Suborder SEPTATINA Superfamily GREGARINICAE Family CEPHALOIDOPHORIDAE Genus <i>Caridohabitans</i> Ball, 1959		
161. <i>C. macrobrachii</i> Kalavati and Aravindan, 1998	<i>Macrobrachium rosenbergi</i>	Visakhapatnam and East Godavari
Family CEPHALOLOBIDAE Genus <i>Cephalolobus</i> Kruse, 1959		
162. <i>C. andhrae</i> Kalavati and Aravindan, 1998	<i>Penaeus indicus</i>	East Godavari
Family URADIOPHORIDAE Genus <i>Heliospora</i> Goodrich, 1949		
163. <i>H. sp.</i>	<i>Caridina laevis</i>	Visakhapatnam ...
Family GREGARINIDAE Genus <i>Gregarina</i> Dufour, 1866		
164. <i>G. crescentica</i> Halдар and Chakravarty, 1978	<i>Raphidopalpa stevensi</i>	Visakhapatnam

165. <i>G. macrotermis</i> Kalavati and Narasimhamurti, 1978	<i>Macrotermes estherae</i>	Visakhapatnam and Krishna
166. <i>G. poeciloceri</i> Ganapati and Mrytyumjaya Devi, 1954	<i>Poecilocerus pictus</i>	Visakhapatnam and Guntur
Genus <i>Anisolobus</i> Vincent, 1924		
167. <i>A. triboli</i> n. sp.	<i>Tribolium ferruginum</i>	Visakhapatnam
Family METAMERIDAE		
Genus <i>Gopaliella</i> Ganapati, Kalavati and Sundaram, 1974		
168. <i>G. marphysae</i> Ganapati, Kalavati and Sundaram, 1974	<i>Marphysa graveleyi</i>	Visakhapatnam
Family DIDYMOPHYIDAE		
Genus <i>Didymophyes</i> Stein, 1848		
169. <i>D. penaei</i> Kalavati and Aravindan, 1998	<i>Penaeus monodon</i>	Visakhapatnam
Genus <i>Liposcelis</i> Sarkar and Halder, 1980		
170. <i>L. dytiscusi</i> Kalavati and Prasada Rao, 1995	<i>Dytiscus</i> sp.	Visakhapatnam
Family HIRMOCYSTIDAE		
Genus <i>Retractocephalus</i> Halder and Chakraborty, 1976		
171. <i>R. corcyrae</i> n. sp.	<i>Corcyra cephalanica</i>	Visakhapatnam
172. <i>R. melanopli</i> Kalavati and Krishnamurthy, 1989	<i>Melanoplus</i> sp.	Visakhapatnam
173. <i>R. waltirensis</i> Rajakumari and Narasimhamurti, 1984	<i>Raphidopalpa stevensi</i>	Visakhapatnam
Superfamily STENOPHORICAE		
Family STENOPHORIDAE		
Genus <i>Hyalosporina</i> Chakraborty, 1935		
174. <i>H. froilanoi</i> Karandikar and Rodgi, 1955	<i>Chondromorpha keelarti</i>	Visakhapatnam
Genus <i>Stenophora</i> Labbe, 1899		
175. <i>S. thyrogluti</i> Ganapati and Narasimhamurti, 1962	<i>Thyroglutus</i> sp.	Visakhapatnam

176. <i>S. xenoboli</i> Ganapati and Narasimhamurti, 1956	<i>Xenobolus</i> sp.	Visakhapatnam
177. <i>S.</i> sp. 1	<i>Strongylosoma contortipes</i>	Visakhapatnam
178. <i>S.</i> sp. 2	<i>Strongylosoma contortipes</i>	Visakhapatnam
179. <i>S.</i> sp. 3	<i>Strongylosoma contortipes</i>	Visakhapatnam
Family MONODUCTIDAE Genus <i>Monoductus</i> Ray and Chakravarty, 1933		
180. <i>M. lunatus</i> Ray and Chakravarty, 1933	<i>Strongylosoma contortipes</i>	Visakhapatnam
Family SPHAEROCYSTIDAE Genus <i>Sphaerocystis</i> Leger, 1892		
181. <i>S. odontotermis</i> Kalavati and Narasimhamurti, 1979	<i>Odontotermes</i> sp.	Visakhapatnam, Vizianagaram and East Godavari
Family DACTYLOPHORIDAE Genus <i>Grebneckiella</i> Bhatia, 1938		
182. <i>G. pixellae</i> Misra, 1942	<i>Scolopendra morsitans</i>	Visakhapatnam
Genus <i>Dendrorhynchus</i> Keilin, 1920		
183. <i>D. keilini</i> Nazeer Ahmed and Narasimhamurti, 1979	<i>Ceriagrion coromandelianum</i>	Visakhapatnam
Genus <i>Mecistophora</i> Ganapati and Narasimhamurti, 1960		
184. <i>M. legeri</i> Ganapati and Narasimhamurti, 1960	<i>Mecistocephalus punctifrons</i>	Visakhapatnam
Family STYLOCEPHALIDAE Genus <i>Cystocephalus</i> Schneider, 1886		
185. <i>C. gonocephali</i> n. sp.	<i>Gonocephalum arenarium</i>	Visakhapatnam
Genus <i>Stylocephalus</i> Ellis, 1912		
186. <i>S. gonocephali</i> Bhusana Rao, 1962	<i>Gonocephalum arenarium</i> <i>Gonocephalum brachyelytra</i>	Visakhapatnam Visakhapatnam
187. <i>S. serpentula</i> Devdhar and Amoji, 1977	<i>Gonocephalum arenarium</i>	Visakhapatnam
188. <i>S.</i> sp	<i>Gonocephalum arenarium</i>	Visakhapatnam

Genus <i>Xiphicephalus</i> Corbel, 1971		
189. <i>X. rhytinotus</i> n. sp.	<i>Rhytinota</i> sp.	Visakhapatnam
Family ACTINOCEPHALIDAE		
Subfamily ACTINOCEPHALINAE		
Genus <i>Actinocephalus</i> Stein, 1848		
190. <i>A. bradinopygi</i> Narasimhamurti and Nazeer Ahmed, 1980	<i>Bradinopyga geminata</i>	Visakhapatnam
Genus <i>Anthorhynchus</i> Labbe, 1887		
191. <i>A. hanumanthi</i> Kalavati and Narasimhamurti, 1978	<i>Odontotermes</i> sp.	Visakhapatnam
Genus <i>Acanthogregarina</i> Kalavati, Narasimhamurti and Vidyullatha Devi, 1988		
192. <i>A. hoshidei</i> Kalavati, Narasimhamurti and Vidyullatha Devi, 1988	<i>Leiogryllus</i> sp.	Visakhapatnam
Genus <i>Harendraia</i> Sarkar, 1984		
193. <i>H. murtii</i> n. sp.	<i>Gallerucida bicolor</i>	Visakhapatnam
Genus <i>Steinina</i> Leger and Duboscq, 1904		
194. <i>S. coptotermis</i> Kalavati and Narasimhamurti, 1978 (Syn. <i>S. coptotermi</i>)	<i>Coptotermes heimi</i>	Visakhapatnam
195. <i>S. rodgii</i> Patil and Amoji, 1986	<i>Heliocorpis</i> sp.	Visakhapatnam
Subfamily ACANTHOSPORINAE		
Genus <i>Ancyrophora</i> Leger, 1892		
196. <i>A. ceriagrioni</i> Nazeer Ahmed and Narasimhamurti, 1979	<i>Ceriagrion coromandelianum</i>	Visakhapatnam
Subclass COCCIDIA		
Order EUCOCCIDIIDA		
Suborder ADELEINA		
Family ADELEIDAE		
Genus <i>Adelea</i> Schneider, 1885		
197. <i>A. hyalospora</i> Narasimhamurti, 1960	<i>Rhysida longipes</i>	Visakhapatnam

Genus <i>Adelina</i> Hesse, 1910		
198. <i>A. dimidiata</i> (Schneider, 1885)	<i>Rhysida longipes</i>	Visakhapatnam
199. <i>A. rayi</i> Narasimhamurti, 1977	<i>Rhysida longipes</i>	Visakhapatnam
Genus <i>Chagasella</i> Machado, 1911		
200. <i>C. ganapatii</i> Narasimhamurti and Kalavati, 1968	<i>Odontotermes obesus</i>	Visakhapatnam
Genus <i>Ganapatiella</i> Kalavati, 1977		
201. <i>G. odontotermis</i> Kalavati, 1977 (Syn. <i>G. odontotermi</i>)	<i>Odontotermes obesus</i>	Visakhapatnam
Family HAEMOGREGARINIDAE		
Genus <i>Haemogregarina</i> Danilewsky, 1885		
202. <i>H. ganapatii</i> Saratchandra, 1981	<i>Lissemys punctata granosa</i>	Visakhapatnam
203. <i>H. mirabilis</i> Castallani and Willey, 1904	<i>Ptyas mucosus</i> (Syn. <i>Zamenis mucosus</i>)	Krishna
204. <i>H. waltirensis</i> Saratchandra, 1981	<i>Calotes versicolor</i>	Visakhapatnam
Genus <i>Hepatozoon</i> Miller, 1908		
205. <i>H. canis</i> (James, 1905)	Dog	Andhra Pradesh
Suborder EIMERIINA		
Family SELENOCOCCIDIIDAE		
Genus <i>Selenococcidium</i> Leger and Duboscq, 1910		
206. <i>S. indicus</i> Aravindan, Kalavati and Sheeja, 2002	<i>Penaes indicus</i>	East Godavari
Family AGGREGATIDAE		
Genus <i>Aggregata</i> Frenzel, 1885		
207. <i>A. kudo</i> Narasimhamurti, 1979	<i>Sepia elliptica</i>	Visakhapatnam
Family EIMERIIDAE		
Genus <i>Eimeria</i> Schneider, 1875		
A. <i>Eimeria</i> of centipedes		
208. <i>E. mecistophori</i> Narasimhamurti, 1976	<i>Mecistocephalus punctifrons</i>	Visakhapatnam

B. <i>Eimeria</i> of reptiles		
209. <i>E. knowlesi</i> Bhatia, 1936	<i>Hemidactylus prashadi</i>	Visakhapatnam
C. <i>Eimeria</i> of birds		
210. <i>E. anatis</i> Scholtyseck, 1955	<i>Anas platyrhynchos</i>	Nalgonda
211. <i>E. brunetti</i> Levine, 1942	<i>Gallus</i> sp.	Warangal
212. <i>E. columbae</i> Mitra and Dasgupta, 1937	<i>Columba livia intermedia</i>	Hyderabad
213. <i>E. necatrix</i> Johnson, 1930	<i>Gallus domesticus</i>	Nalgonda
214. <i>E. tenella</i> (Railliet and Lucet, 1891)	<i>Gallus domesticus</i>	Khammam
D. <i>Eimeria</i> of mammals		
215. <i>E. arloingi</i> (Marotel, 1905)	<i>Capra hircus</i>	Nalgonda, Khammam, Warangal and Hyderabad
216. <i>E. bovis</i> (Zublin, 1908)	<i>Bubalus bubalis</i>	Nalgonda, Khammam, Warangal and Hyderabad
217. <i>E. crandallis</i> Honess, 1942	<i>Ovis aires</i>	Nalgonda, Khammam and Hyderabad
218. <i>E. debliccki</i> Douwes, 1921	<i>Sus scrofa</i>	Nalgonda, Khammam, Warangal and Hyderabad
219. <i>E. faurei</i> (Moussu and Marotel, 1902)	<i>Ovis aires</i>	Khammam
220. <i>E. ninakohlyakimovae</i> Yakimoff and Rastegaieff, 1930	<i>Capra hircus</i>	Khammam and Hyderabad
221. <i>E. tirupatiensis</i> Sivanarayan and Venkatratnam, 1969	<i>Capra hircus</i>	Chittoor
222. <i>E. zuernii</i> (Rivolta, 1878)	<i>Bos indicus</i>	Nalgonda, Khammam, Warangal and Hyderabad

Genus <i>Isospora</i> Schneider, 1881		
A. <i>Isospora</i> of birds		
223. <i>I. lacazei</i> Labbe, 1893	<i>Passer domesticus</i>	Andhra Pradesh
224. <i>I. rajulii</i> , Satyanarayanacharyulu, Subba Rao and Christopher, 1969	<i>Acridotheres t. tristis</i>	Chittoor
B. <i>Isospora</i> of mammals		
225. <i>I. bigemina</i> (Stiles, 1891)	<i>Canis</i> sp.	East Godavari
226. <i>I. felis</i> Wenyon, 1923	<i>Canis</i> sp.	East Godavari
Genus <i>Montonella</i> Vincent, 1936		
227. <i>M. macrobrachii</i> Aravindan Kalavati and Sheeja, 2002	<i>Macrobrachium rosenbergi</i>	Visakhapatnam
Suborder HAEMOSPORINA		
Family PLASMODIIDAE		
Genus <i>Plasmodium</i> Marchiafava and Celli, 1885		
A. <i>Plasmodium</i> of reptiles		
228. <i>P.</i> sp.	<i>Hemidactylus prashadi</i>	Andhra Pradesh
B. <i>Plasmodium</i> of birds		
229. <i>P. fallax</i> Schwetz, 1930	<i>Ploceus philippinus</i>	Andhra Pradesh
230. <i>P. formosam</i> Manwell, 1962	<i>Corvus splendens</i>	Andhra Pradesh
231. <i>P. garnhami</i> Guindy, Hoogstral and Mohammed, 1965	<i>Coturnix coromandelica</i>	Andhra Pradesh
232. <i>P. huffi</i> Muniz, Soares and Batista, 1951	<i>Ploceus philippinus</i>	Andhra Pradesh
233. <i>P. matuitinum</i> (Huff, 1937)	<i>Corvus splendens</i> <i>Passer domesticus</i>	Andhra Pradesh Andhra Pradesh
234. <i>P. nucleophilum</i> Manwell, 1935	<i>Corvus splendens</i> <i>Passer domesticus</i>	Andhra Pradesh Andhra Pradesh
235. <i>P. pinotti</i> Muniz and Soares, 1954	<i>Perdicula asiatica</i>	Andhra Pradesh
236. <i>P. relictum</i> (Grassi and Felletti, 1891)	<i>Corvus splendens</i> <i>Lonchura malacca</i>	Andhra Pradesh Andhra Pradesh

237. <i>P. vauhani</i> Novy and MacNeal, 1904	<i>Pterocles exustus</i> <i>Streptopelia chinensis</i>	Andhra Pradesh Andhra Pradesh
238. <i>P. venkataramiahi</i> Bhaskar Rao, Devi and Bhaskar Rao, 1977	<i>Corvus splendens</i>	Andhra Pradesh
239. <i>P. sp.</i>	<i>Passer domesticus</i>	Hyderabad
240. <i>P. sp.</i>	<i>Tringa hypoleucos</i>	Andhra Pradesh
241. <i>P. sp.</i>	<i>Athene brama</i>	Andhra Pradesh
242. <i>P. sp.</i>	<i>Dicrurus adsimilis</i>	Andhra Pradesh
243. <i>P. sp.</i>	<i>Cisticola juncidis</i>	Andhra Pradesh
C. <i>Plasmodium</i> of mammals		
244. <i>P. cynomolgi</i> Mayer, 1907	<i>Macaca radiata</i>	Hyderabad
245. <i>P. fragile</i> Dissanaik, Nelson and Garnham, 1965	<i>Macaca radiata</i>	Hyderabad
246. <i>P. inui</i> Halberstadter and von Prowazek, 1907	<i>Macaca radiata</i>	Hyderabad
247. <i>P. shortti</i> , Bray, 1963	<i>Macaca radiata</i>	Hyderabad
D. <i>Plasmodium</i> of man		
248. <i>P. falciparum</i> (Welch, 1897)	<i>Homo sapiens</i>	All districts
249. <i>P. malariae</i> (Grassi and Feletti, 1892)	<i>Homo sapiens</i>	All districts
250. <i>P. vivax</i> (Grassi and Feletti, 1890)	<i>Homo sapiens</i>	All districts
Family HAEMOPROTEIDAE Genus <i>Haemoproteus</i> Kruse, 1890		
A. <i>Haemoproteus</i> in reptiles		
251. <i>H. simondi</i> Castellani and Willey, 1904	<i>Hemidactylus</i> sp. (= <i>Hemidactylus brooki</i>)	Hyderabad
B. <i>Haemoproteus</i> in birds		
252. <i>H. borgesii</i> , Tendeiro, 1947	<i>Dendrocopos mahrattensis</i> <i>mahrattensis</i>	Adilabad
253. <i>H. columbae</i> Kruse, 1890	<i>Columba livia</i>	Hyderabad
254. <i>H. coraciae</i> de Mello and Afonso, 1935	<i>Coracias bengalensis</i>	Warangal

255. <i>H. fringillae</i> Labbe, 1894	<i>Copsychus saularis</i>	Warangal
256. <i>H. meropis</i> (Zargar, 1945)	<i>Merops orientalis</i>	Warangal
257. <i>H. orizivora</i> Anschutz, 1909	<i>Copsychus saularis</i> <i>Ploceus philippinus</i>	Warangal Adilabad
258. <i>H. passeris</i> Kruse, 1890	<i>Passer domesticus</i>	Warangal
259. <i>H. pastoris</i> de Mello, 1935	<i>Acridotheres tristis</i> <i>Sturnus pagodarum</i>	Warangal Warangal
260. <i>H. velans</i> Coatney and Roudabush, 1937	<i>Dendrocopos mahrattensis</i> <i>mahrattensis</i>	Adilabad
261. <i>H. sp.</i>	<i>Spizaetus cirrhatus cirrhatus</i>	Adilabad
262. <i>H. sp.</i>	<i>Nettapus coromandelianus</i>	Adilabad
Family LEUCOCYTOZOIDAE Genus <i>Leucocytozoon</i> Sambon, 1908		
263. <i>L. toddi</i> , Sambon, 1908	<i>Elanus caeruleus vociferus</i> <i>Spizaetus cirrhatus cirrhatus</i>	Adilabad Adilabad
264. <i>L. ziemanni</i> (Laveran, 1902)	<i>Athene brama</i>	Adilabad
Subclass PIROPLASMIA Order PIROPLASMIDA Family BABESIIDAE Genus <i>Babesia</i> Starcovici, 1893		
265. <i>B. argentina</i> Lignieres, 1901	<i>Bos sp.</i>	Chittoor
266. <i>B. bigemina</i> Smith and Kilborne, 1893	<i>Bos indicus</i>	Hyderabad
267. <i>B. sp.</i>	<i>Bos sp.</i>	Andhra Pradesh
268. <i>B. sp.</i>	<i>Manis sp.</i>	Andhra Pradesh
269. <i>B. sp.</i>	Buffalo	Andhra Pradesh
270. <i>B. sp.</i>	Sheep	Andhra Pradesh
271. <i>B. sp.</i>	Dog	Andhra Pradesh
272. <i>B. sp.</i>	Puma	Hyderabad
Family THEILERIIDAE Genus <i>Theileria</i> Bettencourt, Franca and Burgess, 1907		
273. <i>T. hirci</i> Dschunkovsky and Urodshevich, 1924	<i>Capra hircus</i>	Hyderabad

274. <i>T. sp.</i>	Cow	Andhra Pradesh
275. <i>T. sp.</i>	Sheep	Andhra Pradesh
276. <i>T. sp.</i>	Buffalo	Andhra Pradesh
<i>Incertae sedis</i> to Order Piroplasmida		
Genus <i>Anaplasma</i> Theiler, 1910		
277. <i>A. marginale</i> Theiler, 1910	Sheep	Ranga Reddy
278. <i>A. sp.</i>	Cattle	Andhra Pradesh
Phylum MICROSPORA		
Class DIHAPLOPHASEA		
Order MEIODIHAPLOPHASIDA		
Superfamily THELOHANOIDEA		
Family THELOHANIDAE		
Genus <i>Thelohania</i> Henneguy, 1892		
279. <i>T. limbata</i> Narsimhamurti, Nazeer Ahmed and Kalavati, 1980	<i>Tramea limbata</i>	Visakhapatnam
280. <i>T. orchestii</i> Kalavati, 1976	<i>Orchestia platensis</i>	Visakhapatnam
Genus <i>Toxoglugea</i> Leger and Hesse, 1924		
281. <i>Toxoglugea tillargi</i> Kalavati and Narasimhamurti, 1978	<i>Tholymis tillarga</i>	Visakhapatnam
Family DUBOSCQIIDAE		
Genus <i>Duboscqia</i> Perez, 1908		
282. <i>Duboscqia coptotermi</i> Kalavati and Narasimhamurti, 1976	<i>Coptotermes heimi</i>	Visakhapatnam
Superfamily BURENELLOIDEA		
Family BURENELLIDAE		
Genus <i>Burenella</i> Jouvenaz and Hazard, 1978		
283. <i>B. sp.</i>	<i>Saurida tumbil</i>	Visakhapatnam
Order DISSOCIODIHAPLOPHASEA		
Superfamily NOSEMATOIDEA		
Family NOSEMATIDAE		
Genus <i>Nosema</i> Nageli, 1857		
284. <i>N. bengalis</i> Weiser, Kalavati and Sandeep, 1981	<i>Nemipterus japonicus</i>	Visakhapatnam

285. <i>N. gigantea</i> Canning and Madhavi, 1977	<i>Allocreadium fasciatusi</i>	Visakhapatnam
286. <i>N. limbata</i> Narasimhamurti, Nazeer Ahmed and Kalavati, 1980	<i>Tramea limbata</i>	Visakhapatnam
287. <i>N. priacanthi</i> Sandeep and Kalavati, 1985	<i>Priacanthus boops</i>	Visakhapatnam
288. <i>N. valamugili</i> Kalavati and Lakshinarayana, 1982	<i>Valamugil</i> sp.	Visakhapatnam
289. <i>N. sp.</i>	<i>Megalaspis cordyla</i>	Visakhapatnam
Family CAUDOSPORIDAE Genus <i>Octosporea</i> Flu, 1911		
290. <i>Octosporea porcelliolus</i> Kalavati and Narasimhamurti, 1976 emend. Sprague and Vavra, 1977	<i>Porcellio laevus</i>	Visakhapatnam
Family PSEUDOPLEISTOPHORIDAE Genus <i>Steinhausia</i> Sprague, Ormieres and Mainer, 1972		
291. <i>Steinhausia spraguei</i> Kalavati and Narasimhamurti, 1977	<i>Sepia elliptica</i>	Visakhapatnam
Family MRAZEKIIDAE Genus <i>Mrazekia</i> Leger and Hesse, 1916		
292. <i>M. caudata</i> Naidu, 1959	<i>Nais communis</i> <i>Pristina longiseta longiseta</i>	Cuddapah Cuddapah
Class HAPLOPHASEA Order GLUGEIDA Family GLUGEIDAE Genus <i>Glugea</i> Thelohan, 1892		
293. <i>G. malabaracii</i> Narasimhamurti, Kalavati and Sandeep, 1985	<i>Carangoides malabaricus</i>	Visakhapatnam
294. <i>G. nemipteri</i> Weiser, Kalavati and Sandeep, 1981	<i>Nemipterus japonicus</i>	Visakhapatnam
295. <i>G. sp.</i>	<i>Carangoides malabaricus</i>	Visakhapatnam
Genus <i>Loma</i> Morrison and Sprague, 1981		
296. <i>L. trichuri</i> Sandeep and Kalavati, 1985	<i>Trichiurus savala</i>	Visakhapatnam

297. <i>L. sp. I</i>	<i>Tricopterus sp.</i>	Krishna
298. <i>L. sp. II</i>	Sciaenid fish	Krishna
Family PLEISTOPHORIDAE Genus <i>Pleistophora</i> Gurley, 1893 (Syn. <i>Plistophora</i>)		
299. <i>P. atretii</i> Narasimhamurti, Kalavati and Nazeer Ahmed, 1982	<i>Atretium schistosum</i>	Krishna
300. <i>P. blatellae</i> Narasimhamurti and Kalavati, 1977	<i>Blatella germanica</i>	Visakhapatnam
301. <i>P. carangoidi</i> Narasimhamurti and Sonabai, 1977	<i>Carangoides malabaricus</i>	Visakhapatnam
302. <i>P. eretesi</i> Kalavati and Narasimhamurti, 1976	<i>Eretes stictus</i>	Visakhapatnam
303. <i>P. ganapatii</i> Kalavati, 1976	<i>Odontotermes horni</i>	Visakhapatnam
304. <i>P. sauridae</i> Narasimhamurti and Kalavati, 1972	<i>Saurida tumbil</i>	Visakhapatnam
305. <i>P. waltirensis</i> Kalavati and Ganapati, 1971	<i>Euborellia plebeja</i>	Visakhapatnam
306. <i>P. weiseri</i> Kalavati, 1976	<i>Coptotermes heimi</i>	Visakhapatnam
307. <i>P. sp.</i>	<i>Dussumeria acuta</i>	Visakhapatnam
Family UNIKARYONIDAE Genus <i>Unikaryon</i> Canning, Lai and Lie, 1974		
308. <i>U. allocreadii</i> Canning and Madhavi, 1977	<i>Allocreadium fasciatusi</i>	Visakhapatnam
<i>Incertae sedis</i> Family GURLEYIDAE Genus <i>Gurleya</i> Doflein, 1898		
309. <i>G. spraguei</i> Kalavati, 1976	<i>Macrotermes estharae</i>	Visakhapatnam
Family ? Genus <i>Stempellia</i> Leger and Hesse, 1910		
310. <i>S. odontotermi</i> Kalavati, 1976	<i>Odontotermes sp.</i>	Visakhapatnam
Genus <i>Microsporidium</i>		
311. <i>M. sauridae</i> (Narasimhamurti and Kalavati, 1972)	<i>Saurida tumbil</i>	Visakhapatnam

Phylum ASCETOSPORA Class HAPLOSPOREA Order MEIDIHAPLOPHASIDA Family COELOSPORIDAE Genus <i>Coelosporidium</i> Mesnil and Merchoux, 1892		
312. <i>C. schmackeriae</i> Ganapati, Shantakumari and Narasimhamurti, 1964	<i>Schmackeria serricaudata</i>	Visakhapatnam
313. <i>C. oithonae</i> Narasimhamurti and Kalavati, 1976	<i>Oithona rigida</i>	Visakhapatnam
Family NEPHRIDIOPHAGIDAE Genus <i>Nephridiophaga</i> Ivanic, 1937		
314. <i>N. xenoboli</i> Ganapati and Narasimhamurti, 1960	<i>Xenobolus carnifex</i>	Visakhapatnam
Phylum MYXOZOA Class MYXOSPOREA Order BIVALVULIDA Suborder VARIISPORINA Family MYXIDIIDAE Genus <i>Myxidium</i> Butschli, 1882		
315. <i>M. aori</i> Lalitha Kumari, 1969	<i>Macrones aor</i>	Hyderabad, Warangal
316. <i>M. papernae</i> Padma Dorothy and Kalavati, 1992	<i>Liza macrolepis</i>	Visakhapatnam
Genus <i>Zschokkella</i> Auerbach, 1910		
317. <i>Z. ganapatii</i> Padma Dorothy and Kalavati, 1992	<i>Liza macrolepis</i>	Visakhapatnam
318. <i>Z. labeonis</i> Lalitha Kumari, 1969	<i>Labeo nigripinnis</i>	Hyderabad
319. <i>Z. ophicephali</i> Lalitha Kumari, 1969	<i>Channa</i> (= <i>Ophicephalus</i>) <i>striatus</i>	Hyderabad and Visakhapatnam
320. <i>Z. sp.</i>	<i>Heteropreustes</i> (= <i>Saccobranchus</i>) <i>fossilis</i>	Hyderabad

Genus <i>Paraschokkella</i> Kalavati and Narasimhamurti, 1987		
321. <i>P. melanosticti</i> Kalavati and Narasimhamurti, 1987	<i>Bufo melanostictus</i>	Krishna, Visakhapatnam, Vizianagaram
Family ORTHOLINEIDAE Genus <i>Ortholinea</i> Schulman, 1962		
322. <i>O. visakhapatnamensis</i> Padma Dorothy and Kalavati, 1993	<i>Liza macrolepis</i>	Visakhapatnam
Family SINUOLINEIDAE Genus <i>Davisia</i> Laird, 1953		
323. <i>D. cynoglossi</i> Narasimhamurti, Kalavati, Anuradha and Padma Dorothy, 1990	<i>Cynoglossus</i> sp.	Krishna
324. <i>D. filiformis</i> Padma Dorothy, Kalavati and Vaidehi, 1998	<i>Thrissocles setirostris</i>	Visakhapatnam
325. <i>D. murtii</i> Padma Dorothy and Kalavati, 1994	<i>Liza macrolepis</i>	Visakhapatnam
Genus <i>Bipteria</i> Koveleva, Zubchenco and Krasin, 1983		
326. <i>B. indica</i> Kalavati and Anuradha, 1995	<i>Mugil cephalus</i> <i>Liza macrolepis</i>	Visakhapatnam Visakhapatnam
Genus <i>Neobipteria</i> Koveleva, Zubchenco and Krasin, 1983		
327. <i>N. coramandelensis</i> Narasimhamurti, Kalavati, Anuradha and Padma Dorothy, 1990	<i>Nemipterus mesoprion</i>	Krishna
Family CERATOMYXIDAE Genus <i>Leptotheca</i> Thelohan, 1895		
328. <i>L. asymmetrica</i> Lalitha Kumari, 1969	<i>Osteochilus neilli</i>	Hyderabad
Genus <i>Ceratomyxa</i> Thelohan, 1892		
329. <i>C. dissimilaris</i> Narasimhamurti, Kalavati, Anuradha and Padma Dorothy, 1990	<i>Nemipterus mesoprion</i>	Srikakulam
330. <i>C. kudoii</i> Kalavati and Anuradha, 1993	<i>Valamugil cunnesius</i>	Visakhapatnam

331. <i>C. sagarsampadae</i> Narasimhamurti, Kalavati. Anuradha and Padma Dorothy, 1990	<i>Cynoglossus</i> sp.	Krishna
332. <i>C. thrissoclesi</i> Padma Dorothy, Kalavati and Vaidehi, 1998	<i>Thrissocles muystasc</i>	Visakhapatnam
Family SPHAEROSPORIDAE Genus <i>Sphaerospora</i> Thelohan, 1892		
333. <i>S. mayi</i> Moser, Kent and Dennis, 1989	<i>Mugil cephalus</i>	Visakhapatnam
Genus <i>Palliatius</i> Schulman, Koveleva and Dubina, 1979		
334. <i>P. indicus</i> Padma Dorothy and Kalavati, 1998	<i>Liza macrolepis</i>	Visakhapatnam
Genus <i>Myxobilatus</i> Davis, 1917		
335. <i>M. mastacembeli</i> Qadri and Lalitha Kumari, 1965	<i>Mastacembelus armatus</i>	Hyderabad
336. <i>M. sp.</i>	<i>Clarias batrachus</i>	East Godavari
Family CHLOROMYXIDAE Genus <i>Chloromyxum</i> Mingazzini, 1890		
337. <i>C. hoarei</i> Lalitha Kumari, 1969	<i>Labeo nigripinnis</i>	Hyderabad and Warangal
338. <i>C. mitchelli</i> Kalavati and Narasimhamurti, 1984	<i>Therapon jarbua</i>	Visakhapatnam
339. <i>C. tripathi</i> Kalavati and Narasimhamurti, 1984	<i>Therapon jarbua</i>	East Godavari, Srikakulam and Visakhapatnam
Family PARVICAPSULIDAE Genus <i>Parvicapsula</i> Schulman, 1953		
340. <i>P. hoffmanni</i> Padma Dorothy and Kalavati, 1993	<i>Liza macrolepis</i>	Visakhapatnam
Family AUERBACHIDAE Genus <i>Auerbachia</i> Meglitsch, 1968		
341. <i>A. chorinemusi</i> Padma Dorothy, Kalavati and Vaidehi, 1998	<i>Chorinemus</i> sp.	Visakhapatnam

Suborder PLATYSPORINA Family MYXOBOLIDAE Genus <i>Myxobolus</i> Butschli, 1882 (Syn. <i>Myxosoma</i> , <i>Gyrospora</i>)		
342. <i>M. ampullaceus</i> Lalitha Kumari, 1969	<i>Barbus kolus</i>	Hyderabad
343. <i>M. andhrae</i> (Lalitha Kumari, 1969)	<i>Channa</i> (= <i>Ophicephalus</i>) <i>punctatus</i>	Hyderabad
344. <i>M. anili</i> Sarkar, 1989	<i>Liza macrolepis</i>	Visakhapatnam
345. <i>M. bengalensis</i> Chakravarty and Basu, 1948	<i>Catla catla</i>	Guntur
346. <i>M. bivacuolatus</i> Narasimhamurti and Kalavati, 1986	<i>Clarias batrachus</i>	West Godavari
347. <i>M. channai</i> (Kalavati, Sandeep and Narasimhamurti, 1981)	<i>Channa punctata</i>	Visakhapatnam
348. <i>M. clarii</i> Chakravarty, 1943	<i>Clarias batrachus</i>	Hyderabad
349. <i>M. crucifila</i> (Qadri, 1962)	<i>Labeo fimbriatus</i>	Hyderabad
350. <i>M. episquammalis</i> Egusa, Maeno and Sorimachi, 1990	<i>Mugil cephalus</i> <i>Liza macrolepis</i>	Visakhapatnam and East Godavari
351. <i>M. esomi</i> (Kalavati and Narasimhamurti, 1984)	<i>Esomus</i> sp.	Visakhapatnam
352. <i>M. hyderabadense</i> (Lalitha Kumari, 1969)	<i>Barbus pinnauratus</i>	Hyderabad
353. <i>M. indiae</i> (Lalitha Kumari, 1969)	<i>Barbus sarana</i>	Hyderabad and Warangal
354. <i>M. koli</i> Lalitha Kumari, 1969	<i>Barbus kolus</i>	Hyderabad
355. <i>M. lizae</i> (Narasimhamurti and Kalavati, 1979)	<i>Liza macorlepis</i>	Visakhapatnam, East Godavari
356. <i>M. macrolepi</i> Padma Dorothy and Kalavati, 1992	<i>Liza macorlepis</i>	Visakhapatnam
357. <i>M. mahendrae</i> Sarkar, 1986	<i>Catla catla</i>	Guntur

358. <i>M. mugcephalus</i> (Narasimhamurti, Kalavati and Saratchandra, 1980)	<i>Mugil cephalus</i>	Visakhapatnam
359. <i>M. narasii</i> (Narasimhamurti, 1969)	<i>Mughil waigensis</i>	Visakhapatnam
360. <i>M. osmaniae</i> Lalitha Kumari, 1969	<i>Barbus punjaubensis</i>	Hyderabad
361. <i>M. pinnaurati</i> Lalitha Kumari, 1969	<i>Barbus pinnauratus</i>	Hyderabad
362. <i>M. potaili</i> Lalitha Kumari, 1969	<i>Labeo potail</i>	Hyderabad
363 <i>M. psilorhynchi</i> Lalitha Kumari, 1969	<i>Psilorhynchus balitora</i>	Hyderabad
364. <i>M. seshadrii</i> Lalitha Kumari, 1968	<i>Labeo fimbriatus</i>	Kurnool
365. <i>M. sphaeralis</i> Padma Dorothy and Kalavati, 1992	<i>Liza macrolepis</i>	Visakhapatnam
366. <i>M. spinocurvatura</i> Maeno, Sorimachi, Ogawa and Egusa, 1990	<i>Mugil cephalus</i>	Visakhapatnam
367. <i>M. tripathii</i> Kalavati Sandeep and Narasimhamurti, 1981	<i>Clarias</i> sp.	Visakhapatnam and West Godavari
368. <i>M. sp.</i>	<i>Liza macrolepis</i> <i>Mugil cephalus</i>	Visakhapatnam Visakhapatnam
Genus <i>Henneguya</i> Thelohan, 1892		
369. <i>H. ganapatiae</i> Qadri, 1970	<i>Notopterus notopterus</i>	Hyderabad
370. <i>H. jubili</i> Qadri, 1969	<i>Notopterus notopterus</i>	Hyderabad
371. <i>H. notopteriae</i> Qadri, 1965	<i>Notopterus notopterus</i>	Hyderabad
372. <i>H. qadrii</i> Lalitha Kumari, 1965	<i>Ophicephalus gachua</i>	Hyderabad
373. <i>H. singhi</i> Lalitha Kumari, 1969	<i>Notopterus osmanii</i>	Hyderabad
374. <i>H. waltairensis</i> Narasimhamurti and Kalavati 1975	<i>Channa</i> (<i>Ophicephalus</i>) <i>punctatus</i>	Visakhapatnam and Vizianagaram

Genus <i>Thelohanellus</i> Kudo, 1933		
375. <i>T. andhrae</i> Qadri 1962	<i>Labeo fimbriatus</i>	Hyderabad
376. <i>T. batae</i> Lalitha Kumari, 1969	<i>Labeo bata</i>	Hyderabad
377. <i>T. boggoti</i> Qadri, 1962	<i>Labeo boggut</i>	Hyderabad
378. <i>T. chelae</i> Lalitha Kumari, 1969	<i>Chela bacaila</i>	Hyderabad
379. <i>T. chrysopomati</i> , Lalitha Kumari, 1969	<i>Barbus chrysopoma</i>	Hyderabad
380. <i>T. potaili</i> Lalitha Kumari, 1969	<i>Labeo potail</i>	Hyderabad
381. <i>T. qadrii</i> Lalitha Kumari, 1969	<i>Labeo potail</i>	Hyderabad
382. <i>T. shortii</i> Qadri, 1967	<i>Labeo fimbriatus</i>	Hyderabad
Genus <i>Unicauda</i> Davis, 1944		
383. <i>U. andhrae</i> Kalavati and Narasimhamurti, 1981	<i>Channa (Ophicephalus) gachua</i>	Visakhapatnam
Genus <i>Phlogospora</i> Qadri, 1962		
384. <i>P. mysti</i> Qadri, 1962	<i>Mystus bleekeri</i>	Hyderabad
Order MULTIVALVULIDA		
Family KUDOIDAE		
Genus <i>Kudoa</i> Meglitsch, 1960		
385. <i>K. atropi</i> Sandeep, Kalavati and Narasimhamurti, 1986	<i>Atropus atropus</i>	Visakhapatnam
386. <i>K. sphraeni</i> Narasimhamurti and Kalavati, 1979	<i>Sphyraena jello</i>	Visakhapatnam
387. <i>K. tetraspora</i> Kalavati and Narasimhamurti, 1979	<i>Mugil cephalus</i>	Visakhapatnam
388. <i>K. valamugili</i> Kalavati and Anuradha, 1993	<i>Valamugil cunnessius</i>	Visakhapatnam
Class ACTINOSPOREA		
Subclass ACTINOMYXEA		
Order ACTINOMYXIDA		
Family ACTINOMYXIDAE		
Genus <i>Triactinomyxon</i> Stolc, 1899		
389. <i>T. naidanum</i> Naidu, 1956	<i>Nais communis punjabensis</i>	Cuddapah
390. <i>T. sp.</i>	<i>Pristina longiseta</i>	Cuddapah

Phylum CILIOPHORA Class KINETOFRAGMINIPHOREA Order TRICHOSTOMATIDA Family BALANTIDAE Genus <i>Balantidium</i> Claparede and Lachman, 1858		
391. <i>B. caprae</i> Abraham, 1962	<i>Capra hircus</i>	Hyderabad
392. <i>B. coli</i> (Malmsten, 1857)	<i>Bubalus bubalis</i>	Cuddapah
393. <i>B. duodeni</i> Stein, 1867	<i>Rana tigrina</i>	Vizianagaram
394. <i>B. elongatum</i> Stein, 1867	<i>Rana breviceps</i>	Nellore
395. <i>B. helenae</i> Bezzenberger, 1904	<i>Rana limnocharis</i>	Visakhapatnam
396. <i>B. indicum</i> Abraham, 1962	<i>Bos indicus</i>	Hyderabad
397. <i>B. osmaniae</i> Qadri and Navarathnam, 1966	<i>Macaca radiata</i>	Andhra Pradesh
398. <i>B. rhacophori</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rhacophorus maculatus</i>	Visakhapatnam
399. <i>B. waltirensis</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i>	Visakhapatnam
Order RHYNCHODIDA Family ANCISTROCOMIDAE Genus <i>Enerthecoma</i> Jarocki, 1935		
400. <i>E. dissimilis</i> Mahmood and Khan, 1980	<i>Viviparus dissimilis</i>	Hyderabad
401. <i>E. melanoidi</i> Kalavati, Ramakumari and Narasimhamurti, 1987	<i>Melanoides tuberculatus</i>	Visakhapatnam
Genus <i>Holocoma</i> Chatton and Lwoff, 1950		
402. <i>H. singhii</i> Kalavati, Ramakumari and Narasimhamurti, 1987	<i>Melanoides tuberculatus</i>	Visakhapatnam
Genus <i>Raabella</i> Chatton and Lwoff, 1950		
403. <i>R. helensis</i> Chatton and Lwoff, 1950	<i>Modiolus (Modiolus) striatulus</i>	East Godavari

404. *P. equi* Abraham, 1961 *Equus caballus* Hyderabad

Incertae sedis

405. *K. aplocheilusi* Rao, 1979 *Aplocheilus melastigma* Visakhapatnam

406. <i>C. indiae</i> Bhaskar Rao and Bhaskar Rao, 1969	<i>Cavia cutleri</i>	Hyderabad

407.	<i>A. ganapatii</i> Kalavati, Ramakumari and Narasimhamurti, 1987	<i>Pila globosa</i>	West Godavari

408. <i>F. kapili</i> Jamadar and Choudhury, 1988	<i>Cerithidea obtusa</i>	East Godavari

409. <i>F. sagarica</i> Jamadar and Choudhury, 1988	<i>Cerithidea obtusa</i>	East Godavari

410. <i>P. indica</i> Jamadar and Choudhury, 1988	<i>Littorina (Littorinopsis)</i> <i>scabra scabra</i>	Visakhapatnam

411. *R. puytoraci* Naidu, 1961 *Aeolosoma travancorens* Cuddapah

412. *R. visakhapatnamensis* Joseph and Rao, 1980 *Aeolosoma hyalinum* Visakhapatnam

Order PERITRICHIDA Family TRICHODINIDAE Genus <i>Trichodina</i> Ehrenberg, 1838		
413. <i>T. cyanophlycti</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i>	West Godavari
414. <i>T. waltirensis</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana breviceps</i> <i>Rana cyanophlyctis</i>	Vizianagaram Vizianagaram
Class POLYHYMENOPHOREA Order HETEROCHIDA Family NYCTOTHERIDAE Genus <i>Nyctotherus</i> Leidy, 1849		
415. <i>N. indica</i> Bhaskar Rao, 1969	<i>Corydia petiveriana</i>	Hyderabad
Genus <i>Nyctotheroides</i> Grasse, 1928		
416. <i>N. bhatiae</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana limnocharis</i>	Visakhapatnam
417. <i>N. cordiformis</i> (Ehrenberg, 1838)	<i>Rana cyanophlyctis</i>	Vizianagaram
418. <i>N. foliatus</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana breviceps</i>	Visakhapatnam
419. <i>N. hexadactyli</i> , Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana hexadactyla</i>	Vizianagaram
420. <i>N. reniformis</i> (Bhatia and Gulati, 1927)	<i>Rana hexadactyla</i>	Guntur
421. <i>N. rhacophori</i> , Kalavati, Narasimhamurti and Usharani, 1991	<i>Rhacophorus maculatus</i>	Visakhapatnam
422. <i>N. waltirensis</i> , Usharani and Narasimhamurti, 1991	<i>Bufo melanostictus</i>	Visakhapatnam
Family SICUOPHORIDAE Genus <i>Metasicuophora</i> Albert, 1973		
423. <i>M. cyanophlycti</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i>	Guntur
424. <i>M. melanosticti</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Bufo melanostictus</i>	Krishna

Genus <i>Prosicuophora</i> de Puytorac and Oktem, 1967		
425. <i>P. andhrae</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i>	Visakhapatnam
426. <i>P. hexadactyli</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana hexadactyla</i>	Visakhapatnam
Genus <i>Sicuophora</i> de Puytorac and Grain, 1969		
427. <i>S. fragilis</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i> <i>Rana hexadactyla</i>	Nellore Nellore
428. <i>S. levinei</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i>	Visakhapatnam
429. <i>S. limnochari</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i> <i>Rana limnocharis</i>	Vizianagaram Vizianagaram
430. <i>S. macropharyngea</i> (Bezzenberger, 1904)	<i>Rana cyanophlyctis</i> <i>Rana breviceps</i>	Visakhapatnam Visakhapatnam
431. <i>S. puytoraci</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana breviceps</i>	Krishna
432. <i>S. ranae</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana cyanophlyctis</i> <i>Rana hexadactyla</i> <i>Rana limnocharis</i>	West Godavari West Godavari West Godavari
433. <i>S. waltirensis</i> Kalavati, Narasimhamurti and Usharani, 1991	<i>Rana breviceps</i> <i>Rana cyanophlyctis</i> <i>Rana limnocharis</i>	Visakhapatnam Visakhapatnam Visakhapatnam

HOST-PARASITE LIST OF PARASITIC PROTOZOA

The host-parasite list of parasitic protozoa from Andhra Pradesh along with reference to the species concerned is given below :

Host	Parasite	Reference
Phylum PLATYHELMINTHES		
Class TREMATODA		
Order DIGENEA		
1. <i>Allocreadium fasciatusi</i>	<i>Nosema gigantea</i> <i>Unikaryon allocreadii</i>	Canning and Madhavi (1977) Canning and Madhavi (1977)

Phylum MOLLUSCA Class GASTROPODA		
2. <i>Cerithidea obtusa</i>	<i>Fenchelia kapili</i> <i>Fenchelia sagarica</i>	Jamadar and Choudhury (1988) Jamadar and Choudhury (1988)
3. <i>Littorina</i> (<i>Littorinopsis</i>) <i>scabra scabra</i>	<i>Protophrya indica</i>	Jamadar and Choudhury (1988)
4. <i>Melanoides tuberculatus</i>	<i>Enerthecoma melanoidii</i> <i>Holocoma singhii</i>	Kalavati <i>et al.</i> (1987) Kalavati <i>et al.</i> (1987)
5. <i>Modiolus (Modiolus) striatulus</i>	<i>Raabella helensis</i>	Jamadar and Choudhury (1988)
6. <i>Pila globosa</i>	<i>Ancistrum ganapatii</i>	Kalavati <i>et al.</i> (1987)
7. <i>Viviparus dissimilis</i>	<i>Enerthecoma dissimilis</i>	Mahmood and Khan (1980)
Class CEPHALOPODA		
8. <i>Sepia elliptica</i>	<i>Aggregata kudoii</i> <i>Steinhausia spraguei</i>	Narasimhamurti (1979) Kalavati and Narasimhamurti (1977)
Phylum ANNELIDA Class OLIGOCHAETA		
9. <i>Aelosoma hyalinnum</i>	<i>Radiophryoides visakhapatnamensis</i>	Joseph and Hanumantha Rao (1980)
10. <i>Aelosoma travancorensis</i>	<i>Radiophryoides puytoraci</i>	Naidu (1961)
11. <i>Nais communis</i>	<i>Mrazekia caudata</i>	Naidu (1959)
12. <i>Nais communis punjabensis</i>	<i>Triactinomyxon naidanum</i>	Naidu (1956)
13. <i>Pontodrilus bermudensis</i>	<i>Monocystis pontodrili</i>	Subba Rao <i>et al.</i> (1979)
14. <i>Pristina longiseta</i>	<i>Triactinomyxon</i> sp.	Naidu (1959)
15. <i>Pristina longiseta longiseta</i>	<i>Mrazekia caudata</i>	Naidu (1959)
Class POLYCHAETA		
16. <i>Marphysa gravelyi</i>	<i>Gopaliella marphysae</i>	Ganapati <i>et al.</i> (1974)

Phylum ARTHROPODA

Class CRUSTACEA

17. <i>Caridina laevis</i>	<i>Heliospora</i> sp.	Sailaja (1978); Narasimhamurti and Sailaja (1981)
18. <i>Macrobrachium rosenbergi</i>	<i>Caridohabitan macrobrachii</i> <i>Montonella macrobrachii</i> <i>Rosculus macrobrachii</i>	Kalavati and Aravindan (1998) Aravindan <i>et al.</i> (2002) Aravindan <i>et al.</i> (2002)
19. <i>Oithona rigida</i>	<i>Coelosporidium oithonae</i>	Narasimhamurti and Kalavati (1976)
20. <i>Orchestia platensis</i>	<i>Thelohania orchestii</i>	Kalavati (1976)
21. <i>Penaeus indicus</i>	<i>Cephalolobus andhrae</i> <i>Selenococcidium indicus</i>	Kalavati and Aravindan (1998) Aravindan <i>et al.</i> (2002)
22. <i>Penaeus monodon</i>	<i>Didymophyes penaei</i>	Kalavati and Aravindan (1998)
23. <i>Porcellio laevis</i>	<i>Octosporea porcelliolus</i>	Kalavati and Narasimhamurti (1976) emend. Sprague and Vavra (1977)
24. <i>Schmackeria serricaudata</i>	<i>Coelosporidium schmackeriae</i>	Ganapati <i>et al.</i> (1964)

Class INSECTA

Order ODONATA

25. <i>Bradinopyga geminata</i>	<i>Actinocephalus bradinopygi</i>	Narasimhamurti and Nazeer Ahmed (1980)
26. <i>Ceriagrion coromandelianum</i>	<i>Ancyrophora ceriagrini</i> <i>Dendrorhynchus keilini</i>	Nazeer Ahmed and Narasimhamurti (1979) Nazeer Ahmed and Narasimhamurti (1979)
27. <i>Tholymis tillarga</i>	<i>Toxoglugea tillargi</i>	Kalavati and Narasimhamurti (1978)
28. <i>Tramea limbata</i>	<i>Nosema limbata</i> <i>Thelohania limbata</i>	Narasimhamurti <i>et al.</i> (1980) Narasimhamurti <i>et al.</i> (1980)

Order ORTHOPTERA		
29. <i>Gryllotalpa africana</i>	<i>Hexamastix singhi</i> <i>Hexamita gryllotalpae</i> <i>Hexamita honigbergii</i> <i>Monocercomonoides ganapatii</i> <i>Retortamonas wenrichi</i> <i>Rhizomastix gryllotalpae</i>	Bhaskar Rao (1970) Bhaskar Rao (1968) Bhaskar Rao (1969) Bhaskar Rao (1968; cited from Sultana, 1976) Bhaskar Rao (1968, 1970) Bhaskar Rao (1970)
30. <i>Leiogryllus</i> sp.	<i>Acanthogregarina hoshidei</i>	Kalavat <i>et al.</i> (1988)
31. <i>Melanoplus</i> sp.	<i>Retractocephalus melanopli</i>	Kalavati and Krishnamurthy (1989)
32. <i>Poecilocercus pictus</i> (= <i>Poekilocercus pictus</i>) (Syn. <i>Poecilocera picta</i>)	<i>Gregarina poecilocerum</i> <i>Malamoeba indica</i>	Ganapati and Mrutyunjayadevi (1954); Pamathi Rao (1958); Narasimhamurti and Ganapati (1961) Narasimhamurti and Nazeer Ahmed (1980)
Order DICTYOPTERA		
33. <i>Blatta orientalis</i>	<i>Retortamonas blattae</i>	Bhaskar Rao (1968; cited from Sultana, 1976)
34. <i>Blatella germanica</i>	<i>Pleistophora blatellae</i>	Narasimhamurti and Kalavati (1978)
35. <i>Corydea petiveriana</i>	<i>Monocercomonas corydiae</i> <i>Nyctotherus indica</i> <i>Retortamonas blattae</i> <i>Trichomitus corydiae</i>	Bhaskar Rao (1970) Bhaskar Rao (1969) Bhaskar Rao (1968; cited from Sultana, 1976) Bhaskar Rao and Todd (1968)
36. <i>Cryptocercus</i> sp.	<i>Monocercomonas osmaniae</i> <i>Retortamonas blattae</i>	Bhaskar Rao (1970) Bhaskar Rao (1968; cited from Sultana, 1976)
37. <i>Leucophaea sinninamensis</i>	<i>Monocercomonas leucophaeae</i> <i>Retortamonas blattae</i>	Bhaskar Rao (1970) Bhaskar Rao (1968; cited from Sultana, 1976)

38. <i>Periplaneta americana</i>	<i>Hexmastix periplanetae</i>	Bhaskar Rao (1970)
	<i>Monocercomonoides garnhami</i>	Bhaskar Rao (1969)
	<i>Polymastix periplanetae</i>	Qadri and Bhaskar Rao (1963)
	<i>Retortamonas blattae</i>	Bhaskar Rao (1968; cited from Sultana, 1976)
	<i>Rhizomastix periplanetae</i>	Bhaskar Rao (1963)
Order DERMOPTERA		
39. <i>Euborellia plebeja</i>	<i>Pleistophora waltairensis</i>	Kalavati and Ganapati (1971)
Order ISOPTERA		
40. <i>Coptotermes heimi</i>	<i>Dubosqia coptotermi</i>	Kalavati and Narasimhamurti (1976)
	<i>Pleistophora weiseri</i>	Kalavati (1976)
	<i>Steinina coptotermitis</i>	Kalavati and Narasimhamurti (1978)
41. <i>Heliocorpis</i> sp.	<i>Steinina rodgii</i>	Present report
42. <i>Macrotermes estherae</i>	<i>Gregarina macrotermitis</i>	Kalavati and Narasimhamurti (1978)
	<i>Gurleya spraguei</i>	Kalavati (1976)
43. <i>Odontotermes horai</i>	<i>Pleistophora ganapatii</i>	Kalavati and Narasimhamurti (1982)
44. <i>Odontotermes horni</i>	<i>Diplocystis horni</i>	Kalavati (1977)
	<i>Pleistophora ganapatii</i>	Kalavati (1976)
45. <i>Odontotermes obesus</i>	<i>Chagasella ganapatii</i>	Kalavati and Narasimhamurti (1968)
	<i>Ganapatiella odontotermitis</i>	Kalavati (1977)
	<i>Monocystis odontotermitis</i>	Kalavati (1979)
46. <i>Odontotermes</i> sp.	<i>Anthorhynchus hanumanthi</i>	Kalavati and Narasimhamurti (1978)
	<i>Sphaerocystis odontotermitis</i>	Kalavati and Narasimhamurti (1979)
	<i>Stempellia odontotermi</i>	Kalavati (1976)
Order HEMIPTERA		
47. <i>Laccotrephes maculatus</i>	<i>Monocercomonas laccotrephis</i>	Bhaskar Rao (1970)
	<i>Retortamonas toddi</i>	Bhaskar Rao (1968)

48. <i>Lygaeus hospes</i>	<i>Leptomonas indica</i>	Prasad and Kalavati (1987)
49. <i>Lygaeus militaris</i>	<i>Leptomonas bakeri</i>	Prasad and Kalavati (1987)
Order COLEOPTERA		
50. <i>Dytiscus</i> sp.	<i>Liposcelisus dytiscusi</i>	Kalavati and Prasada Rao (1995)
51. <i>Eretes stictus</i>	<i>Pleistophora eretesi</i>	Kalavati and Narasimhamurti (1976)
52. <i>Gallerucida bicolor</i>	<i>Harendraia murtii</i> n. sp.	Present report
53. <i>Gonocephalum arenarium</i>	<i>Cystocephalus gonocephali</i> n. sp.	Present report
	<i>Stylocephalus gonocephali</i>	Bhusana Rao (1962)
	<i>Stylocephalus serpentula</i>	Sailaja (1978)
	<i>Stylocephalus</i> sp.	Sailaja (1978)
54. <i>Gonocephalum brachyelytra</i>	<i>Stylocephalus gonocephali</i>	Bhusana Rao (1962)
55. <i>Oryctes rhinoceros</i>	<i>Dientamoeba dobelli</i>	Bhaskar Rao (1970)
	<i>Monocercomonoides qadrii</i>	Bhaskar Rao (1969)
56. <i>Raphidopalpa stevensi</i>	<i>Gregarina crescentica</i>	Present report
	<i>Retractocephalus waltirensis</i>	Rajakumari and Narasimhamurti (1984)
57. <i>Rhytinota</i> sp.	<i>Xiphicephalus rhytinotus</i> n. sp.	Present report
58. <i>Tribolium ferruginum</i>	<i>Anisobolus triboli</i> n. sp.	Present report
Order DIPTERA		
Order LEPIDOPTERA		
59. <i>Corcyra cephalanica</i>	<i>Retractocephalus corcyrae</i> n. sp.	Present report
Class MYRIAPODA		
Order CHILOPODA		
60. <i>Mecistocephalus punctifrons</i>	<i>Eimeria mecistophori</i> <i>Mecistophora legeri</i>	Narasimhamurti (1976) Ganapati and Narasimhamurti (1960)

61. <i>Rhysida longipes</i>	<i>Adelea hyalospora</i> <i>Adelina dimidiata</i> <i>Adelina rayi</i>	Narasimhamurti (1960) Narasimhamurti (1960) Narasimhamurti (1977)
62. <i>Scolopendra moristans</i>	<i>Grebneckiella pixellae</i>	Ganapati and Narasimhamurti (1955)
Order DIPLOPODA		
63. <i>Chondromorpha keelarti</i>	<i>Hyalosporina froilani</i>	Sailaja (1978)
64. <i>Strongylosoma contortipes</i>	<i>Monodactus lunatus</i> <i>Stenophora</i> sp. 1 <i>Stenophora</i> sp. 2 <i>Stenophora</i> sp. 3	Sailaja (1978) Sailaja (1978) Sailaja (1978) Sailaja (1978)
65. <i>Thyropygus</i> sp.	<i>Chakravartiella krishnamurthyi</i>	Sailaja (1995)
66. <i>Xenobolus carnifex</i>	<i>Nephridiophaga xenoboli</i> <i>Stenophora xenoboli</i>	Ganapati and Narasimhamurti (1960) Ganapati and Narasimhamurti (1956)
67. <i>Xenobolus</i> sp.	<i>Stenophora xenoboli</i>	Ganapati and Narasimhamurti (1956)
Uncertain Order of Myriapoda		
68. <i>Thyroglutus</i> sp.	<i>Stenophora thyrogluti</i>	Ganapati and Narasimhamurti (1962)
Phylum CHORDATA Class OSTEICHTHYES Order CLUPEIFORMES		
69. <i>Dussumeria acuta</i>	<i>Pleistophora</i> sp.	Narasimhamurti and Kalavati (1979)
Order CLUPEIFORMES		
70. <i>Thrissocles muystasc</i>	<i>Ceratomyxa thrissoclesi</i>	Padma Dorothy <i>et al.</i> (1998)
71. <i>Thrissocles setirostris</i>	<i>Davisia filiformis</i>	Padma Dorothy <i>et al.</i> (1998)
Order OSTEOGLOSSIFORMES		
72. <i>Notopterus notopterus</i>	<i>Henneguya ganapatiae</i> <i>Henneguya jubili</i> <i>Henneguya notopteriae</i>	Qadri (1970) Qadri (1969) Qadri (1965)

73. <i>Notopterus osmanii</i>	<i>Henneguya singhi</i>	Lalitha Kumari (1969)
Order CYPRINIFORMES		
74. <i>Catla catla</i>	<i>Myxobolus bengalensis</i> <i>Myxobolus mahendrae</i> <i>Myxobolus sphaeralis</i>	Lakshminarayana (1988) Lakshminarayana (1988) Padma Dorothy and Kalavati (1992)
75. <i>Chela bacaila</i> (= <i>Salmostoma bacaila</i>)	<i>Thelohanellus chelae</i>	Lalitha Kumari (1969)
76. <i>Esomus</i> sp.	<i>Myxobolus esomi</i> (Syn. <i>Rudicapsula esomi</i>)	Kalavati and Narasimhamurti (1984)
77. <i>Labeo bata</i>	<i>Thelohanellus batae</i>	Lalitha Kumari (1969)
78. <i>Labeo boggut</i>	<i>Thelohanellus boggoti</i>	Qadri (1962); Lalitha Kumari (1969)
79. <i>Labeo fimbriatus</i>	<i>Myxobolus crucifila</i> <i>Myxobolus seshadrii</i> <i>Thelohanellus andhrae</i> <i>Thelohanellus shortii</i>	Qadri (1962) Lalitha Kumari (1968) Qadri (1962); Lalitha Kumari (1969) Qadri (1967)
80. <i>Labeo nigripinnis</i>	<i>Chloromyxum hoarei</i> <i>Myxobolus hoarei</i> <i>Zschokkella labeonis</i>	Lalitha Kumari (1969) Lalitha Kumari (1969) Lalitha Kumari (1969)
81. <i>Labeo potail</i>	<i>Myxobolus potaili</i> <i>Thelohanellus potaili</i> <i>Thelohanellus qadrii</i>	Lalitha Kumari (1969) Lalitha Kumari (1969) Lalitha Kumari (1969)
82. <i>Osteochilus neilli</i>	<i>Leptotheca asymmetrica</i>	Lalitha Kumari (1969)
83. <i>Psilorhynchus</i> <i>balitora</i>	<i>Myxobolus psilorhynchi</i>	Lalitha Kumari (1969)
84. <i>Puntius chrysopoma</i> (Syn. <i>Barbus</i> <i>chrysopoma</i>)	<i>Thelohanellus</i> <i>chrysopomati</i>	Lalitha Kumari (1969)
85. <i>Puntius kolus</i> (Syn. <i>Barbus kolus</i>)	<i>Myxobolus ampullaceus</i> <i>Myxobolus koli</i>	Lalitha Kumari (1969) Lalitha Kumari (1969)
86. <i>Puntius punjaubensis</i> (Syn. <i>Barbus panjaubensis</i>)	<i>Myxobolus osmaniae</i>	Lalitha Kumari (1969)

87. <i>Puntius pinnauratus</i> (Syn. <i>Barbus pinnauratus</i>)	<i>Myxobolus pinnaurati</i> <i>Myxobolus hyderabadense</i>	Lalitha Kumari (1969) Lalitha Kumari (1969)
88. <i>Puntius sarana</i> (Syn. <i>Barbus sarana</i>)	<i>Myxobolus indiae</i>	Lalitha Kumari (1969)
89. <i>Salmostoma bacaila</i> (Syn. <i>Chela bacaila</i>)	<i>Thelohanellus chelae</i>	Lalitha Kumari (1969)
Order SILURIFORMES		
90. <i>Aorichthys aor</i> (Syn. <i>Macrones aor</i>)	<i>Myxidium aori</i>	Lalitha Kumari (1969)
91. <i>Clarias batrachus</i>	<i>Myxobilatus</i> sp. <i>Myxobolus bivacuolatus</i> <i>Myxobolus clarii</i> <i>Trypanosoma batrachi</i> <i>Trypanosoma qadrii</i>	Anuradha and Kalavati (1987) Narasimhamurti and Kalavati (1986) Lalitha Kumari (1969) Qadri (1962) Narasimhamurti and Saratchandra (1980)
92. <i>Clarias</i> sp.	<i>Myxobolus tripathi</i>	Kalavati <i>et al.</i> (1981)
93. <i>Heteropneustes</i> (= <i>Saccobranchus</i>) <i>fossilis</i>	<i>Trypanosoma danilewskyi</i> var. <i>saccobranchi</i> <i>Zschokkella</i> sp.	Qadri (1962) Qadri (1951)
94. <i>Mystus bleekeri</i>	<i>Phlogospora mysti</i>	Qadri (1962)
Order MYCTOPHIFORMES		
95. <i>Saurida tumbil</i>	<i>Burenella</i> sp. <i>Pleistophora sauridae</i> <i>Microsporidium sauridae</i> (Syn. <i>Nosema sauridae</i>)	Kalavati and Sandeep (1985) Narasimhamurti and Kalavati (1972) Narasimhamurti and Kalavati (1972)
Order ATHERINIFORMES		
96. <i>Aplocheilus melastigma</i>	<i>Kofoidella aplocheilusi</i>	Rao (1979)
Order CHANNIFORMES		
97. <i>Channa gachua</i> (Syn. <i>Ophicephalus gachua</i>)	<i>Henneguya qadri</i> <i>Unicauda andhrae</i>	Lalitha Kumari (1965, 1969) Kalavati and Narasimhamurti (1981)

98. <i>Channa punctatus</i> (Syn. <i>Ophicephalus punctatus</i>)	<i>Henneguya waltirensis</i> <i>Myxobolus andhrae</i> <i>Myxobolus channai</i> <i>Trypanosoma channai</i> <i>Trypanosoma godavariensis</i> <i>Trypanosoma striati</i>	Kalavati and Narasimhamurti (1981, 1984, 1985); Narasimhamurti and Kalavati (1975,1981,1984) Lalitha Kumari (1969) Kalavati <i>et al.</i> (1981) Narasimhamurti and Saratchandra (1980) Saratchandra and Jayramaraju (1981) Qadri (1955)
99. <i>Channa</i> (= <i>Ophicephalus</i>) <i>striatus</i>	<i>Trypanosoma striati</i> <i>Zschokella ophicephali</i>	Qadri (1955, 1962) Lalitha Kumari (1969)
Order PERCIFORMES		
100. <i>Atropus atropus</i>	<i>Kudoa atropi</i>	Sandeep <i>et al.</i> (1986)
101. <i>Carangoides malabaricus</i>	<i>Glugea malabaricii</i> <i>Glugea</i> sp. <i>Pleistophora carangoidi</i>	Narasimhamurti <i>et al.</i> (1985); Kalavati <i>et al.</i> (1985) Kalavati and Narasimhamurti (1982) Narasimhamurti and Sonabai (1977)
102. <i>Chorinemus</i> sp.	<i>Auerbachia chorinomusi</i>	Padma Dorothy <i>et al.</i> (1998)
103. <i>Gobius giuris</i>	<i>Hexamita</i> sp.	Qadri (1962)
104. <i>Liza macrolepis</i>	<i>Bipteria indica</i> <i>Davisia murtii</i> <i>Myxidium papernae</i> <i>Myxobolus anili</i> <i>Myxobolus episquammalis</i> <i>Myxobolus lizae</i> <i>Myxobolus macrolepi</i>	Kalavati and Anuradha (1995) Padma Dorothy and Kalavati (1994) Padma Dorothy and Kalavati (1992) Padma Dorothy and Kalavati (1992) Kalavati and Anuradha (1992) Narasimhamurti and Kalavati (1979) Padma Dorothy and Kalavati (1992)

	<i>Myxobolus sphaeralis</i>	Padma Dorothy and Kalavati (1992)
	<i>Myxobolus</i> sp.	Padma Dorothy and Kalavati (1992)
	<i>Ortholinea visakhapatnamensis</i>	Padma Dorothy and Kalavati (1993)
	<i>Palliatius indicus</i>	Padma Dorothy and Kalavati (1998)
	<i>Parvicapsula hoffmani</i>	Padma Dorothy and Kalavati (1993)
	<i>Zschokkella ganapatii</i>	Padma Dorothy and Kalavati (1992)
105. <i>Megalaspis cordyla</i>	<i>Auerbachia chakravartyi</i>	Narasimhamurti <i>et al.</i> (1990)
	<i>Nosema</i> sp.	Narasimhamurti and Kalavati (1979)
106. <i>Mugil cephalus</i>	<i>Biptera indica</i>	Kalavati and Anuradha (1995)
	<i>Kudoa tetraspora</i>	Kalavati and Narasimhamurti (1979)
	<i>Myxobolus episquammalis</i>	Kalavati and Anuradha (1992)
	<i>Myxobolus microspora</i>	Narasimhamurti <i>et al.</i> (1980)
	<i>Myxobolus mugcephalus</i>	Narasimhamurti <i>et al.</i> (1980)
	<i>Myxobolus spinocurvatura</i>	Kalavati and Anuradha (1992)
	<i>Myxobolus</i> sp.	Padma Dorothy and Kalavati (1992)
	<i>Sphaerospora mayi</i>	Kalavati and Anuradha (1992)
107. <i>Mugil waigensis</i>	<i>Myxobolus narasii</i>	Narasimhamurti (1969)
108. <i>Nemipterus japonicus</i>	<i>Glugea nemipteri</i>	Weiser <i>et al.</i> (1981)
	<i>Leptotheca apogoni</i>	Narasimhamurti <i>et al.</i> (1990)
	<i>Nosema bengalis</i>	Weiser <i>et al.</i> (1981)
109. <i>Nemipterus mesoprion</i>	<i>Ceratomyxa dissimilaris</i>	Narasimhamurti <i>et al.</i> (1990)
	<i>Neobiptera coromandelensis</i>	Narasimhamurti <i>et al.</i> (1990)
110. <i>Priacanthus boops</i> (= <i>Pariacanthus boops</i>)	<i>Nosema priacanthi</i>	Sandeep and Kalavati (1985)
111. <i>Sphyraena jello</i>	<i>Kudoa sphyraeni</i>	Narasimhamurti and Kalavati (1979)
112. <i>Therapon jarbua</i>	<i>Chloromyxum mitchelli</i>	Kalavati and Narasimhamurti (1984)
	<i>Chloromyxum tripathi</i>	Kalavati and Narasimhamurti (1984)

113. <i>Trichiurus savala</i>	<i>Loma trichiuri</i>	Sandeep and Kalavati (1985)
114. <i>Tricopterus</i> sp. (Syn. <i>Trachipterus</i> sp.)	<i>Loma</i> sp. I	Narasimhamurti <i>et al.</i> (1990)
115. Sciaenid fish (Unidentified)	<i>Loma</i> sp. II	Narasimhamurti <i>et al.</i> (1990)
116. <i>Valamugil cunnesius</i>	<i>Ceratomyxa kudo</i> <i>Kudoa valamugili</i>	Kalavati and Anuradha (1993) Kalavati and Anuradha (1993)
117. <i>Valamugil</i> sp.	<i>Nosema valamugili</i>	Kalavati and Lakshinarayana (1982)
Order PLEURONECTIFORMES		
118. <i>Cynoglossus</i> sp.	<i>Davisia cynoglossi</i> <i>Ceratomyxa sagarsampadae</i>	Narasimhamurti <i>et al.</i> (1990) Narasimhamurti <i>et al.</i> (1990)
Order MASTACEMBELIFORMES		
119. <i>Mastacembelus armatus</i>	<i>Myxobilatus mastacembeli</i>	Qadri and Lalitha Kumari (1965)
Class AMPHIBIA		
Order ANURA		
120. <i>Bufo melanostictus</i>	<i>Metasacuophora melanosticti</i> <i>Nyctotheroides waltirensis</i> <i>Parazschokella melanosticti</i>	Kalavati <i>et al.</i> (1991) Usha and Narasimhamurti (1981) Kalavati and Narasimhamurti (1987)
121. <i>Hyla arboea</i>	<i>Cepedea hylae</i>	Khan (1962)
122. <i>Rana breviceps</i>	<i>Balantidium elongatum</i> <i>Nyctotheroides foliatus</i> <i>Sicuophora macrophryngea</i> <i>Sicuophora puytoraci</i> <i>Sicuophora waltirensis</i> <i>Tricodina waltirensis</i>	Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991)
123. <i>Rana cyanophlyctis</i>	<i>Balantidium waltirensis</i> <i>Metasacuophora cyanophlycti</i> <i>Nyctotheroides cordiformis</i>	Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991) Kalavati <i>et al.</i> (1991)

	<i>Prosicuophora andhrae</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora fragilis</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora levinei</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora limnochari</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora</i> <i>macropharyngea</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora ranae</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora waltirensis</i>	Kalavati <i>et al.</i> (1991)
	<i>Trichodina cyanophlycti</i>	Kalavati <i>et al.</i> (1991)
	<i>Trichodina waltirensis</i>	Kalavati <i>et al.</i> (1991)
124. <i>Rana hexadactyla</i>	<i>Nyctotheroides hexadactyli</i>	Kalavati <i>et al.</i> (1991)
	<i>Nyctotheroides reniformis</i>	Kalavati <i>et al.</i> (1991)
	<i>Prosicuophora hexadactyli</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora fragilis</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora ranae</i>	Kalavati <i>et al.</i> (1991)
125. <i>Rana limnocharis</i>	<i>Balantidium helenae</i>	Kalavati <i>et al.</i> (1991)
	<i>Nyctotheroides bhatiae</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora limnochari</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora ranae</i>	Kalavati <i>et al.</i> (1991)
	<i>Sicuophora waltirensis</i>	Kalavati <i>et al.</i> (1991)
126. <i>Rana tigrina</i>	<i>Balantidium duodeni</i>	Kalavati <i>et al.</i> (1991)
	<i>Chilomastix qadrii</i>	Krishnamurthy (1970)
	<i>Hexamita hoarei</i>	Krishnamurthy (1967)
	<i>Rhizomastix ranae</i>	Krishnamurthy (1969)
	<i>Trichomitus</i> <i>hyderabadensis</i>	Krishnamurthy (1968, 1969)
127. <i>Rhacophorus</i> <i>maculatus</i>	<i>Balantidium racophori</i>	Kalavati <i>et al.</i> (1991)
	<i>Nyctotheroides rhacophori</i>	Kalavati <i>et al.</i> (1991)
'Class REPTILIA Order CHELONIA		
128. <i>Geochelone elegans</i> (= <i>Testudo elegans</i>)	<i>Hexamastix dobelli</i>	Janakidevi (1961)
	<i>Monocercomonoides</i> <i>filamentum</i>	Janakidevi (1962)
	<i>Retortamonas cheloni</i>	Janakidevi (1962)
129. <i>Lissemys punctata</i> <i>granosa</i>	<i>Alexiefella cheloni</i>	Janakidevi (1961)
	<i>Haemogregarina</i> <i>ganapatii</i>	Saratchandra (1981)
	<i>Tritrichomonas lissemysi</i>	Janakidevi (1961)
	<i>Trypanosoma lissamysi</i>	Saratchandra (1980)

Order SQUAMATA Suborder LACERTILIA		
130. <i>Calotes versicolor</i>	<i>Haemogregarina wallairensis</i> <i>Hexamita kakatiyae</i> <i>Monocercomonas calotesi</i> <i>Monocercomonas srikakulamensis</i> <i>Proteromonas krishnamurthyi</i>	Saratchandra (1981) Bhaskar Rao (1975) Janakidevi (1962) Saratchandra and Narasimhamurti (1979) Saratchandra and Babu (1982)
131. <i>Calotes nimericola</i>	<i>Chilomastix wenyoni</i>	Janakidevi (1961)
132. <i>Chameleon zeylanicus</i>	<i>Hexamita</i> sp. <i>Monocercomonoides singhi</i> <i>Proteromonas chameleoni</i> <i>Proteromonas</i> sp. <i>Trichomitus</i> sp.	Krishnamurthy (1968) Krishnamurthy (1967) Krishnamurthy (1968) Krishnamurthy (1967) Krishnamurthy (1968)
133. <i>Hemidactylus brooki</i>	<i>Proteromonas hemidactyli</i>	Krishnamurthy (1968)
134. <i>Hemidactylus giganteus</i>	<i>Monocercomonas</i> sp. <i>Proteromonas ganapatii</i> <i>Proteromonas lacertae-viridis</i>	Krishnamurthy (1968) Saratchandra (1981) Krishnamurthy (1968)
135. <i>Hemidactylus prashadi</i>	<i>Chilomastix kudoii</i> <i>Eimeria knowlesi</i> <i>Monocercomonas ganapatii</i> <i>Monocercomonas prashadi</i> <i>Monocercomonas rayi</i> <i>Monocercomonas waltairensis</i> <i>Plasmodium</i> sp. <i>Proteromonas grassei</i> <i>Proteromonas waltairensis</i>	Saratchandra and Narasimhamurti (1980) Saratchandra and Narasimhamurti (1981) Saratchandra and Narasimhamurti (1982) Saratchandra (1981) Saratchandra and Narasimhamurti (1982) Narasimhamurthi and Saratchandra (1980) Narasimhamurthi and Saratchandra (1980) Saratchandra and Narasimhamurti (1980) Saratchandra and Narasimhamurti (1980)

136. <i>Hemidactylus</i> sp.	<i>Chilomastix hemidactyli</i> <i>Haemoproteus simondi</i> <i>Hypotrichomonas hemidactyli</i> <i>Proteromonas kakatiyae</i>	Bhaskar Rao <i>et al.</i> (1976) Shortt (1962) Bhaskar Rao <i>et al.</i> (1976) Bhaskar Rao <i>et al.</i> (1978)
137. <i>Mabuya beddomii</i>	<i>Proteromonas mabuiae</i>	Saratchandra <i>et al.</i> (1984)
138. <i>Mabuya carinata</i>	<i>Proteromonas warangalensis</i>	Bhaskar Rao <i>et al.</i> (1978)
139. <i>Varanus indica</i>	<i>Monocercomonas kakatiyae</i>	Dayakar <i>et al.</i> (1978)
140. <i>Varanus</i> sp.	<i>Chilomastix</i> sp. <i>Hexamita</i> sp. <i>Hypotrichomonas osmaniae</i> <i>Hypotrichomonas venkataramiahii</i> <i>Monocercomonas varani</i> <i>Monocercomonas</i> sp. <i>Retortamonas</i> sp. <i>Trichomitus batrachorum</i>	Krishnamurthy (1968) Krishnamurthy (1968) Krishnamurthy (1967) Dayakar <i>et al.</i> (1977) Krishnamurthy (1968) Krishnamurthy (1968) Krishnamurthy (1968) Krishnamurthy (1967)
Suborder OPHIDIA		
141. <i>Atretium schistosum</i>	<i>Pleistophora atretii</i>	Narasimhamurti <i>et al.</i> (1982)
142. <i>Dryophis mycterizans</i>	<i>Monocercomonas gopali</i>	Krishnamurthy (1967)
143. <i>Eryx johnii</i>	<i>Monocercomonas eryxi</i> <i>Trichomitus batrachorum</i>	Krishnamurthy (1968) Krishnamurthy (1967)
144. <i>Lycodon aulicus</i>	<i>Monocercomonas garnhami</i>	Krishnamurthy (1968)
145. <i>Tropidonotus piscator</i>	<i>Rosculus tropidonoti</i>	Kalavati and Lakshminarayana (1982)
146. <i>Zamenis mucosus</i> (= <i>Ptyas mucosus</i>)	<i>Haemogregarina mirabilis</i> <i>Monocercomonas colubrorum</i> <i>Retortamonas</i> sp.	Saratchandra (1979, 1981) Krishnamurthy (1968) Krishnamurthy (1968)
Class AVES		
Order ANSERIFORMES		
147. <i>Anas platyrhynchos</i>	<i>Eimeria anatis</i>	Present report

148. <i>Anas</i> sp.	<i>Hexamita singhi</i> <i>Monocercomonas anasae</i>	Navarathnam (1970) Navarathnam (1971)
149. <i>Nettapus coromandelianus</i>	<i>Haemoproteus</i> sp.	Nandi and Mandal (1984)
Order FALCONIFORMES		
150. <i>Elanus caeruleus vociferus</i>	<i>Leucocytozoon toddi</i>	Nandi and Mandal (1984)
151. <i>Spizaetus c. cirrhatus</i>	<i>Haemoproteus</i> sp <i>Leucocytozoon toddi</i>	Nandi and Mandal (1984) Nandi and Mandal (1984)
Order GALLIFORMES		
152. <i>Alectoris graeca</i>	<i>Chilomastix graecae</i>	Navarathnam (1971)
153. <i>Coturnix coromandelica</i>	<i>Plasmodium garnhami</i>	Bhaskar Rao and Bhaskar Rao (1980)
154. <i>Coturnix coturnix</i>	<i>Tetratrichomonas garnhami</i> <i>Tritrichomonas gigantea</i>	Navarathnam (1971) Navarathnam (1970)
155. <i>Cryptoplectron erythrorhynchum</i>	<i>Hypotrichomonas avium</i>	Navarathnam (1970)
156. <i>Gallus gallus domestica</i> (= <i>Gallus domesticus</i>)	<i>Chilomastix osmaniae</i> <i>Eimeria necatrix</i> <i>Eimeria tenella</i> <i>Monocercomonas qadrii</i>	Navarathnam (1971) Present report Padmavathi <i>et al.</i> (1987, 1988); Present report Navarathnam (1971)
157. <i>Gallus</i> sp.	<i>Eimeria brunetti</i>	Present report
158. <i>Perdicula asiatica</i>	<i>Plasmodium pinotti</i>	Bhaskar Rao and Bhaskar Rao (1980)
159. <i>Pterocles exustus</i>	<i>Plasmodium vaughani</i>	Bhaskar Rao and Bhaskar Rao (1980)
Order CHARADRIIFORMES		
160. <i>Capella gallinago</i>	<i>Pentatrichomonas capellae</i>	Navarathnam (1970)
161. <i>Tringa hypoleucos</i>	<i>Plasmodium</i> sp.	Bhaskar Rao and Bhaskar Rao (1980)

Order COLUMBIFORMES		
162. <i>Columbia livia intermedia</i> (= <i>Columba livia</i>)	<i>Eimeria columbae</i> <i>Haemoproteus columbae</i>	Present report Bhaskar Rao <i>et al.</i> (1992)
163. <i>Streptopelia chinensis</i>	<i>Plasmodium vaughani</i> <i>Trypanosoma</i> sp.	Bhaskar Rao and Bhaskar Rao (1980) Qadri (1962)
Order CUCULIFORMES		
164. <i>Centropus sinensis</i>	<i>Pentatrachomonas centropi</i>	Navarathnam (1970)
165. <i>Eudynamis scolopacea</i>	<i>Trypanosoma</i> sp.	Qadri (1962)
Order STRIGIFORMES		
166. <i>Athene brama</i>	<i>Leucocytozoon ziemanni</i> <i>Plasmodium</i> sp. <i>Trichomonas bramae</i>	Nandi and Mandal (1984) Bhaskar Rao and Bhaskar Rao (1980) Sambasivarao and Narasimhamurti (1982)
Order CORACIIFORMES		
167. <i>Coracias bengalensis</i>	<i>Haemoproteus coraciae</i>	Nandi and Mandal (1984)
168. <i>Merops orientalis</i>	<i>Haemoproteus meropis</i>	Nandi and Mandal (1984)
Order PICIFORMES		
169. <i>Dendrocopos m. mahrattensis</i>	<i>Haemoproteus borgesii</i> <i>Haemoproteus velans</i>	Nandi and Mandal (1984) Nandi and Mandal (1984)
Order PASSERIFORMES		
170. <i>Acridotheres t. tristis</i> (= <i>Acridotheres tristis</i>)	<i>Isospora rajuli</i> <i>Haemoproteus pastoris</i>	Satyanaranacharlu <i>et al.</i> (1969) Nandi and Mandal (1984)
171. <i>Budgerigars</i> (Love bird)	<i>Trichomonas gallinae</i> <i>Trichomonas</i> sp.	Sampurnanand <i>et al.</i> (2002) Mukherjea <i>et al.</i> (1970)
172. <i>Cisticola juncidis</i>	<i>Plasmodium</i> sp.	Qadri (1962)
173. <i>Copsychus saularis</i>	<i>Haemoproteus fringillae</i> <i>Haemoproteus orizivora</i>	Nandi and Mandal (1984) Nandi and Mandal (1984)

174. <i>Corvus splendens</i>	<i>Plasmodium formosum</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium matuitinum</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium nucleophilum</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium relictum</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium venkataramiahii</i>	Bhaskar Rao <i>et al.</i> (1977)
175. <i>Dicrurus adsimilis</i>	<i>Plasmodium</i> sp.	Bhaskar Rao and Bhaskar Rao (1980)
176. <i>Dicrurus macrocercus</i>	<i>Trypanosoma avium</i>	Nandi and Mandal (1984)
177. <i>Loncura malacca</i>	<i>Plasmodium relictum</i>	Bhaskar Rao and Bhaskar Rao (1980)
178. <i>Passer domesticus</i>	<i>Isospora lacazei</i>	Satyanarayancharlur <i>et al.</i> (1971)
	<i>Haemoproteus passeris</i>	Nandi and Mandal (1984)
	<i>Plasmodium matuitinum</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium nucleophilum</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium</i> sp.	Qadri (1973)
179. <i>Ploceus philippinus</i>	<i>Plasmodium fallax</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Plasmodium huffi</i>	Bhaskar Rao and Bhaskar Rao (1980)
	<i>Haemoproteus orizivora</i>	Nandi and Mandal (1984)
180. <i>Sturnus pagodarum</i>	<i>Haemoproteus pastoris</i>	Nandi and Mandal (1984)
Class MAMMALIA		
Order RODENTIA		
181. <i>Cavia cutleri</i>	<i>Chilomastix megamorpha</i>	Abraham (1962)
	<i>Cyathodinium indiae</i>	Bhaskar Rao and Bhaskar Rao (1969)
	<i>Hexamastix hyderabadensis</i>	Navarathnam (1971)
	<i>Monocercomonas cutleri</i>	Navarathnam (1971)
	<i>Trichomitus honigbergi</i>	Navarathnam (1971)

182. <i>Gerbillus indicus</i>	<i>Chilomastix indica</i>	Todd (1963)
	<i>Hexamastix gerbilli</i>	Navarathnam (1970)
	<i>Hexamita spinulus</i>	Todd (1963)
	<i>Monocercomonas gerbilli</i>	Todd (1963)
	<i>Monocercomonoides indica</i>	Navarathnam (1970)
	<i>Trichomonas singhi</i>	Todd (1963)
183. <i>Hystrix leucura</i>	<i>Proteromonas hystrixi</i>	Todd (1963)
	<i>Trichomonas leucuri</i>	Todd (1963)
184. <i>Nesokia bandicota</i> (= <i>Nesocia bandicota</i>)	<i>Chilomastix bandicoti</i>	Todd (1963)
	<i>Enteromonas ratti</i>	Navarathnam (1970)
	<i>Hexamastix spheroides</i>	Todd (1963)
	<i>Hexamita nesocium</i>	Todd (1963)
	<i>Trichomonas frugivori</i>	Todd (1963)
	<i>Trypanosoma bandicoti</i>	Todd (1963)
185. <i>Rattus rattus</i>	<i>Giardia indica</i>	Saratchandra <i>et al.</i> (1982)
	<i>Proteromonas rattusi</i>	Kalavati <i>et al.</i> (1986)
	<i>Octomitus rattusi</i>	Saratchandra <i>et al.</i> (1982)
	<i>Monocercomonas ardhrae</i>	Kalavati <i>et al.</i> (1986)
186. <i>Rattus rattus</i> <i>frugivorus</i>	<i>Caviomonas frugivori</i>	Navarathnam (1970)
	<i>Chilomastix hyderabadensis</i>	Todd (1963)
	<i>Enteromonas ratti</i>	Navarathnam (1970)
	<i>Hexamastix gopali</i>	Navarathnam (1970)
	<i>Hexamita pigmentatus</i>	Todd (1963)
	<i>Monocercomonas hoarei</i>	Navarathnam (1970)
	<i>Monocercomonoides shortii</i>	Navarathnam (1970)
	<i>Trichomonas frugivori</i>	Todd (1963)
	<i>Trypanosoma lewisi</i>	Todd (1963)
187. <i>Sciurus palmorum</i>	<i>Chilomastix palmari</i>	Todd (1963)
	<i>Hexamastix sciuri</i>	Todd (1963)
	<i>Trypanosoma indicum</i>	Todd (1963)
Order PHOLIDOTA		
188. <i>Manis</i> sp.	<i>Babesia</i> sp.	Qadri (1962)
Order LAGOMORPHA		
189. <i>Lepus nigricollis</i>	<i>Chilomastix nigricollisi</i>	Todd (1963)
	<i>Monocercomonoides lepusi</i>	Todd (1963)
	<i>Spheromonas anteronucleatus</i>	Todd (1963)

Order CARNIVORA		
190. <i>Canis aureus</i> (=Jackal)	<i>Trypanosoma</i> sp.	Rao <i>et al.</i> (1986)
191. <i>Canis familiaris</i> (=Dog)	<i>Babesia</i> sp.	Rao <i>et al.</i> (1986)
	<i>Hepatozoon canis</i>	Rao <i>et al.</i> (1986)
	<i>Trypanosoma evansi</i>	Mandal <i>et al.</i> (1977); Mandal and Nandi (1983)
	<i>Trypanosoma</i> sp.	Rao <i>et al.</i> (1986)
192. <i>Canis</i> sp. (Alsatian pup)	<i>Isospora bigemina</i>	Rao (1968)
	<i>Isospora felis</i>	Rao (1968)
193. <i>Herpestes smithi</i>	<i>Pentatrichomonas smithi</i>	Navarathnam (1970)
194. <i>Panthera tigris</i> (=Tiger)	<i>Trypanosoma</i> sp.	Rao <i>et al.</i> (1986)
195. <i>Paradoxurus h. hermaphroditus</i>	<i>Giardia dasi</i>	Abraham (1962)
196. <i>Puma concolor</i> (=Puma)	<i>Babesia</i> sp.	Rao <i>et al.</i> (1986)
	<i>Trypanosoma</i> sp.	Rao <i>et al.</i> (1986)
197. <i>Vulpes bengalensis</i>	<i>Pentatrichomonas vulpi</i>	Todd (1963)
	<i>Trypanosoma</i> sp.	Todd (1963)
Order ARTIODACTYLA		
198. <i>Axis axis</i> (= Spotted deer)	<i>Anaplasma marginale</i>	Sundaran and Bhaskar Rao (1989)
199. <i>Bos indicus</i> (= Cattle/cow)	<i>Anaplasma</i> sp.	Rao <i>et al.</i> (1986)
	<i>Balantidium indicum</i>	Abraham (1962)
	<i>Babesia bigemina</i>	Pers. Comm.
	<i>Babesia</i> sp.	Rao <i>et al.</i> (1986)
	<i>Eimeria zuernii</i>	Present report
	<i>Theileria</i> sp.	Rao <i>et al.</i> (1986)
	<i>Trypanosoma evansi</i>	Mandal <i>et al.</i> (1977); Mandal and Nandi (1983)
200. <i>Bos</i> sp. (Cross-bred cow)	<i>Trypanosoma</i> sp.	Rao <i>et al.</i> (1986)
	<i>Babesia argentina</i>	Padmavathi <i>et al.</i> (1974)
	<i>Babesia</i> sp.	Rao <i>et al.</i> (1986)
201. <i>Bubalus bubalis</i> (= Buffalo)	<i>Babesia</i> sp.	Rao <i>et al.</i> (1986)
	<i>Balantidium coli</i>	Rao and Anjanyulu (1974)
	<i>Eimeria bovis</i>	Present report
	<i>Theileria</i> sp.	Rao <i>et al.</i> (1986)
	<i>Trypanosoma evansi</i>	Mandal <i>et al.</i> (1977); Mandal and Nandi (1983)
	<i>Trypanosoma theileri</i> <i>Trypanosoma</i> sp.	Mandal and Kahali (1984) Rao <i>et al.</i> (1986)

202. <i>Capra hircus</i>	<i>Balantidium caprae</i>	Abraham (1962)
	<i>Eimeria arloingi</i>	Present report
	<i>Eimeria</i> <i>ninakohlyakimovae</i>	Present report
	<i>Eimeria tirupatiensis</i>	Sivanarayana and Venkataratnam (1969)
	<i>Giardia qadrii</i>	Navarathnam (1969)
	<i>Monocercomonoides</i> <i>sayeedi</i>	Abraham (1961)
	<i>Theileria hirci</i>	Raghavachari and Reddy (1959)
203. <i>Ovis aires</i> (=Sheep)	<i>Anaplasma marginale</i>	Sundaran and Bhaskar Rao (1989)
	<i>Babesia</i> sp.	Rao <i>et al.</i> (1986)
	<i>Eimeria crandallis</i>	Present report
	<i>Eimeria faurei</i>	Present report
	<i>Theileria</i> sp.	Rao <i>et al.</i> (1986)
204. <i>Sus scrofa</i>	<i>Eimeria deblickei</i>	Present report
Order PERISSODACTYLA		
205. <i>Equus caballus</i> (Horse/pony)	<i>Chilomastix equi</i>	Abraham (1961)
	<i>Paraisotricha equi</i>	Abraham (1961)
	<i>Trichomonas caballi</i>	Abraham (1961)
	<i>Trypanosoma</i> sp.	Rao <i>et al.</i> (1986)
Order PRIMATE		
206. <i>Homo sapiens</i>	<i>Entamoeba histolytica</i>	Pers. comm.; Nayeem and Habibullah (1993)
	<i>Leishmania donovani</i>	Kalra <i>et al.</i> (1977)
	<i>Giardia intestinalis</i>	Pers. comm.
	<i>Plasmodium falciparum</i>	Knowles <i>et al.</i> (1930)
	<i>Plasmodium malariae</i>	Knowles <i>et al.</i> (1930)
	<i>Plasmodium vivax</i>	Knowles <i>et al.</i> (1930)
207. <i>Loris tardigradus</i> <i>lydekkerianus</i>	<i>Giardia wenyoni</i>	Abraham (1962)
	<i>Monocercomonas lori</i>	Abraham (1962)
	<i>Pentatrichomonas</i> <i>tardigardi</i>	Navarathnam (1970)
208. <i>Macaca radiata</i>	<i>Balantidium osmaniae</i>	Qadri and Navarathnam (1966)
	<i>Plasmodium cynomolgi</i>	Anantaraman (1980)
	<i>Plasmodium fragile</i>	Anantaraman (1980)
	<i>Plasmodium inui</i>	Anantaraman (1980)
	<i>Plasmodium shortii</i>	Anantaraman (1980)

SYSTEMATIC ACCOUNT

Kingdom	PROTISTA
Subkingdom	PROTOZOA
Phylum	SARCOMASTIGOPHORA
Subphylum	MASTIGOPHORA
Class	ZOOMASTIGOPHOREA
Order	KINETOPLASTIDA
Suborder	BODONINA
Family	CERCOBODONIDAE
Genus	<i>Alexeiefella</i> Janakidevi, 1961

1961. *Alexeiefella* Janakidevi, *Ann. Mag. Nat. Hist. (13)*, 4 : pp. 199-202.

Diagnosis : Three blepharoplasts placed close to the nucleus; cysts typically oval or elongated in form with little chromatoid substance.

1. *Alexeiefella cheloni* Janakidevi, 1961
(Fig. 1)

1961. *Alexeiefella cheloni* Janakidevi, *Ann. Mag. Nat. Hist. (13)*, 4 : pp. 199-202.

Diagnosis : Body round or pear-shaped, measuring 5.0-10.0 (6.9) μm x 3.0-8.5 (5.5) μm in dimensions; cytoplasm loaded with granules and vacuoles containing ingested bacteria; nucleus round and vesicular, situated at the extreme anterior end, generally containing a small endosome; three blepharoplasts; three unequal flagella, two anterior (averaging 10.7 μm and 6.1 μm respectively) and one recurrent (averaging 18.2 μm) with a long acroneme; each flagellum originating from a separate blepharoplast; a short, thick funis associated with the recurrent flagellum; cysts oval or elongated oval in form, averaging 8.0 μm in diameter.

Host : Turtle, *Lissemys punctata granosa*; site of infection : large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Suborder TRYPANOSOMATINA

Family TRYPANOSOMATIDAE

Diagnosis : Body characteristically leaf-like; a single nucleus, a blepharoplast, a flagellum and an undulating membrane present; blepharoplast giving rise to the flagellum; exclusively parasitic; a number of species responsible for serious diseases of man and domestic animals.

Key to the genera

- 1(2) Body highly flattened, leaf-like, pointed at flagellar end and bluntly rounded or pointed at the other, parasite in the circulatory system of vertebrates Genus *Trypanosoma*
- 2(1) Body not so highly flattened and leaf-like; parasitic in vertebrates and invertebrates.
- 3(4) Body spindle-shaped; leishmanial stage non-flagellated; exclusively parasitic in intestine of invertebrates Genus *Leptomonas*
- 4(3) Body ovoid or round in leishmanial stage and spindle-shaped in leptomonad stage, intracellular parasite in the cells of reticulo-endothelial system Genus *Leishmania*

Genus *Leishmania* Ross, 1903

1903. *Leishmania* Ross, *Brit. Med. J.*, 2 : pp. 1261, 1401.

Diagnosis : Body ovoid or round with a nucleus and a blepharoplast in leishmanial stage as intracellular parasite in the cells of reticulo-endothelial system of vertebrates; multiplication by binary fission; leptomonad stage spindle-shaped in the intestine of blood sucking sand-flies of the genus *Phlebotomus*, multiplication by longitudinal fission.

2. *Leishmania donovani* (Laveran and Mesnil, 1903)

1903. *Piroplasma donovani* Laveran and Mesnil, *C. R. Acad. Sci.*, 137 : p. 957.

1926. *Leishmania donovani*: Wenyon, *Protozoology*, Vol. 1, Bailliere, Tindal and Cox, London, p. 397.

Diagnosis : Leishmanial stage round or ovoid in stained spleen puncture smears, measuring 2.5-5.0 μm x 1.5-2.0 μm in dimensions; cytoplasm homogenous, but often with minute vacuoles; nucleus comparatively large, often spread out and of varied shapes; blepharoplast or kinetoplast staining more deeply and small; a few to over 100 parasites in a host cell; occurring in man and other mammals primarily rodents; heteroxenous parasite transmitted by sand flies belonging to the genus *Phlebotomus* in which spindle-shaped leptomonad stage measuring 14-20 μm x 1.5-3.5 μm in dimensions.

Host : Man, *Homo sapiens*; site of infection: reticulo-endothelial system.

Distribution : India : Andhra Pradesh (exact locality not known, possibly in Hyderabad, Krishna and West Godavari districts), Assam and Bihar.

Remarks : It causes a disease known as kala-azar or visceral leishmaniasis. Kalra *et al.* (1977) reported this disease as endemic in this state. The distribution of phlebotomid sand fly vectors of this disease was recorded from Hyderabad (Qutubuddin, 1944), Krishna and West Godavari districts (Modi and Samon, 1978).

Genus *Trypanosoma* Gruby, 1843

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

Diagnosis : Body highly flattened, pointed at flagellate end, and bluntly rounded, or pointed at the other; usually pleomorphic; nucleus central; a blepharoplast near aflagellate end; a flagellum arising from the blepharoplast running towards the opposite end, making the outer boundary of the undulating membrane; in most cases flagellum extending freely beyond the body; many with myonemes; multiplication by binary fission; parasitic in the circulatory system of vertebrate; transmitted by blood sucking invertebrate vectors.

Key to the species**A. Key to the species of *Trypanosoma* of fishes**

- 1(4) Trypomastigote form monomorphic
- 2(3) Cytoplasm granular with large vacuoles situated mostly at anterior end; nucleus located at the posterior half *T. danilewskyi saccobranchi*
- 3(2) Cytoplasm nongranular with few vacuoles on either side of the nucleus located more towards the kinetoplast and lying parallel to the long axis of the body *T. qadrii*
- 4(1) Trypomastigote form not monomorphic
- 5(8) Trypomastigote form dimorphic
- 6(7) Trypomastigote form with long and slender (41-57 μm) as well as short slender (19-30 μm) forms, having pointed ends; approximately centrally placed nucleus and almost terminal nucleus *T. godavariensis*
- 7(6) Trypomastigote form with volutin granules present sometimes in the form of compact mass in large forms measuring 22-29 μm ; nucleus located towards posterior end and always encircled with a clear halo *T. batrachi*
- 8(5) Trypomastigote form pleomorphic
- 9(10) Trypomastigote form with hyaline cytoplasm devoid of vacuoles or inclusions in slender forms, nucleus of slender forms located at the middle of the body *T. channai*
- 10(9) Trypomastigote form with cytoplasm having less granules and containing many vacuoles in larger forms; nucleus located at the anterior half of the body *T. striati*

B. Key to the *Trypanosoma* species of reptiles

Trypomastigote elongate, 52-83 μm in total length, with pointed ends, occurring in freshwater turtle *T. lissemys*

C. Key to the species of *Trypanosoma* of birds

Pleomorphic, cell body 30–55 μm in length, nucleus located at about middle of the body, occurring in wide range of avian hosts *T. avium*

D. Key to the species of *Trypanosoma* of mammals

- 1(6) Trypomastigote form monomorphic
- 2(3) Nucleus usually elongated, rod-like, sometimes oval, triangular and bean-shaped, chromatin characteristically localised at anterior and posterior regions of nucleus, parasitic in bandicoot rat *T. bandicotti*
- 3(2) Nucleus usually oval and without chromatin granules as above
- 4(5) Parasitic in rats, cell body 30.02-38.14 μm in length, nucleus located at anterior half of the body *T. lewisi*
- 5(4) Parasitic in buffalo, cell body large, usually 31.20-64.90 μm in length, nucleus located near the middle of the body. *T. theileri*
- 6(1) Trypomastigote form usually di- or pleomorphic
- 7(8) Trypomastigote form dimorphic, parasitic in squirrel, cell body 19.74-33.84 μm in length *T. indicum*
- 8(7) Trypomastigote form pleomorphic, sometimes monomorphic, cell body 15-33 μm in length, parasitic in bovines, equines, camels, dogs, etc..... *T. evansi*

A. *Trypanosoma* of fishes

3. *Trypanosoma batrachi* Qadri, 1962

(Fig. 2)

1962. *Trypanosoma batrachi* Qadri, *Parasitology*, **52** : p. 225.

1984. *Trypanosoma batrachi* : Mandal, *Tech. Monograph No. 9*, Zool. Surv. India : p. 7.

Diagnosis : Dimorphic trypanosome with volutin granules and granular cytoplasm; cell body in large trypomastigote form measuring 22-29 μm , with long flagellum of 9-14 μm in length; nucleus located towards posterior end and always encircled with a clear halo; kinetoplast compact, oval, round or bean-shaped, situated posteriorly covering more than the entire width of the body.

Host : *Clarias batrachus* (Linnaeus); site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district), Goa, Maharashtra, Uttar Pradesh, West Bengal.

Remarks : Qadri (1962) described this species as dimorphic but Mandal (1984) did not come across any stumpy form in hosts collected from Calcutta market, West Bengal.

4. *Trypanosoma channai* Narasimhamurti and Saratchandra, 1980
(Figs. 3 & 4)

1980. *Trypanosoma channai* Narasimhamurti and Saratchandra, *Proc. Indian Acad. Sci.(Anim. Sci.)*, **89** : p. 371.
1984. *Trypanosoma channai* : Mandal, *Tech. Monograph No. 9*, Zool. Surv. India, p. 11.

Diagnosis : Trimorphic trypanosome with slender, medium and stumpy forms, measuring 38.4-51.2 μm , 44.8-62.0 μm and 42.0-53.0 μm in total length respectively; cytoplasm hyaline containing no vacuoles or inclusions in slender forms only; cell body in slender forms, elongated, measuring 23.2-41.6 μm with both anterior and posterior ends tapering to fine points; free flagellum of slender form 8-12 μm in length; nucleus of slender form located almost at the middle with irregular mass of deeply stained chromatin materials; kinetoplast round or oval and subterminal in position.

Host : *Channa punctatus* (Bloch); site of infection: blood.

Distribution : India : Andhra Pradesh (Visakhapatnam and Srikakulam districts).

5. *Trypanosoma danilewskyi saccobranchi* Qadri, 1962
(Fig. 5)

1962. *Trypanosoma danilewskyi saccobranchi* Qadri, *Parasitology*, **52** : p. 226.
1984. *Trypanosoma danilewskyi saccobranchi* : Mandal, *Tech. Monograph No. 9*, Zool. Surv. India : p. 13.

Diagnosis : Monomorphic trypanosome with granular cytoplasm having large vacuoles situated mostly at the anterior end; cell body measuring 27-33.5 μm and free flagellum 11-15.5 μm in length; nucleus compact, elongated and located at the posterior half of the body and not always across the entire width of the body; kinetoplast very dense, elongated, round or bar-like, sometimes covering entire width of the body.

Host : *Heteropneustes fossilis* (Bloch); site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district) and West Bengal.

Remarks : Besides *T. danilewskyi saccobranchi*, another species, namely, *T. saccobranchi* also occurs in the same host, *Heteropneustes fossilis* (syn. *Saccobranthus fossilis* and this parasite was named solely due to its occurrence in this host). In *T. saccobranchi* Castellani and Willey, 1905, the caudal prolongation is obsolescent. The centrosome is placed very far backwards much as in *T. danilewskyi* Laveran and Mesnil, 1904 from *Cyprinus carpio*. Qadri (1962) found that except in dimension his material of *T. danilewskyi saccobranchi* resembled in many respect with *T. danilewskyi*, in having a narrow undulating membrane, an elongated nucleus surrounded by a narrow halo and, relatively large and variously shaped kinetoplast. It was for these reasons Qadri (1962) treated it as a new variety and named it as *T. danilewskyi* var. nov. *saccobranchi*. However, the status of this variety can be properly ascertained only after the taxonomic review of the trypanosomes from Heteropneustidae : Siluriformes.

6. *Trypanosoma godavariensis* Saratchandra and Jayaramaraju, 1981

1981. *Trypanosoma godavariensis* Saratchandra and Jayaramaraju, *Proc. Indian Acad. Parasitol.*, **2** : p. 53.

Diagnosis : Dimorphic trypanosome with long-slender, 41-57 μm , and short-slender, 19-30 μm , forms, identical in structure but differing in dimensions, one being twice as long as the other; trypanosomes elongated with pointed ends; cell body 34-42 μm and 11-18 μm respectively; cell membrane thin; cytoplasm finely granular and vacuolated; nucleus elongate, measuring 2.5-5.0 μm and 2.0 μm respectively, approximately centrally placed; kinetoplast round or oval and almost terminal; undulating membrane with 5-10 folds; free flagellum 9-15 μm and 5-12 μm respectively.

Host : *Channa punctata* (Bloch) site of infection: blood.

Distribution : India : Andhra Pradesh (East Godavari district).

7. *Trypanosoma qadrii* Narasimhamurti and Saratchandra, 1980

(Figs. 6 & 7)

1980. *Trypanosoma qadrii* Narasimhamurti and Saratchandra, *Proc. Indian Acad. Sci. (Anim. Sci.)*, **89** : p. 374.

1984. *Trypanosoma qadrii* : Mandal, *Tech. Monograph No. 9*, Zool. Surv. India, p. 25.

Diagnosis : Monomorphic trypanosome with a few vacuoles on either side of the nucleus and non-granular cytoplasm; cell body elongated with pointed anterior and posterior ends measuring 20.0-31.5 μm excluding free flagellum of 6-14 μm in length; nucleus elongated and located more towards the kinetoplast and lying parallel to the long axis of the body; kinetoplast oval or slightly elongated, subterminal in position; undulating membrane distinct with 6-8 convolutions over the body.

Host : *Clarias batrachus* (Linnaeus); site of infection : blood.

Distribution : India : Andhra Pradesh (Visakhapatnam and Srikakulam districts).

8. *Trypanosoma striati* Qadri, 1955

1955. *Trypanosoma striati* Qadri, *Parasitology*, **45** : p. 80.

1984. *Trypanosoma batrachi* : Mandal, *Tech. Monograph No. 9*, Zool. Surv. India, p. 30.

Diagnosis : Polymorphic trypanosome with small (average 40 μm in total length), intermediate (49 μm) and large (65 μm) forms, the latter appearing very broad and stumpy and the commonest in occurrence; cytoplasm of smaller forms usually with dense granules and very few vacuoles but larger forms with less granules and containing many vacuoles; cell body elongated and fusiform, measuring about 30-54 μm excluding free flagellum of 8-11 μm in average length; nucleus spherical, oval, pear-shaped or bean-shaped and located at the

anterior half of the body; kinetoplast oval, rounded, varying in size; undulating membrane completely hyaline, narrow in all forms and having 5-8 folds.

Host : *Ophicephalus striatus* (= *Channa striatus* (Bloch) and *Ophicephalus punctatus* (= *Channa punctatus*); site of infection : blood.

Distribution : India : Andhra Pradesh (Hyderabad district) and West Bengal.

B. *Trypanosoma* of reptiles

9. *Trypanosoma lissemysi* Saratchandra, 1980 (Figs. 8 & 9)

1980. *Trypanosoma lissemysi* Saratchandra, *Proc. Indian Acad. Parasitol.*, 1 : pp. 9-11.

Diagnosis : Body elongated with pointed ends, measuring 52-83 μm in total length including free flagellum of 5-33 μm ; cell body measuring 33-66 μm x 2.3-4.0 μm ; cytoplasm coarsely alveolated; nucleus oval, 2.6-5.3 μm x 1.5-2.9 μm , containing irregular chromatin masses; distance between the anterior end of the cell body and the nucleus 28-44 μm , nucleus and the kinetoplast 2.0-7.5 μm and kinetoplast and the posterior end 4.5-14.5 μm ; a single large vacuole associated with the kinetoplast; undulating membrane with 8-12 folds.

Host : Freshwater turtle, *Lissemys punctata granosa* (Shoepff); site of infection : blood.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

C. *Trypanosoma* of birds

10. *Trypanosoma avium* Danilewsky, 1885

1885. *Trypanosoma avium* Danilewsky, *Biol. Zentrabl.*, 5 : p. 529.

Material examined : A few exs., Warangal, 12.ii.1979, N. C. Nandi.

Diagnosis : Pleomorphic forms measuring 30-55 μm in length; kinetoplast small, elliptical, staining deep red; nucleus round or oval, located at about the middle of the cell body; free flagellum short.

Host : *Dicrurus macrocercus* (Vieillot); site of infection : blood.

Distribution : India : Andhra Pradesh (Warangal district); Delhi, Jammu and Kashmir, Goa, West Bengal.

Remarks : It is a cosmopolitan species with worldwide distribution. Nandi and Mandal (1984) reported this species from this state.

11. *Trypanosoma* sp.

Host : *Eudynamis scolopacius*; site of infection: blood.

Distribution : India : Andhra Pradesh.

Remarks : Qadri (1962) reported this unnamed species from this state without mentioning the collection site.

12. *Trypanosoma* sp.

Host : *Streptopelia chinensis*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Qadri (1962) reported this unnamed species from this state without mentioning the collection site.

D. *Trypanosoma* of mammals

13. *Trypanosoma bandicotti* Lingard, 1904 (Figs. 10 & 11)

1904. *Trypanosoma bandicotti* Lingard, *Indian Med. Gaz.*, **39** : p. 445.

1972. *Trypanosoma (Herpetosoma) bandicotti* : Hoare, *The Trypanosomes of Mammals : A Zoological Monograph* : p. 239.

Diagnosis : Body usually long, slightly curved and fusiform, pointed at both ends, measuring 24.44-36.19 (32.96) μm in length; nucleus elongated, rod-like or sometimes oval, triangular or bean-shaped, situated anterior to the central point of the body; chromatin characteristically localised at the anterior and posterior regions of the nucleus; parabasal body spherical, oval, triangular or bar-like, well developed, situated at a considerable distance from the posterior end of the body; rounded or pear-shaped vacuoles always present in front of the parabasal body; free flagellum well developed, 2.35-11.28 (6.13) μm in length; undulating membrane hyaline, conspicuous but narrow, with a few folds.

Host : *Nesocia bandicota* (= *Nesokia* (= *Mus*) *gigantea*); site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district), Maharashtra.

Remarks : Todd (1963) reported this species from this state.

14. *Trypanosoma evansi* (Steel, 1885)

1885. *Spirochaete evansi*, Steel, Investigation into an obscure and fatal disease among transport mules in British Burma. (Bombay?); cited from Hoare (1972).

1888. *Trypanosoma evansi*: Balbiani, *J. Micrograph*, **12**, p. 394.

1972. *Trypanosoma (Trypanozoon) evansi*: Hoare, *The Trypanosomes of Mammals : A Zoological Monograph* : p. 555.

Material examined : Several blood smears from domestic animals of Krishna, Guntur and Kakinada areas.

Diagnosis : Usually monomorphic and sometimes pleomorphic with slender, intermediate and stumpy forms; slender forms with 15-33 μm cell body and long free flagellum; intermediate form with 19-21 μm cell body and short free flagellum; stumpy form with 15-19 μm cell body and short free flagellum; slender forms with small kinetoplast and more or less drawn out narrow rounded or truncated posterior end; stumpy and dyskinetioplasic form rare.

Host : Cattle, *Bos indicus*; Buffalo, *Bubalus bubalis*; Dog, *Canis familiaris*.

Distribution : India : Andhra Pradesh (Krishna, Guntur and East Godavari districts), West Bengal.

Remarks : This parasite is the causative agent of 'Surra' disease which is one of the most important and wide spread diseases in domestic animals like cattle, buffalo, horse, camel and some carnivores. Mandal *et al.* (1977) reported the outbreak of this disease in bovines from Krishna district, Andhra Pradesh. Mandal and Nandi (1983) studied the behaviour of *Trypanosoma evansi* in some domestic animals from Andhra Pradesh and observed the higher intensity of infection in dogs, less in cattle and moderate in buffalo. Venkataratnam *et al.* (1964) recorded *T. evansi* in bears received from Clinical Laboratory, Cuddapah, Andhra Pradesh, which revealed the presence of large number of trypanosomes measuring 15-24 (18.62 ± 0.36) μm in length. Govinda Reddy *et al.* (1975) also recorded *T. evansi* in six tiger in a circus stationed at Vijayawada, Andhra Pradesh.

15. *Trypanosoma indicum* (Luhe, 1906)

(Fig. 12)

1906. *Trypanozoon indicum* Luhe, In: Mense's *Handb. d. Tropenkrankh.*, 1st ed., 3 : p. 69.

1972. *Trypanosoma (Herpetosoma) indicum* : Hoare, *The Trypanosomes of Mammals : A Zoological Monograph* : p. 250.

Diagnosis : Dimorphic, a slender and a broad form, almost equal in length, entire body 19.74-33.84 (28.19) μm ; nucleus elongated oval or spherical or pear-shaped, situated in the anterior half of the body; kinetoplast rounded or oval, sub-terminal, situated a short distance from the posterior extremity; free flagellum nearly one-third the length of the body; undulating membrane universally straight in thin forms and thrown into 2-6 folds in broad forms.

Host : Squirrel, *Sciurus palmarum*; site of infection : blood.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : This species is reported from above-mentioned host by Todd (1963).

16. *Trypanosoma lewisi* Kent, 1880

(Fig. 13)

1880. *Herpetomonas lewisi* Kent, *A Manual of Infusoria*, 1, London.

1972. *Trypanosoma (Herpetosoma) lewisi*: Hoare, *The Trypanosomes of Mammals : A Zoological Monograph* : p. 219.

Diagnosis : Body spindle-shaped and pointed at both ends, measuring 30.02-38.14 μm in length; nucleus oval, 2.35-3.29 μm in length situated at the anterior half of the body; parabasal body large and round or rarely oval; free flagellum quite long, measuring 3.29-8.46 μm in length, nearly one-third the length of the body; undulating membrane thin, conspicuously thrown into 2-6 folds.

Host : Rat, *Rattus rattus frugivorous*; site of infection : blood.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Todd (1963) reported this species from this state.

17. *Trypanosoma theileri* Laveran, 1902

1902. *Trypanosoma theileri* Laveran, C. R. Acad. Sci., **134** : p. 512.

1972. *Trypanosoma (Megatrypanum) theileri* : Hoare, *The Trypanosomes of Mammals : A Zoological Monograph* : p. 125.

Diagnosis : Large trypanosome, usually 31.2-64.9 μm and sometimes 25-120 μm including free flagellum measuring 3.6-26.5 μm in length; cell body usually 34-40 μm in length and 1.4-5.0 μm in breadth; nucleus round, oval or elliptical located near the middle of the body; kinetoplast large, 1.1 μm , typically rounded and occupying a marginal position, far from posterior extremity of the body (12-43 μm).

Host : Buffalo, *Bubalus bubalis*; site of infection : blood.

Distribution : India : Andhra Pradesh (Guntur district).

Remarks : Mandal and Kahali (1984) reported this species in five she buffaloes from Nidubrolu, Guntur district, Andhra Pradesh. These buffaloes did not show response to treatment with the common antitrypanosomal drug.

18. *Trypanosoma* sp.

Host : Fox, *Vulpes bengalensis*; site of infection : blood.

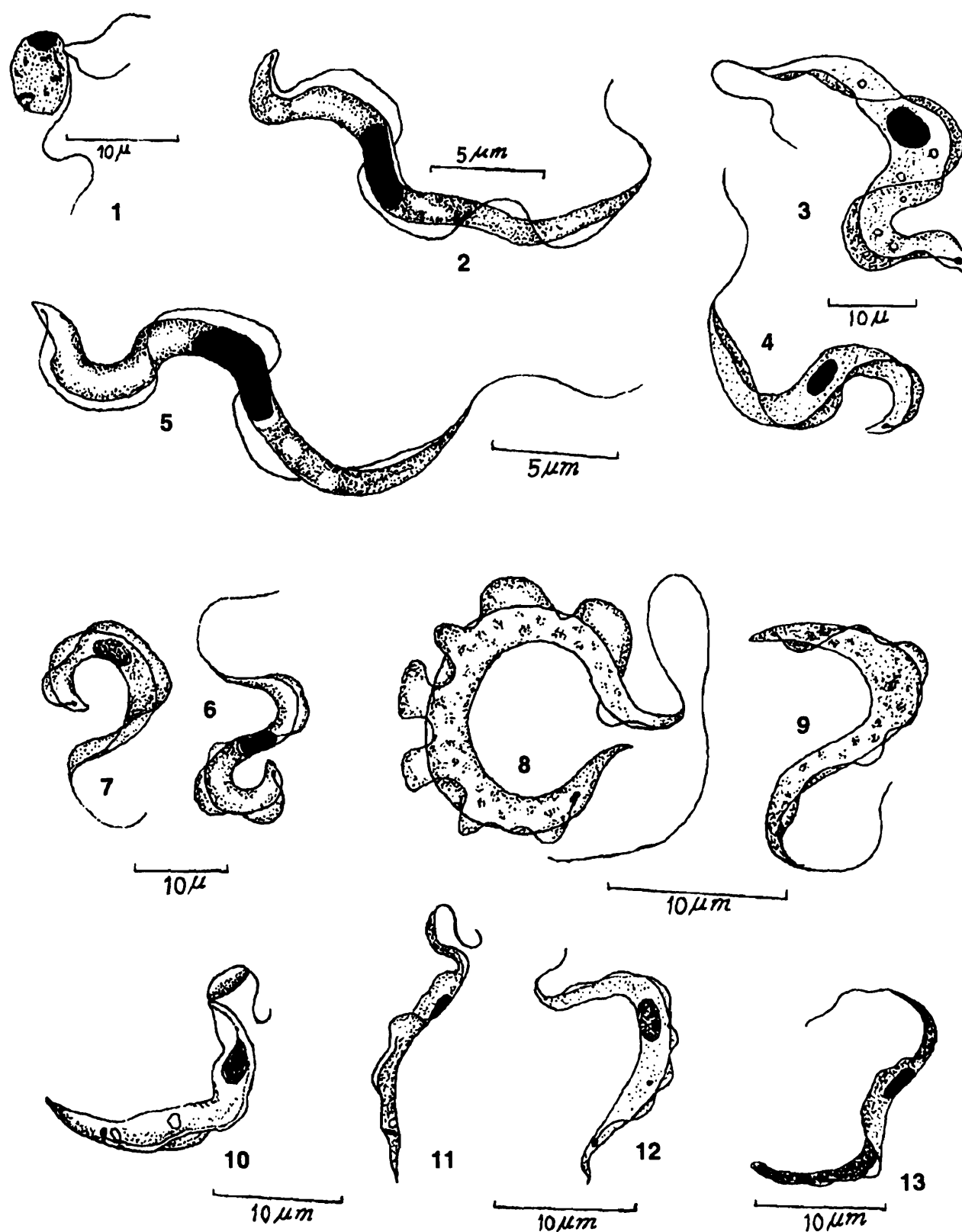
Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Todd (1963) reports this unnamed species from above-mentioned host.

19. *Trypanosoma* sp.

Host : Cow, *Bos indicus* ; site of infection : blood.

Distribution : India : Andhra Pradesh.



Figs. 1-13. Flagellate parasites of Andhra Pradesh : 1. *Alexeiefella cheloni*; 2. *Trypanosoma batrachi*; 3-4. *Trypanosoma channai*; 5. *Trypanosoma danilewskyi saccobranchi*; 6-7. *Trypanosoma gadrii*; 8-9. *Trypanosoma lissemysi*; 10-11. *Trypanosoma bandicotti*; 12. *Trypanosoma indicum* and 13. *Trypanosoma lewisi*.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state above-mentioned host without mentioning the collection site..

20. *Trypanosoma* sp.

Host : Buffalo, *Bubalus bubalis*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state above-mentioned host without mentioning the collection site.

21. *Trypanosoma* sp.

Host : Dog, *Canis familiaris*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from above-mentioned host without mentioning the collection site.

22. *Trypanosoma* sp.

Host : Pony, *Equus caballus*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state above-mentioned host without mentioning the collection site.

23. *Trypanosoma* sp.

Host : Tiger, *Panthera tigris*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state above-mentioned host without mentioning the collection site..

24. *Trypanosoma* sp.

Host : Puma, *Puma concolor*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state above-mentioned host without mentioning the collection site.

25. *Trypanosoma* sp.

Host : Jackel, *Canis aureus*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state above-mentioned host without mentioning the collection site.

Genus *Leptomonas* Kent, 1880

1880. *Leptomonas* Kent, *A Manual of the Infusoria*, Part 1-3 : 432pp. Bogue, London

Diagnosis : Blepharoplast very close to flagellate end; without undulating membrane; non-flagellate phase resembling *Leishmania*; exclusively parasitic in invertebrates.

Key to the species

- 1(2) Promastigotes elongated and fusiform, L : W ratio 7.91 : 1; nucleus situated at the anterior third of the body *L. bakeri*
- 2(1) Promastigotes tadpole-shaped, L : W ratio 6.6 : 1; nucleus situated at the posterior third of the body *L. indica*

26. *Leptomonas bakeri* Prasad and Kalavati, 1987 (Fig. 14)

1987. *Leptomonas bakeri* Prasad and Kalavati, *Acata Protozool.*, 26(4) : pp. 315-324.

Material examined : Sev. exs., from Andhra University campus, Waltair.

Diagnosis : Promastigotes elongate and fusiform, measuring 20.7 μm x 2.6 μm ; with a pointed anterior end and a drawn out posterior end; length : width 7.91 : 1; length of flagellum 24.3 μm ; body length : flagellar length 0.85 : 1; nucleus oval vesicular with a centrally placed endosome measuring 1.7 μm x 1.85 μm in dimension situated at the anterior third of the body; nuclear index 1.96; kinetoplast index 3.87; length of flagellar pocket 2.99 μm ; parasitic in the midgut and hindgut of *Lygaeus militaris*.

Host : *Lygaeus militaris* (Insecta : Hemiptera); site of infection : midgut and hindgut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

27. *Leptomonas indica* Prasad and Kalavati, 1987 (Fig. 15)

1988. *Leptomonas indica* Prasad and Kalavati, *Acata Protozool.*, 26(4) : pp. 315-324.

Material examined : Sev. exs., from Andhra University campus, Waltair.

Diagnosis : Promastigotes tadpole-shaped, measuring 18.5 μm x 2.8 μm ; with a broadly rounded anterior end, and a pointed posterior end with maximum breadth at the anterior third

of the body; length : width 6.6 : 1; length of flagellum 21.6 μm ; body length : flagellar length 0.85 : 1; nucleus vesicular with a centrally placed endosome measuring 1.46 μm in diameter situated at the posterior third of the body; nuclear index 1.206; kinetoplast index 1.984; length of flagellar pocket 2.48 μm ; parasitic in the crop, midgut and hindgut of *Lygaeus hospes*.

Host : *Lygaeus hospes* (Insecta : Hemiptera); site of infection : midgut and hindgut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Order PROTEROMONADIDA

Family PROTEROMONADIDAE

Diagnosis : Uninucleate flagellates equipped with two or four flagella; a single big mitochondrion. Golgi apparatus, rhizoplast and centrosome present; body limited by pellicle folded in strips containing subpellicular microtubules; kinetoplast and flagellar pocket absent; parasitic in the gut of vertebrates.

Genus *Proteromonas* Kunstler, 1883

1883. *Proteromonas* Kunstler, C. R. Acad. Sci., 97 : p. 755.

Diagnosis : Elongated pyriform; two flagella from anterior end, one directed anteriorly and the other posteriorly; nucleus anterior; encysted stage capable of increasing in size to a marked degree; exclusively parasitic in the gut of various species of amphibians, reptiles and mammals.

Key to the species of *Proteromonas* in reptiles

- 1(6) Body elongate, anterior end pointed and posterior end terminating in a spike-like structure or narrowed in a typically spatulate form, sometimes tapering into a caudal spine
- 2(3) Paranuclear body triangular, lying in contact with the posterior border of the nucleus *P. grassei*
- 3(2) Paranuclear body not triangular
- 4(5) Paranuclear body long, narrow, ribbon-like, appearing 'S' or '8' shaped or as an irregular body; two blepharoplasts and a sub-blepharoplastic mass fairly large and kidney-shaped *P. hemidactyli*
- 5(4) Paranuclear body ribbon or rod-like, sometimes spherical; posterior end narrowed in a typically spatulate form, sometimes tapering into a caudal spine; single blepharoplasts but sub-blepharoplastic mass absent *P. kakatiyae*

- 6(1) Body elongate, fusiform without any spike like structure in the posterior end
- 7(18) Sub-blepharoplastic body present
- 8(11) Sub-blepharoplastic body kidney-shaped present beneath the blepharoplast
- 9(10) Dimorphic with elongate forms 11-23 μm x 4-7 μm and rounded forms 7-10 μm in dimensions; large crescent-shaped parabasal body present in front of nucleus; occurring in the Wall lizard, *Hemidactylus giganteus* *P. ganapatii*
- 10(9) Dimorphic with elongate forms 10-16 μm x 2.5-5.0 μm and round or slightly oval forms 6.8-8.5 μm x 5.5-8.0 μm in dimensions; parabasal body absent; occurring in the Skink, *Mabuya beddomii* *P. mabuiae*
- 11(8) Sub-blepharoplastic body not kidney-shaped
- 12(15) Both blepharoplast and sub-blepharoplastic body appearing like a single mass
- 13(14) Body spindle-shaped or elongate, ranging from 6-23 μm in length *P. waltirensis*
- 14(13) Body round, pear-shaped or oval ranging from 6-11 μm in length *P. warangalensis*
- 15(12) Both blepharoplast and sub-blepharoplastic body not appearing like a single mass
- 16(17) Sub-blepharoplastic body cone-shaped lying below the basal granules without having any connection, a prenuclear body or the ring-like parabasal body present *P. lacertae-viridis*
- 17(16) Sub-blepharoplastic body crescent-shaped; paranuclear body round, crescentic or elongated; parabasal body absent *P. krishnamurthyi*
- 18(7) Sub-blepharoplastic body absent, blepharoplasts two in numbers and dot-like, nucleus spherical or oval lying little above the middle of the body with a prenuclear body behind and on the sites of the nucleus *P. chameleoni*

Key to the species of *Proteromonas* in mammals

- 1(6) Body elongate, 11–20 μm x 2–3 μm ; with two blepharoplasts; parasitic in *Rattus rattus* *P. rattusi*
- 2(1) Body fusiform, ovoid or rounded, 3.52–16.92 μm x 2.35–5.32 μm ; with a blepharoplast; parasitic in porcupine, *Hystrix leucura* *P. hystrixi*

A. *Proteromonas* in reptiles

28. *Proteromonas chameleoni* Krishnamurthy, 1963 (Fig. 16 & 17)

1963. *Proteromonas chameleoni* Krishnamurthy, *J. Biol. Sci.*, 6(1) : pp. 14-18, figs. 1-6.

Diagnosis : Elongated fusiform parasites, sometimes rounded or oval, measuring 10.0-15.5 (12.58) μm in length excluding flagella and 4.0-10.0 (6.73) μm in breadth at the widest portion of the body; cytoplasm devoid of any granules; nucleus spherical or oval, measuring 1.0-3.0 (1.99) μm x 1.5-3.5 (2.4) μm , situated a little above the middle of the body with a paranuclear body behind and on the sides of the nucleus; blepharoplast two in numbers, closely placed and dot-like; two unequal flagella arising from two blepharoplasts, long flagellum 26.5-54.5 (42.33) μm in length, about 1.5 times the short flagellum measuring 19.0-36.5 (27.99) μm , and 2.5-4.0 times the length of the body.

Host : *Chameleon zeylanicus*; site of infection: large intestine and caecum.

Distribution : India : Andhra Pradesh (Hyderabad district), Maharashtra.

Remarks : Krishnamurthy (1963, 1967 and 1968) reported this species from Hyderabad in Andhra Pradesh and Aurangabad in Maharashtra state. Kulda and Nohynkova (1978) treated this species as a synonym of *Proteromonas lacertae-viridis* (Grassi, 1879) even though there are morphological differences. However, this species is retained herein as a valid species until further taxonomic review of the proteromonids from reptiles and amphibians based on type materials/ specimens.

29. *Proteromonas ganapatii* Saratchandra, 1981 (Fig. 18 & 19)

1981. *Proteromonas ganapatii* Saratchandra, *Proc. Indian Acad. Parasitol.* : 2, pp. 10-12.

Diagnosis : Body round, oval or elongate with rounded anterior end and bluntly pointed posterior end; elongate forms measuring 11-23 μm x 4-7 μm and round forms 7-10 μm in diameter; cell membrane thin; cytoplasm vacuolated; nucleus oval, 2.5-4.0 μm x 1.5-3.0 μm ; two flagella, equal in thickness and unequal in length, originated from two blepharoplasts situated at the anterior end; anteriorly directed flagellum 14-41 μm and trailing flagellum 12-32 μm in length; a small kidney-shaped, sub-blepharoplastic body present; a thin rhizoplast extending between the blepharoplast and the nucleus and a clear space present around the rhizoplast; a large crescent-shaped parabasal body present in front of nucleus; crescentic, elongate or 'S' shaped paranuclear body situated behind the nucleus.

Host : *Hemidactylus giganteus*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

30. *Proteromonas grassei* Saratchandra and Narasimhamurti, 1980 (Figs. 20 & 21)

1980. *Proteromonas grassei* Saratchandra and Narasimhamurti, *Proc. Indian Acad. Sci. (Anim. Sci.)*, **89**(3) : pp. 293-295.

Diagnosis : Body elongate, measuring 12.0-22.0 μm x 2.2-5.0 μm , with anterior end abruptly pointed; posterior end drawn out into a short, narrow, slightly curved spike of

1.5-2.5 μm ; nucleus round, oval or slightly elongate, 2.0-3.5 μm x 1.2-1.8 μm , containing coarsely packed chromatin masses lacking distinct nuclear membrane, situated at the anterior end; paranuclear body, triangular, measuring 2.0-4.5 μm x 2.0-3.5 μm , lying in contact with the posterior border of the nucleus; blepharoplast situated at the anterior tip, connected to nucleus by a thread-like rhizoplast; flagella two in number, unequal, arising from the anterior tip; anterior flagellum, thick, 13-26 μm in length, while the trailing flagellum, thin, measuring 10-26 μm in length; sub-blepharoplastic and parabasal bodies absent.

Host : *Hemidactylus prashadi* Smith; site of infection: gut.

Distribution : India : Andhra Pradesh (Srikakulam district).

31. *Proteromonas hemidactyli* Krishnamurthy, 1968
(Figs. 22 & 23)

1968. *Proteromonas hemidactyli* Krishnamurthy, *Parasitology*, **58** : pp. 531-534, figs. 1-9.

Diagnosis : Body slender, elongated and fusiform, measuring 12.85-25.19 (17.42) μm x 2.06-5.66 (3.61) μm excluding the posterior spike 1.03-3.09 (1.89) μm ; anterior end slightly tapering while posterior end attenuated and often terminating in a spike-like structure; with a pair of flagella, almost equal to distinctly unequal, measuring 16.45-32.39 (25.49) μm and 22.62-33.93 (28.20) μm , arising from two blepharoplasts situated at the anterior end of the body; sub-blepharoplastic mass fairly large and kidney-shaped; nucleus small, round, vesicular with a central endosome and situated about 1.5-2.0 μm away from the anterior end; paranuclear body long, narrow, ribbon-like, appearing S or 8 shaped or an irregular body, extremely characteristic in this species; 'parabasal body' absent.

Host : *Hemidactylus brooki*; site of infection; large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Kulda and Nohynkova (1978) treated this species as a synonym of *Proteromonas lacertae-viridis* (Grassi, 1879) even though there are morphological differences between them. However, this species is retained herein as a valid species until further taxonomic review of the proteromonids from reptiles and amphibians based on type materials / specimens.

32. *Proteromonas kakatiyae* Bhaskar Rao, Devi, Dayakar,
Dhamodar Reddy and Bhaskar Rao, 1978
(Figs. 24 & 25)

1978. *Proteromonas warangalensis* Bhaskar Rao, Devi, Dayakar, Dhamodar Reddy and Bhaskar Rao, *Acta Protozool.*, **17**(1) : pp. 1-7.

Diagnosis : Body long, slender, 10.0-14.09 (12.04) μm x 2.72-3.86 (3.29) μm ; posterior end slightly narrowed in a typically spatulate form, sometimes tapering into a caudal spine; nucleus spherical or dumbbell or oval and sometimes sausage-shaped, 1.36-2.72 (2.01) μm in

length, situated at the anterior third of the body, with 3-4 darkly stained chromatin granules; paranuclear body ribbon or rod-like, sometimes spherical, located in the middle or slightly towards the posterior end, rarely seen just below the nucleus; a single blepharoplast situated at the anterior end, giving rise to two dissimilar flagella; both the flagella longer than the body length, thicker one 15.0-22.72 (18.86) μm in length and the thinner 12.95-19.09 (16.02) μm in length; thread-like rhizoplast extending from blepharoplast to nuclear membrane present; sub-blepharoplastic mass, rhizoplastic ring or parabasal body absent.

Host : *Hemidactylus* sp.; site of infection: rectum.

Distribution : India : Andhra Pradesh (Warangal district).

33. *Proteromonas krishnamurthyi* Saratchandra and Babu, 1982 (Figs. 26 & 27)

1982. *Proteromonas krishnamurthyi* Saratchandra and Babu, *Indian J. Parasitol.*, 6(1) : pp.163-165.

Diagnosis : Body round, oval, pear or spindle-shaped, 8.0-18.0 μm x 2.5-9.0 μm ; cytoplasm containing a few vacuoles; nucleus, 1.7-3.5 μm x 1.0-2.5 μm , situated at the anterior end; two flagella originating from two different blepharoplasts of anterior end; anteriorly directed flagellum longer (15-44 μm) and thicker than the trailing flagellum (12-25 μm); sub-blepharoplastic body crescent-shaped; a thin rhizoplast surrounded by a clear halo; paranuclear body round, crescentic or elongate, situated behind the nucleus; parabasal body absent.

Host : *Calotes versicolor* (Daudin); site of infection: rectum.

Distribution : India: Andhra Pradesh (Waltair, Visakhapatnam district).

34. *Proteromonas lacertae-viridis* (Grassi, 1879)

1879. *Monocercomonas lacertae* Grassi, *Gaz. Med. Ital. Lombard*, 39 : pp. 445-448.

1951. *Proteromonas lacertae-viridis*: Moskowitz, *J. Morph.*, 89 : pp. 257-321.

Diagnosis : Body fusiform, 11-13 μm in length and 2-5 μm in width; two conspicuous but unequal flagella of uniform thickness, each originating from a basal granule lying at the apex of the body; coarser and longer one usually directed anteriorly, measuring 3-4 times the length of the body; trailing flagellum seldom longer than twice the body; sub-blepharoplastic cone present below the basal granules but without any physical connection; a pre-nuclear body or acroneme, paracentrosome or "Golgi apparatus" and "peri-rhizoplastic ring" or the ring-like parabasal body (Nie, 1950) present lying between the cone and the nucleus; cytoplasm vacuolated; nucleus oval or spherical with an endosome, partially obscured by the paranuclear body.

Host : *Hemidactylus giganteus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) observed this species along with an unnamed species of *Monocercomonas* in 3 out of 14 specimens of *Hemidactylus giganteus*. It is a common flagellate occurring in a number of lizards (Moskowitz, 1951).

**35. *Proteromonas mabuiae* Saratchandra,
Vijayananda and Venkataswarlu, 1984
(Fig. 28)**

1984. *Proteromonas mabuiae* Saratchandra, Vijayananda and Venkataswarlu, *Indian J. Parasitol.*, 8(1) : pp. 125-127.

Diagnosis : Body round or slightly oval, 6.8-8.5 x 5.5-8.0 μm , or elongate forms, 10.0-16.0 μm x 2.5-5.0 μm , with rounded ends; cytoplasm containing a few small vacuoles; nucleus, 2-3 μm x 1-2 μm , situated at the anterior end; paranuclear body crescent-shaped; two flagella originated from two blepharoplasts situated at the anterior end; anteriorly directed flagellum, 15-41 μm , much thicker and longer than the trailing flagellum of 13-27 μm length; sub-blepharoplastic body small, kidney-shaped; rhizoplast present but parabasal body absent.

Host : *Mabuya beddomii* Jerdon, site of infection: rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

**36. *Proteromonas waltirensis* Saratchandra and Narasimhamurti, 1980
(Fig. 29)**

1980. *Proteromonas waltirensis* Saratchandra and Narasimhamurti, *Indian J. Parasitol.*, 4(1) : pp.73-75, figs. 1-4.

Diagnosis : Body spindle-shaped or elongate, 6.5-23.0 μm x 2.5-4.0 μm ; anterior end broader than posterior end, but both ends bluntly pointed; cell membrane thin; cytoplasm vacuolated; nucleus round or oval, 2.0-3.5 μm x 1.5-2.5 μm , central in small forms and anteriorly placed in larger forms; 2 flagella, equal in thickness, unequal in length, originating from two blepharoplasts lying close together at the anterior end, one flagellum directed anteriorly and the other directed posteriorly; a small sub-blepharoplastic body present below the blepharoplast, sometimes both appearing like a single mass; rhizoplast extending between the blepharoplasts and the nucleus; parabasal body crescent-shaped, lying close to the nucleus in some larger forms.

Host : *Hemidactylus prashadi* Smith; site of infection : rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

**37. *Proteromonas warangalensis* Bhaskar Rao, Devi, Dayakar,
Dhamodar Reddy and Bhaskar Rao, 1978
(Figs. 30 & 31)**

1978. *Proteromonas warangalensis* Bhaskar Rao, Devi, Dayakar, Dhamodar Reddy and Bhaskar Rao, *Acta Protozool.*, 17(1) : pp. 1-7.

Diagnosis : Body round, pear-shaped or oval, 6.81-11.1 (8.5) μm x 3.86-7.72 (5.94) μm ; nucleus spherical or ellipsoidal, 1.81-2.4 μm x 1.36-2.49 μm , situated at the anterior half of the body or sometimes towards the middle, with compact endosome in the centre, few individuals with 3 large granules; paranuclear body laterally compressed or oval, situated just below the nucleus or adhering to the nuclear membrane; a single blepharoplast situated at the extreme anterior end of the body; sub-blepharoplastic mass and blepharoplast fusing together to form a triangular mass; thread-like filamentous rhizoplast joining the blepharoplast and nuclear membrane; two unequal flagella arising from the blepharoplast, measuring 14.13-22.71 μm , and 15.12- 23.8 μm respectively; perirhizoplastic ring or parabasal body present.

Host : *Mabuya carinata*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Warangal district).

38. *Proteromonas* sp.

Host : *Chameleon zeylanicus*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1967) recorded this unnamed species from this state.

Proteromonas in mammals

39. *Proteromonas hystrixi* Todd, 1963

(Figs. 32 & 33)

1963. *Proteromonas hystrixi* Todd, *Arch. Protistenk.*, **107** : pp. 30-34, figs. 1-9.

Diagnosis : Body fusiform, ovoid or rounded, 3.52-16.92 (11.64) μm x 2.35-5.32 (4.62) μm ; anterior border broad and rounded while posteriorly tapering, bifurcated and forming a fork-like structure with the caudal prong separated a little or wide apart; periplast tough and rigid; cytoplasm vacuolated and denser at the periphery; anterior tip elevated knob-like; a blepharoplast, 0.93 μm in diameter situated in the anterior region, giving rise to a pair of flagella, 9.87-29.61 (20.36) μm , one very long while the other short, even shorter than the length of the body; nucleus round or elongated, average dimensions 1.30 μm x 0.73 μm , surrounded by a 'halo', located in the anterior half of the body, with distinct nuclear membrane and uniformly scattered chromatin granules; rhizoplast rod-like, 2.32-2.82 (2.72) μm in length, extending from the blepharoplast to the nucleus; paranuclear body and perirhizoplastic ring present.

Host : Indian Porcupine, *Hystrix leucura* Sykes; site of infection : caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

40. *Proteromonas rattusi* Kalavathi, Saratchandra and Sambasivarao, 1983
(Figs. 33 & 35)

1963. *Proteromonas rattusi* Kalavathi, Saratchandra and Sambasivarao, *Riv. Parassitol.*, **46**(2) : pp. 157-161.

Material examined : Sev. exs., from Visakhapatnam

Diagnosis : Body elongate with a broadly pointed anterior end and a finely pointed posterior end, measuring 11-20 μm x 2-3 μm ; nucleus 1.5-2.5 μm in diameter, containing irregular clumps of chromatin at the anterior end; two blepharoplasts bound together by a small sub-blepharoplastic mass and a thin rhizoplast extending between the blepharoplast and the nucleus; hemispherical paranuclear body present behind the nucleus; two flagella, 17-26 μm in length, equal in thickness, each originating from a blepharoplast, one anteriorly directed and the other posteriorly, posterior one slightly longer; parabasal body absent.

Host : *Rattus rattus*; site of infection : rectal content.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Order RETORTAMONADIDA

Family RETORTAMONADIDAE

Diagnosis : Uninucleate flagellates with a conspicuous cytostomal area situated ventrally in the anterior part of the cell; possessing two or four flagella, one recurrent and associated with the cytostome; mitochondria and Golgi apparatus absent; all parasitic.

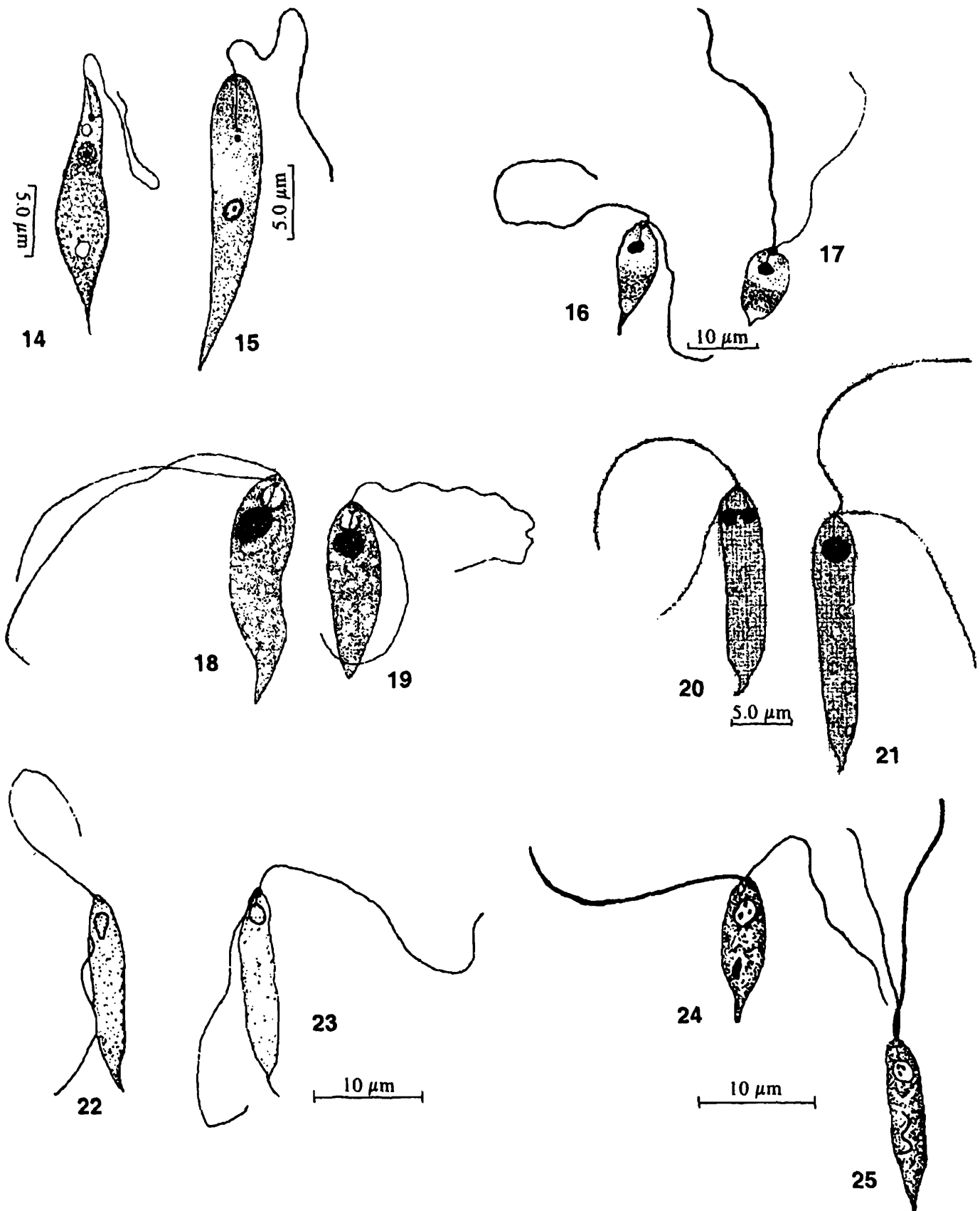
Key to the genera

- 1(2) Two flagella present, a free anterior flagellum and a recurrent flagellum associated with the cytostome; four kinetosomes or basal bodies present in two orthogonal pairs, only two kinetosomes possessing flagella, the remaining two being barren *Retortamonas*
- 2(1) Four flagella and four kinetosomes present, each kinetosomes being equipped with a flagellum; three anterior flagella and a short recurrent flagellum confined to cytostomal groove *Chilomastix*

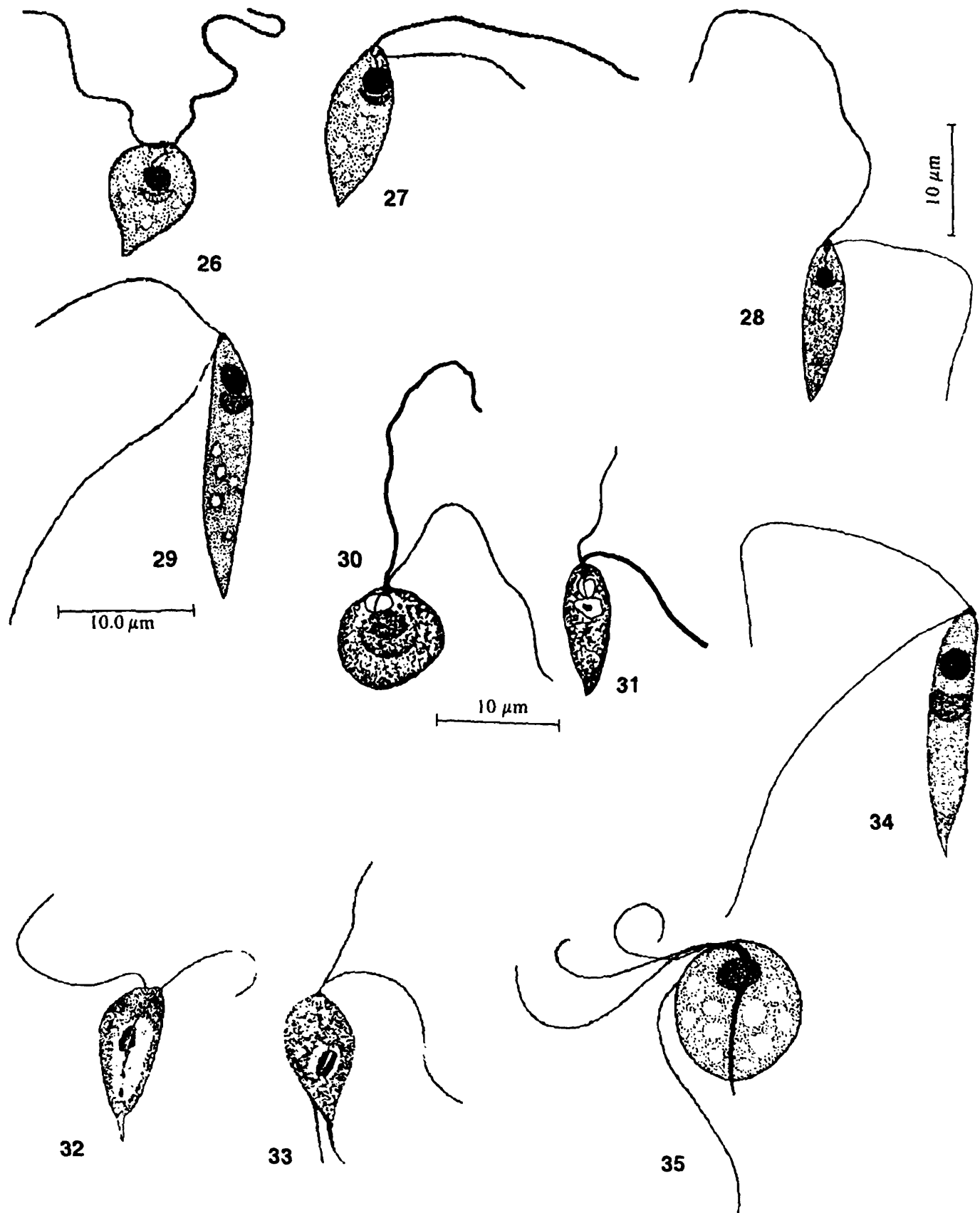
Genus *Retortamonas* Grassi, 1879

1879. *Retortamonas* Grassi, *Gaz. Med. Ital. Lombardi.*, **39** : pp. 445-448.

Diagnosis : Body plastic, usually pyriform or fusiform, drawn out posteriorly; a large cytostome toward anterior end; nucleus anterior; two flagella; cysts pyriform or ovoid; parasitic in the intestine of various animals.



Figs. 14-25. Flagellate parasites of Andhra Pradesh : 14. *Leptomonas bakeri*; 15. *L. indica*; 16-17. *Proteromonas chameleoni*; 18-19. *P. ganapatii*; 20-21. *P. grassei*; 22-23. *P. hemidactyli*; 24-25. *P. kakatiyae*.



Figs. 26-35. Flagellate parasites of Andhra Pradesh : 26-27. *Proteromonas krishnamurthyi*; 28. *P. mabuiae*; 29. *P. waltirensis*; 30-31. *P. warangalensis*; 32-33. *P. hystrixi* and 34-35. *P. rattusi*.

Key to the species of *Retortamonas*

- 1(2) Parasitic in reptiles (chelonians), body oval measuring 4.2-11.5 (7.9) μm x 3.0-6.5 (4.4) μm and with a long caudal process *R. cheloni*
- 2(1) Parasitic in insects 3
- 3(4) Tail long, measuring 3.2-58.5 (23.3) μm ; body dimensions 8-25 (18) μm x 4-15 (8.20) μm ; occurring in *Gryllotalpa africana* (Order Orthoptera) *R. wenrichi*
- 4(3) Tail not so long
- 5(6) Tail moderate, measuring 3.5-18.5 (9.7) μm ; body dimensions 9.5-15.0 (12.7) μm x 7-11 (8.2) μm ; occurring in aquatic insects, *Laccotrephes maculatus* (Order Hemiptera) *R. toddi*
- 6(5) Tail short; body dimensions ranging from 3.5-18.5 (10.8) μm x 1.5-12.0 (5.7) μm ; occurring in different terrestrial insects (Order Dictyoptera) *R. blattae*

A. *Retortamonas* in insects

41. *Retortamonas blattae* (Bishop, 1931)

1931. *Embadomonas blattae* Bishop, *Parasitology*, **26** : pp. 17-26.

Diagnosis : Body size much variable ranging from 3.5-18.5 (10.8) μm x 1.5-12.0 (5.7) μm ; nucleus with scattered chromatin granules. According to Bishop (1931) *R. blattae* measuring 6-9 μm in length and quite slender, with rounded anterior end and the posterior end terminating in a sharp spike in many individuals; nucleus rather poor in chromatin with a thin peripheral layer and a more or less well defined karyosome; flagella usually shorter than the body and their posterior end confined within the oral pouch.

Host : *Periplaneta americana*, *Blatta orientalis*, *Corydia petiveriana*, *Cryptocercus* sp., *Leucophaea sinninamensis*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Bhaskar Rao (1968, cited from Sultana, 1976) reported this species from this state.

42. *Retortamonas toddi* Bhaskar Rao, 1968 (Figs. 36 & 37)

1968. *Retortamonas toddi* Bhaskar Rao, *Riv. Parasitol.*, **29** : pp. 153-160.

Diagnosis : Body size variable measuring 9.5-15.0 (12.7) μm x 7-11 (8.2) μm , with bulged anterior end giving oval shape of the body and moderate tail end, abruptly tapering into a spike measuring 3.5-18.5 (9.7) μm at the posterior end; nucleus spherical, 2.0-3.5 μm

in diameter, with scattered chromatin granules but lacking a definite endosome, located at the anterior end; two blepharoplasts located apart on either side of the nucleus near the anterior end of oral pouch, each giving rise to one flagellum of unequal size ending in acroneme; oral pouch almost extending upto two-thirds as long as trunk of the body, bordered by a chromophile margin of two fibrils of which left one longer and right one shorter.;

Host : *Laccotrephes maculatus*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

43. *Retortamonas wenrichi* Stabler, 1944
(Figs. 38 & 39)

1944. *Retortamonas wenrichi* Stabler, *J. Parasitol.*, pp. 30 : pp. 173-176.

Diagnosis : Body dimensions 8.0-25.0 (18.0) μm x 4.0-15.0 (8.2) μm ; nucleus anteriorly placed, containing a thickly granulated mass or a large endosome; two blepharoplasts placed near the nucleus at the anterior end of the body, each giving rise to an almost equal-sized, acronematic and anteriorly directed flagellum; tail-like projection very conspicuous, measuring 2.0-38.5 (21.3) μm ; a definite periplast enclosing a granular cytoplasm, frequently with vacuoles containing bacteria and other inclusions present; cytostome prominent, anteriorly placed, bordered on one side by a longer distinctly stained cytostomal fiber and on the other by a short fibril.

Host : *Gryllotalpa africana*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district) and Maharashtra.

Remarks : Bhaskar Rao (1968, cited from Sultana, 1976) reported this species from this state. Sultana (1976) recorded this species from Maharashtra State.

B. *Retortamonas* in reptiles

44. *Retortamonas cheloni* Janakidevi, 1962

1962. *Retortamonas cheloni* Janakidevi, *Parasitology*, 52 : pp. 165-168.

Diagnosis : Body oval, measuring 4.2-11.5 (7.9) μm x 3.0-6.5 (4.4) μm , with a long caudal process of 1.0-7.0 (4.0) μm in length; nucleus round, situated at the extreme anterior end with a thin ring of chromatin adjacent to the nuclear membrane and sometimes an endosome present in the centre; cytophyge deep, extending one-third to one-half of the body-length and bordered by two siderophilic threads; two blepharoplasts, situated close to nucleus, giving rise to two unequal flagella and the two siderophilic threads; periplast rigid.

Host : Tortoise, *Testudo elegans*; site of infection: large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

45. *Retortamonas* sp.

Host : *Varanus* sp.; site of infection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

46. *Retortamonas* sp.

Host : *Zamenis mucosus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

Genus *Chilomastix* Alexeieff, 1912

Diagnosis : Pyriform, with a large cytostomal cleft at anterior end; nucleus anterior; three anteriorly directed flagella; short fourth flagellum recurrent and undulating within the cytostomal cleft; a rounded nucleus with several basophilic peripheral plaques situated anteriorly; cyst common; in intestine of vertebrates.

A. Key to the species of *Chilomastix* of amphibians

Body pear-shaped or ovoidal with a pointed spike-like posterior end; cytostome large, sac-like, extending about $\frac{1}{3}$ to $\frac{1}{2}$ the length of the body *C. qadrii*

B. Key to the species of *Chilomastix* of reptiles

- 1(4) Blepharoplasts less than four in number
- 2(3) Body oval, anterior end rounded, posterior end drawn into a short, straight or curved spike, 1 or 2 blepharoplasts, nucleus round or oval with chromatin materials uniformly distributed or irregular masses *C. kudoi*
- 3(2) Body round or oval, posterior end with a small spike, blepharoplasts 2 or 3 in number, nucleus round with distinct endosome at the centre *C. hemidactyli*
- 4(1) Blepharoplasts 4 in number, arranged in two sets with two in each set, body elongate-oval, anterior end slightly pointed and posterior end drawn out into a long spike-like tail, nucleus round with a chromatin plaque at its anterior pole *C. wenyoni*

C. Key to the species of *Chilomastix* of birds

- 1(2) Body oval or pyriform, blepharoplasts 3 in number, cytostome sac-like, nucleus round possessing a large irregular endosome with fine chromatin granules *C. graecae*

- 2(1) Body fusiform or oval, blepharoplasts 2 in number, cytostome 'V' or 'U' shaped, nucleus spherical or oval possessing 4-5 chromatin granules *C. osmaniae*

D. Key to the species of *Chilomastix* of mammals

- 1(2) Body fusiform, pear-shaped and round, blepharoplast 2 or 3 abutting or slightly above the nuclear membrane, parasitic in bandicoot rat..... *C. bandicooti*
- 2(1) Body pyriform, elongate-oval or turnip-shaped
- 3(6) Blepharoplasts not clearly visible
- 4(5) Body turnip-shaped, cytostome 8-shaped and very large covering more than two-third the length of the body, parasitic in squirrels *C. palmari*
- 5(4) Body pyriform, spiral groove absent, cytostome large and extensive, parasitic in Indian hare..... *C. nigricollisi*
- 6(3) Blepharoplast distinct
- 7(10) Blepharoplasts 3 in number, peripheral portion of the body modified into spiral groove, parasitic in gerbils *C. indica*
- 8(9) Body pyriform, spiral groove U-shaped, blepharoplasts 4 in number, 3 in one row on anterior border of the body on the cytostomal side and the remaining one lying behind them, parasitic in horse *C. equi*
- 9(8) Body typically pyriform, spiral groove not U-shaped, blepharoplast 2 in number, parasitic in rats *C. hyderabadensis*
- 10(7) Blepharoplasts 4 in number, cytostome with lips supported by siderophilic fibrils originating from the fourth blepharoplast, parasitic in Guinea-pig *C. megamorpha*

A. *Chilomastix* in amphibians

47. *Chilomastix qadrii* Krishnamurthy, 1970 (Figs. 40 & 41)

1970 *Chilomastix qadrii* Krishnamurthy, *Ann. Parasit. Hum. Comp.*, **45**(3) : pp. 261- 265, figs. 1-10.

Diagnosis : Body pear-shaped or ovoidal, measuring 7.71-13.37 (10.58) μm in length and 5.66-10.28 (8.63) μm in width, with a pointed spike-like posterior end; nucleus rounded or transversely elongated, located about μm behind the anterior tip of body, with one or two central or eccentric endosomes; blepharoplasts three, between the nucleus and anterior end; cytostome large, sac-like, about $\frac{1}{3}$ to $\frac{1}{2}$ body length and with one cytostomal fibril.

Host : *Rana tigrina* (Daud.); site of infection: large intestine and rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According to Kulda and Nohynkova (1978) *Chilomastix qadrii* Krishnamurthy, 1970 is similar to the species *Chilomastix bursa* Moskowitz, 1951 occurring in lizards. So, a taxonomic review of the species of the genus *Chilomastix* from amphibians and reptiles based on type materials/specimens is needed to determine the validity of species inhabiting herpetofauna.

B. *Chilomastix* in reptiles

48. *Chilomastix hemidactyli* Bhaskar Rao, Bhaskar Rao and Devi, 1976

1976. *Chilomastix hemidactyli* Bhaskar Rao, Bhaskar Rao and Devi, *Acta Protozool.*, 15(3) : pp.289-292.

Diagnosis : Body round or oval, measuring 7.0-15.6 μm x 4.3-8.6 μm ; nucleus round with endosome at the centre; cytostome small, $\frac{1}{4}$ or $\frac{1}{2}$ of the body length, with a distinct cytostomal fibril; five flagella, arising from 2-3 blepharoplasts, all unequal in length and much shorter than *C. kudoi*; with small posterior spike.

Host : *Hemidactylus* sp.; site of infection: rectum.

Distribution : India : Andhra Pradesh (Warangal district).

Remarks : Madre (1979) described *Chilomastix hemidactyli* as a new species from the rectal content of *Hemidactylus giganteus* from Aurangabad, Maharashtra without knowing about the species described by Bhaskar Rao *et al.* (1976) under the same name. Being preoccupied, the name of the species described by Madre (1979) is required to be changed while reviewing these parasites.

49. *Chilomastix kudoi* Saratchandra and Narasimhamurti, 1980 (Fig. 42)

1979. *Chilomastix kudoi* Saratchandra and Narasimhamurti, *Indian J. Parasitol.*, 4(1) : pp. 65-66, figs. 1-3.

Diagnosis : Body oval, measuring 10.4-14.8 μm x 5.6-10.0 μm ; anterior end rounded and posterior end narrow and drawn into a short, straight or curved spike of 2-3 μm in length (spike absent in some); cytoplasm finely vacuolated, vacuole containing bacteria and other food particles; pellicle not clearly visible; nucleus rounded or oval, 2.4-3.2 μm x 1.6-3.2 μm , with a delicate nuclear membrane, chromatic materials uniformly distributed or irregular masses; 1 or 2 blepharoplasts situated in front of the nucleus, 4 or 5 flagella arising from them, one cytostomal flagellum and one free flagellum arising from one of the two blepharoplasts lying closer to the left cytostomal fibril; remaining flagella arising from the other blepharoplast; two free flagella equal in length, 6.0-12.4 μm and the remaining unequal of 5-22 μm in length; cytostomal flagellum adhering to the cytostomal fibril for a greater part and then free distally, 5-8 μm ; cytostome extending half of the body, 6.0-8.5 μm x 1.5- 3.5 μm , narrow anteriorly and broad posteriorly; left cytostomal fibril thicker, longer and recurved at the distal portion, while the right fibril thinner, shorter and slightly curved.

Host : *Hemidactylus prashadi* Smith; site of infection: rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

50. *Chilomastix wenyoni* Janakidevi, 1961
(Fig. 43)

1961. *Chilomastix wenyoni* Janakidevi, *Z. Parasitenk.*, 20 : pp. 563-567, figs. 1-11.

Diagnosis : Body elongated-oval, measuring 8.0-28.5 (18.0) μm in length and 2.5-10.5 (6.0) μm in width, with its anterior end slightly pointed and sharply pointed posterior end drawn out into a long spike-like tail; with 4 or 3 blepharoplasts; nucleus a round vesicle placed 2 μm below the anterior end and with a chromatin plaque at its anterior pole; four flagella, three anterior and one cytostomal, arising from four blepharoplasts arranged in two sets of two each, one set located in front of the nucleus and the other to its side; cytostome a narrow elongated pouch bordered by two siderophilic fibrils extending for $\frac{1}{2}$ to $\frac{2}{3}$ of the body length.

Host : *Calotes nemoricola* Jerdon; site of infection: large intestine and caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According to Kulda and Nohynkova (1978) *Chilomastix wenyoni* Janakidevi, 1961 is a synonym of *Chilomastix bursa* Moskowitz, 1951. However, *C. wenyoni* is retained here as valid species until further review of the species of *Chilomastix* from reptiles based on type materials / specimens.

51. *Chilomastix* sp.

Host : *Varanus* sp.; site of infection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

C. *Chilomastix* in birds

52. *Chilomastix graecae* Navarathnam, 1971
(Fig. 44)

1971. *Chilomastix graecae* Navarathnam, 1971, *Proc. Indian Acad. Sci. (B)*, 74 : pp. 307-313.

Diagnosis : Body oval or pyriform, measuring 10.0-16.5(12.2) μm in length and 7.5-12.5(10.49) μm in breadth, posterior end of a few individuals drawn out into a short spine; nucleus usually round in shape situated about 1-2 μm away from anterior extremity, possessing a large irregular eccentric or centrally placed endosome with fine chromatin granules; blepharoplasts three in number situated at the anterior part of the body, two of them at the anterior extremity while the third one slightly posteriorly located in front of cytostome, two

anterior ones larger than the posterior one; flagella four in number, three anteriorly directed and one cytostomal, two arising from each of the anterior blepharoplast, two of three anterior flagella equal in length while the third one longer than two, cytostomal flagella shortest very rarely projecting beyond the cytostome; cytostome sac-like, large and conspicuous, lined by two fibrils bordering the right and left lips; cytoplasm is usually vacuolated and containing bacteria.

Host : *Alectoris graeca*; site of infection caecum and large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According to Kulda and Nohynkova (1978) *Chilomastix graecae* Navarathnam, 1971 is a possible synonym of *Chilomastix gallinarum* Martin and Robertson, 1911.

53. *Chilomastix osmaniae* Navarathnam, 1971 (Fig. 45)

1971. *Chilomastix osmaniae* Navarathnam, 1971, *Proc. Indian Acad. Sci. (B)*, **74** : pp. 307-313.

Diagnosis : Body fusiform or oval, measuring 8.5-20.0 (11.7) μm in length and 7.5-15.5 (9.98) μm in breadth, abruptly tapering into a spike at the posterior end in some assuming a turnip shape; nucleus spherical or oval, located at the anterior end or in the anterior third of the body, possessing 4-5 large chromatin granules; blepharoplasts distinct, two in number, located wide apart but above the nucleus; flagella four in number, two short unequal flagella originating from each blepharoplast, three anteriorly directed and the fourth one either extending into the cytostome or projecting outside; cytostome 'V' or 'U'-shaped, supported by very cytostomal fibril on the right side and very delicate one on the left side; cytoplasm vacuolated and containing bacteria.

Host : *Gallus gallus domesticus*; site of infection: caecum and large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According to Kulda and Nohynkova (1978) *Chilomastix osmaniae* Navarathnam, 1971 in chicken is also a possible synonym of *Chilomastix gallinarum* Martin and Robertson, 1911.

D. *Chilomastix* in mammals

54. *Chilomastix bandicooti* Todd, 1963 (Fig. 46 & 47)

1963. *Chilomastix bandicooti* Todd, *Arch. Protistenk.*, **107** : pp.79-83.

Diagnosis : Body fusiform, pear-shaped or round in living condition, entire body measuring 10.75-21.91 (14.76) μm in length and 2.82-12.22 (7.76) μm at its widest region; anterior end broad and rounded while posterior end protruding as a caudal spike of 0.94-7.05 (3.65) μm

in length; nucleus large, prominent, rounded, oval or irregular in shape, lying close to the anterior extremity; two to three blepharoplasts abutting or slightly above the nuclear membrane, connected to each other by a small rod-like rhizoplast; three anterior flagella, two of which almost equal usually united at the base, measuring 5.17-13.6 (9.14) μm in length arising from a blepharoplast; cytostome 6.58 μm on average lying adjacent to the nucleus and running posterior to it, margins bounded by the right and left chromatic fibrils; right fibril thick, running down the outer lip and ascending the inner lip of the cytostome for some distance while the left fibril thin and running down the inner lip; cytoplasm granular, highly vacuolated and containing bacteria or other food particles; spiral groove running obliquely across the body.

Host : *Nesocia bandicota*; site of infection: caecum.

Distribution : India : Andhra Pradesh : (Hyderabad district).

55. *Chilomastix equi* Abraham, 1961
(Figs. 48 & 49)

1961. *Chilomastix equi* Abraham, *J. Protozool.*, 8(1) : p. 291.

Diagnosis : Body pyriform, measuring 15.7-31.5 (19.6) μm in total body length, 8.5-16.5 (13.6) μm length of body proper, 4-17 (6.5) μm length of spike and 6-15.5 (12) μm in breadth of body; with anterior end pointed and posterior end terminating in a spike; spiral groove U-shaped; nucleus ovoidal or spheroidal, containing an eccentric endosome with either peripheral chromatin or 2 rod-like plaques; 4 blepharoplasts, 3 in one row on the anterior border of the body on the cytostomal side, and one behind them; three anterior flagella arising from first three blepharoplasts and running backwards; broad cytostome narrowed and curved posteriorly occupying $\frac{1}{2}$ to $\frac{2}{3}$ of body proper; cytostomal flagellum originating from fourth blepharoplast; chromatic cloud present.

Host : Horse, *Equus caballus*; site of infection : intestine.

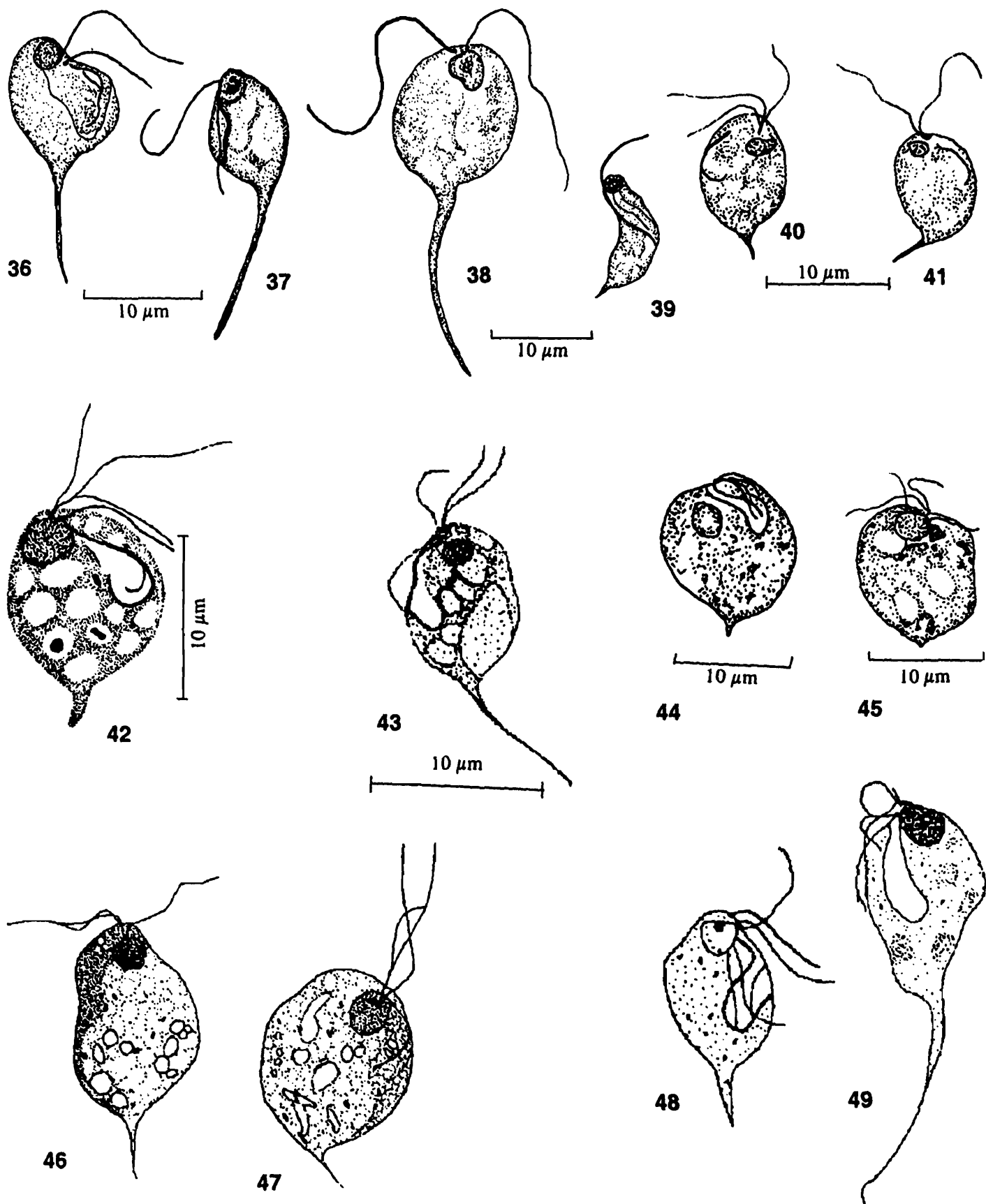
Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

Remarks : The “chromatic cloud” begins near the nucleus and extends downwards for some distance. This is not a well-defined and constant structure and is not universally present in the genus *Chilomastix*, and is not homologous with the ‘parabasal body’ (Becker, 1926; Nie, 1948; Kirby and Honigberg, 1949).

56. *Chilomastix hyderabadensis* Todd, 1963
(Fig. 50)

1963. *Chilomastix hyderabadensis* Todd, *Arch. Protistenk.*, 107 : pp. 84-88.

Diagnosis : Body typically pyriform, entire flagellate 7.99-18.33 (15.73) μm in length and 3.76-13.63 (9.06) μm at its widest region; anterior end snout-like and posterior end drawn



Figs. 36-49. Flagellate parasites of Andhra Pradesh : 36-37. *Retortamonas toddi*; 38-39. *R. wenrichi*; 40-41. *Chilomastix qadrii*; 42. *C. kudo*; 43. *C. wenyoni*; 44. *C. graecae*; 45. *C. osmaniae*; 46-47. *C. bandicooti* and 48-49. *C. equi*.

into a short pointed caudal appendage of average $2.40\ \mu\text{m}$ in length; spiral groove running across the body; cytostome prominent groove-like, average $6.44\ \mu\text{m}$ in length with lips, marginal fibrils and posteriorly directed undulating cytostomal flagellum; cytoplasm finely granulated and vacuolated with ingested bacteria; nucleus rounded or oval with distinct nuclear membrane, situated close to the anterior margin of the body; three anterior flagella, $2.81\text{--}12.03\ (8.38)\ \mu\text{m}$ in length, two generally long arising from one blepharoplast and the third from another.

Host : Indian rat, *Rattus rattus frugivorous*; site of infection: ilico-caecum, caecum and large intestine.

Distribution : India : Andhra Pradesh: (Hyderabad district).

57. *Chilomastix indica* Todd, 1963
(Fig. 51)

1963. *Chilomastix indica* Todd, *Arch. Protistenk.*, **107** : pp. 72-79.

Diagnosis : Body normally elongated, pyriform, entire flagellate measuring $10.34\text{--}21.62\ (14.94)\ \mu\text{m}$ in length and $6.11\text{--}10.81\ (8.65)\ \mu\text{m}$ at its widest region, with a broad anterior end, sides more or less convex and posteriorly tapering abruptly into a caudal spike of $2.35\text{--}7.05\ \mu\text{m}$ length; cytoplasm highly vacuolated with vacuoles of varying size; peripheral portion of the body modified into spiral groove; nucleus spherical, rarely ellipsoidal, with a distinct nuclear membrane, lying to the left of the cytostome, either appressed against the three anterior blepharoplasts or slightly withdrawn from the apex; nuclear rhizoplast, transverse rhizoplast and peristomal rhizoplast present; primary blepharoplast giving rise to two left anterior flagella, secondary blepharoplast giving rise to single right anterior flagellum and the tertiary blepharoplast connected to peristomal rhizoplast, secondary blepharoplast, undulating cytostomal flagellum and giving rise to curved right fibril; three anterior flagella free throughout their whole course and almost equal, measuring $5.64\text{--}15.04\ (10.34)\ \mu\text{m}$ in length; cytostome small compared to the size of the body, measuring $4.23\text{--}8.93\ \mu\text{m}$ in length.

Host : *Gerbillus indicus*; site of infection : alimentary canal.

Distribution : India : Andhra Pradesh (Hyderabad district)

58. *Chilomastrix megamorpha* Abraham, 1961
(Figs. 52 & 53)

1961. *Chilomastrix megamorpha* Abraham, *Z. Parasitenk.*, **21** : pp. 159-163.

Diagnosis : Body elongated oval, $24.0\text{--}42.6\ (31.6)\ \mu\text{m}$ x $10.0\text{--}20.5\ (15.3)\ \mu\text{m}$, with a slightly pointed anterior end, and a spike at the posterior end; cytoplasm crowded with irregular vacuoles and bacterial inclusions; nucleus chestnut-shaped, containing endosomal substance, situated below the anterior border of the body at a distance of about 1/3 its own

diameter; cytostome oblong and its lips supported by two siderophilic fibrils; four blepharoplasts present, first three in a row arising from the first three blepharoplasts at the anterior margin of the body, the fourth one cytostomal flagellum and the cytostomal fibrils arising from the fourth blepharoplast close to anterior tip of the nucleus;

Host : *Cavia cutleri*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

59. *Chilomastix nigricollisi* Todd, 1963

(Figs. 54 & 55)

1963 *Chilomastix nigricollisi* Todd, *Arch. Protistenk.*, **107** : pp. 88-92.

Diagnosis:- Body pyriform, measuring 6.11-7.52 (6.75) μm in entire length and 3.76-6.58 (5.45) μm at its widest region, with or without spike; anterior end usually pointed or rounded possessing three anterior either equal or unequal flagella, 4.23-6.58 (5.43) μm in length, sometimes united at their base only; cytostome large and extensive, average 3.17 μm in length with two cytostomal fibrils, cytostomal flagellum extending to the entire length of cytostomal groove; cytoplasm granular with vacuoles of various sizes, spiral groove absent; nucleus invariably rounded in shape, situated at the extreme anterior end of the body greatly obscuring the blepharoplasts.

Host : Indian hare, *Lepus nigricollis*; site of infection: caecum downwards.

Distribution : India : Andhra Pradesh: (Hyderabad district).

60. *Chilomastix palmari* Todd, 1963

(Figs. 56 & 57)

1963. *Chilomastix palmari* Todd, *Arch. Protistenk.*, **107** : pp. 94-97.

Diagnosis : Body turnip-like, entire flagellate 6.58-10.81 (9.58) μm in length and 5.64-8.93 (7.40) μm at its widest region; anterior end round and dome-like and posteriorly with a caudal spike of average 2.03 μm in length; cytoplasm crowded with vacuoles of various sizes; nucleus more or less rounded or conical, located at the anterior extremity, with distinct nuclear membrane and peculiar disposition of chromatin in the form of horse-shoe shape or restricted to posterior half of the nucleus; cytostome '8'-shaped, very large covering more than two-third the length of the body bordered with prominent fibrils; blepharoplasts not clearly visible; three anterior flagella, 5.64-13.63 (8.54) μm in length, two of them arising together.

Host : Palm squirrel, *Sciurus palmarum*; site of infection: caecum.

Distribution : India : Andhra Pradesh : (Hyderabad district).

Order DIPLOMONADIDA
Suborder ENTEROMONADINA
Family ENTEROMONADIDAE

Diagnosis : One karyomastigont equipped with one to four flagella, and in case of several flagella, one recurrent and associated with a shallow cytostome; funis always present; mitochondria and Golgi apparatus absent.

Remarks : Kulda and Nohynkova (1978) erected this family Enteromonadidae with the type genus *Enteromonas* accomodating other two genera, *Trimitus* and *Caviomonas*. Members of this family are small flagellates which live as harmless commensals in the intestine of various animals, both vertebrates and invertebrates.

Key to the genera

- 1(2) With four flagella of which one recurrent; funis following the recurrent flagellum on the ventral side of the body *Enteromonas*
2(1) With one free flagellum; funis present along the dorsal side of the body
..... *Caviomonas*

Genus *Enteromonas* da Fonseca 1915

1915. *Enteromonas* da Fonseca, *Brazil-Medico*, 29 : p. 281.

Diagnosis : Spherical or pyriform though plastic; three anterior flagella; the fourth flagellum running along the flattened body surface and extending a little freely at the posterior tip of the body; nucleus anterior; no cytostome; cyst ovoid and with four nuclei when mature; parasitic in mammals.

Remarks : da Fonseca (1915) originally observed only three flagella and no cysts. Wenyon and O'Connor (1917) noticed four flagella and encysted forms in *Tricercomonas*. In da Fonseca's original preparations, Dobell (1935) observed four flagella as well as cysts and concluded that *Enteromonas* and *Tricercomonas* are one and the same flagellate.

61. *Enteromonas ratti* Navarathnam, 1970 (Figs. 58 & 59)

1970. *Enteromonas ratti* Navarathnam, *Acta Protozool.*, 8 : pp. 155-165.

Diagnosis : Parasite spherical or oval, measuring 2.25-6.50 μm in length and 2.0-6.0 μm in breadth; nucleus vesicular, spherical or oval, measuring 1.0-2.5 μm x 0.75-3.0 μm , situated at the anterior part of the body, containing dense mass of chromatin granules; blepharoplasts distinct, usually four, situated quite away from each other at the anterior part of the body; flagella four, each arising from a blepharoplast, three unequal flagella shorter or equal to the

body, 2.0-6.0 μm , directed anteriorly while the fourth one recurrent or trailing flagellum, 3.5-12.0 μm , always longer than the body, running posteriorly along the body surface; a filament-like funis extending posteriorly up to three fourths of the body length never associated with the recurrent flagellum after arising from the blepharoplast.

Host : Indian rat, *Rattus rattus frugivorous*; site of infection : intestine.

Distribution : India : Andhra Pradesh : (Hyderabad district).

Genus *Caviomonas* Nie, 1950

1950. *Caviomonas* Nie, *J. Morphol.*, **86** : pp. 381-494.

Diagnosis : Body naked, without chromatophores and with a vesicular nucleus at the anterior end; one flagellum arising from the nuclear membrane, directed freely either anteriorly or posteriorly; a band-like peristyle running posteriorly along the periphery of the body surface after arising from the nuclear membrane opposite to the origin of the flagellum; cytostome and contractile vacuole absent.

62. *Caviomonas frugivori* Navarathnam, 1970 (Fig. 60)

1970. *Caviomonas frugivori* Navarathnam, *Acta Protozool.*, **8** : pp. 155-165.

Diagnosis : Body spherical, oval or irregular in shape, measuring 2.5-8.0 μm in length and 2.0-5.0 μm in breadth; cytoplasm granular and vacuolated, food vacuoles containing bacteria and other particles; nucleus spherical, oval or transversely elongated, 1.0-2.0 μm in length and 1.0-3.0 μm in breadth, containing 3-4 compact chromatin grains, situated at the anterior end of the body; a small blepharoplast situated on one side of the nucleus; a long flagellum, 4.0-16.0 μm in length, three to four times as long as the body, extending backwards or side-wise but occasionally forwards, always terminating in a fine acroneme but never adhering to the body surface after originating from the blepharoplast; a fine thread-like funis arising from the blepharoplast and adhering to the body surface; a filament-like peristyle, 1.0-4.0 μm , running on the opposite side of the funis, passing along the peripheral surface of the body up to the posterior end.

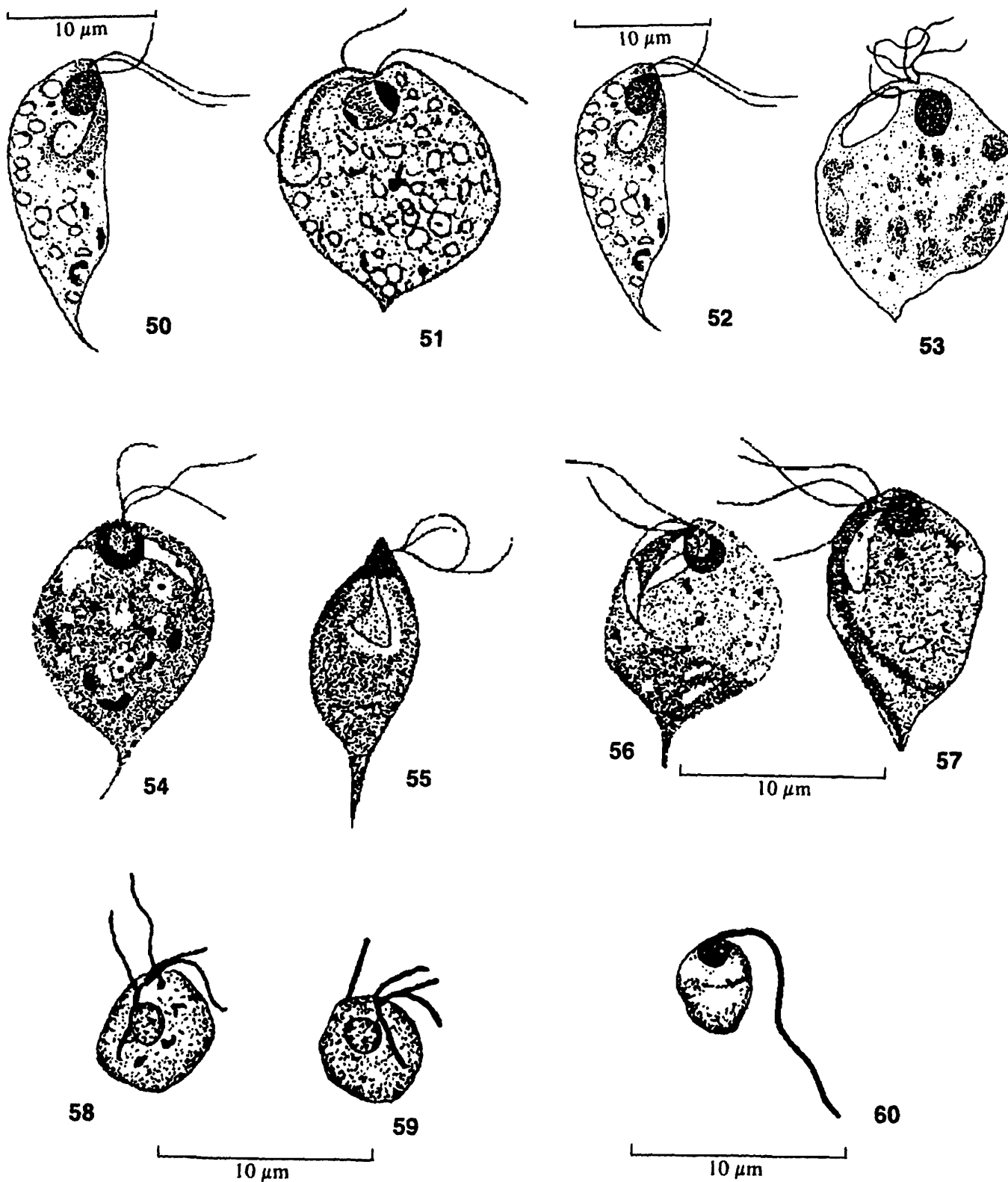
Host : Indian rat, *Rattus rattus frugivorous*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Suborder DIPLOMONADINA

Family HEXAMITIDAE

Diagnosis : Two karyomastigonts, body with two-fold rotational symmetry or bilateral symmetry, each mastigont with 4-flagella, one of them recurrent; accessory fibrillar structures present; mitochondria and Golgi apparatus absent.



Figs. 50-60. Flagellate parasites of Andhra Pradesh : 50. *Chilomastix hyderabadensis*; 51. *C. indica*; 52-53. *C. megamorpha*; 54-55. *C. nigricollisi*; 56-57. *C. palmari*; 58-59. *Enteromonas ratti* and 60. *Caviomonas frugivori*.

Subfamily HEXAMITINAE

Diagnosis : Trophozoites possessing two cytostomes, each accompanied with a microtubular band of funis and with lamellar, striated root fibril; one recurrent flagellum bounded by a cell membrane traversing each cytostome and emerging posteriorly; freeliving, saprozoic and parasitic.

Genus *Hexamita* Dujardin, 1841

1841. *Hexamitus* Dujardin, *Histoire naturelle des zoophytes, Infusoires*, Paris.

Diagnosis : Pyriform; two nuclei near anterior end; six anterior and two posterior flagella; two axostyles; one to two contractile vacuoles in free-living forms; cytostome obscure; endoplasm with refractile granules; encystment; in stagnant water or parasitic.

Remarks : This genus has often been referred as *Hexamitus* but it is considered as *Hexamita* following Kulda and Nohynkova (1978).

Key to the species of *Hexamita* in insects

- 1(2) Body pyriform rod-like axial structures; without any thickenings at the posterior ends, long acronematic eight flagella *H. gryllotalpae*
- 2(1) Body round and dentated posterior end; axostyle tubular, uniform in diameter, or slightly dilated posteriorly; with typical caudal fissures; eight short flagella
..... *H. hongbergi*

Key to the species of *Hexamita* in amphibians

Body inverted fig-shaped, 6.2-10.3 μm x 3.6-8.2 μm ; two blepharoplasts, each giving rise to three anterior unequal flagella; two axostyles filamentous *H. hoarei*

Key to the species of *Hexamita* in reptiles

Body spherical, 8.0-8.5 μm in diameter; blepharoplast complex variable; axostyle continued beyond the body along with posterior flagella *H. kakatiyae*

Key to the species of *Hexamita* in birds

Body pyriform, 5.5-10.0 μm x 3.0-7.5 μm ; blepharoplasts two in number; three pairs of anterior flagella, unequal in size *H. singhi*

Key to the species of *Hexamita* in mammals

- 1(2) Body pyriform or rounded, 3.96-8.93 μm x 3.29-4.70 μm in dimensions, cytoplasm, vacuolated and opaque, nuclei ellipsoidal, a chromatic ring or loop at posterior end, parasitic in Bandicoot-rat *H. nesocium*

- 2(1) Body pyriform, oval or round, cytoplasm not opaque, chromatic ring or loop as above lacking
- 3(4) Body rounded, 7.05-9.40 μm x 5.17-7.52 μm , cytoplasm containing few vacuoles and small, highly siderophilic and deep staining bodies, parasitic in house rat *H. pigmentatus*
- 4(3) Body usually oval or pyriform, 4.70-9.75 μm x 3.29-6.58 μm , periplast very thin and cytoplasm uniformly stained, two chromatin masses rounded or ellipsoidal in appearance, parasitic in Gerbils *H. spinulus*

A. *Hexamita* in insects

63. *Hexamita gryllotalpae* Bhaskar Rao, 1968 (Figs. 61 & 62)

1968. *Hexamitus gryllotalpae* Bhaskar Rao, *Riv Parassitol.*, 29 : pp. 241-246.

Diagnosis : Body usually round or pyriform in some, measuring 6.0-10.0 (7.4) μm x 4.5-10.0 (6.6) μm ; nuclei often closely associated with each other giving a bilobed shape, sometimes appearing as a single mass, containing a prominently large karyosome separated from the nuclear membrane by a clear zone; six anterior flagella, equal in size, 9-23 (12.9) μm , nearly twice the length of the body, mostly ending in fine acronemes; two caudal flagella also equal to the length of the anterior flagella and ending in fine acronemes; with two thin rod-like axial structures, slightly thicker than the flagella.

Host : *Gryllotalpa africana*; site of infection : rectum.

Distribution : India: Andhra Pradesh (probably Hyderabad district, exact locality not mentioned)

64. *Hexamita honigbergi* Bhaskar Rao, 1968 (Figs. 63 & 64)

1968. *Hexamitus honigbergi* Bhaskar Rao, *Riv Parassitol.*, 29 : pp. 241-246.

Diagnosis : Body round, measuring 6.0-14.0 (9.6) μm x 6.0-14.0 (8.7) μm , with dentated anterior surface of the body in a few forms; two nuclei, very small 1.5 μm in diameter and having large endosomes, situated close to each other at the anterior end of the body; blepharoplasts not visible in many cases but a few individuals with three pairs of blepharoplasts adjoining the nuclear membrane giving rise to three pairs of very short non-acronemattic flagella averaging 8-12 (8.4) μm in length, always directed side ways; caudal flagella not prominent, length of all the free flagella as long as the body; two axial structures, tubular, uniform in diameter (known as caudal fissures) or slightly dilated posteriorly, running parallel or divergent up to the posterior end of the body.

Host : *Gryllotalpa africana*; site of infection: rectum.

Distribution : India : Andhra Pradesh (probably Hyderabad district; exact locality not mentioned).

B. Hexamita in fishes

65. *Hexamita* sp.

Host : *Gobius giuris*; site of infection: intestine.

Distribution : India : Andhra Pradesh.

Remarks : Qadri (1962) reported this unnamed species from this state without mentioning the collection site.

C. Hexamita in amphibians

66. *Hexamita hoarei* Krishnamurthy, 1967

(Fig. 65)

1967. *Hexamitus hoarei* Krishnamurthy, *Riv. Parassitol.*, **28**(4) : pp. 233-237, figs. 1-8.

Diagnosis : Body inverted fig-shaped, with a broad and rounded anterior end and a slightly conical posterior end, 6.2-10.3 (8.1) μm in length and 3.6-8.2 (5.4) μm in breadth; cytoplasm homogenous without any granules or bacteria; two blepharoplasts at the anterior end, each giving rise to three anterior subequal flagella, shortest measuring 7.2-13.4 (11.0) μm and longest 11.8-23.1 (14.7) μm ; two axostyles filamentous, crossing each other while extending up to the posterior end of the body and beyond the body as posterior trailing flagella (av. 16 μm in length); a large chromatic ring encircling the axostyles near the posterior end of the body; two nuclei oval, appearing bilobed mass, with two endosomes inside a common nuclear membrane, situated just behind the blepharoplasts.

Host : *Rana tigrina*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According to Kulda and Nohynkova (1978) *Hexamita* (= *Hexamitus*) *hoarei* Krishnamurthy, 1967 is a possible synonym of *Octomitus neglectus* (Lavier, 1936) occurring as infrequent commensal of the cloaca of various anuran and urodelan amphibians. The broadly ovoid body of *O. neglectus* measures 8-12 μm x 6-8 μm . The columnna attenuated in the second fourth of the body and conspicuously widened posteriorly, terminating in a broad and blunt caudal spike. The length of the flagella surpasses slightly that of the body. However, *H. hoarei* is retained herein until further review based on type materials / specimens.

D. *Hexamita* in reptiles**67. *Hexamita kakatiyae* Bhaskar Rao, 1975**

1975. *Hexamastus kakatiyae* Bhaskar Rao, *Curr. Sci.*, **44**(5) : p. 173.

Diagnosis : Body spherical, 8.0-8.5 μm in diameter; blepharoplast complex variable, either fused rod-like structure at the anterior region of the two nuclei with anterior subequal flagella, or in others anterior flagella ending in axoneme; axial structure rod-like, separated to a greater extent but in few forms crossed; axostyle continued beyond the body along with the posterior flagella running close to each other and ending in acroneme; two nuclei round mass-like, associating to form a single lobe, sometimes these nuclei possessing large chromatin granules; cysts very small, 3.5 μm in diameter, oval in shape.

Host : *Calotes versicolor*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Kakatiya, Warangal district).

68. *Hexamita* sp.

Host : *Chameleon zeylanicus* ; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

69. *Hexamita* sp.

Host : *Varanus* sp.; site of infection : intestine

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

E. *Hexamita* in birds**70. *Hexamita singhi* Navarathnam, 1970**

1970. *Hexamitus singhi* Navarathnam, *Zool. Anz.*, **185** : pp. 450-454.

Diagnosis : Body pyriform or oval, 5.5-10.0 (6.7) μm x 3.0-7.5 (5.0) μm , greatest width at anterior third of the body; with two oval nuclei containing spherical endosomes with chromatin granules around, nuclei often fused together and appearing as a bilobed mass, even as a single mass in some; blepharoplasts two in number; three pairs of anterior flagella, directed anteriorly or laterally, unequal in size, 1st pair measuring 8.2 (5.5-14.0) μm , shorter than the other two pairs of 10 (7.0-16.0) μm ; two axostyles 4.8 (3-7) μm , filamentous, crossing each other in the middle; caudal flagella very short, 6.6 (3-12) μm , as continuation of posterior ends of axostyles; cytoplasm granular containing some inclusions; periplast thin.

Host : *Anas* sp.; site of infection : alimentary canal.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : This species is treated as a synonym of *Spironucleus meleagridis* (McNeil, Hinshaw and Kofoid, 1941) by Kulda and Nohynkova (1978). The trophozoites of genus *Spirunucleus* Lavier, 1936 have an elongate body tapering posteriorly and possesses two relatively narrow cytostomes from which recurrent flagella protruding caudally in a long trailing portion and with two sausage-shaped slightly spiral nuclei closely adjacent at their apical ends forming a horseshoe-shaped complex in the anterior part of the cell. *S. meleagridis* is a pathogenic species of cosmopolitan distribution causing catarrhal enteritis (hexamititis) in turkey poults. Its characterized by an elongate body, tapering in the posterior fifth, measuring 6-12 μm x 2-5 μm for specimens from turkeys, nuclei relatively short and extending to one-fifth of the body length and cytostomes opening in the posterior one-fifth of the body. There are some resemblances as well as differences between *S. meleagridis* and the present species, *H. singhi* Navarathnam, 1970. Therefore, the latter is retained until further taxonomic review of the family Hexamitidae from birds based on type materials / specimens.

F. *Hexamita* in mammals

71. *Hexamita nesocium* Todd, 1963 (Figs. 66 & 67)

1962. *Hexamitus nesocium* Todd, *Arch, Protistenk.*, **107** : pp. 102-106.

Diagnosis : Body pyriform or rounded and sometimes oval, measuring 3.96-8.93 (5.58) μm x 3.29-4.70 (3.91) μm in dimension; cytoplasm somewhat vacuolated and opaque; nuclei ellipsoidal, situated at the rounded anterior surface of the body and opposed to each other with their anterior ends in contact and their axes diverging obliquely posterior-ward; a relatively large, spherical blepharoplast at the posterior end of each nucleus; six anterior flagella unequal, ranging from 3.76-8.93 μm in length, first pair shortest and the third pair longest; two axostyles wide apart, arising anteriorly and passing backward between the nuclei to converge posteriorly into a projection but never protruding outside the body; a chromatic ring or loop at the posterior end; a basal granule on each side at the junction of the chromatic ring with the axial filaments; a third granule at the converged tip of the axial filaments from which the caudal spine extending posteriorly.

Host : *Nesocia* (= *Nesokia*) *bandicota*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : *Hexamita nesocium* (= *Hexamitus nesocium* Todd, 1963) is considered to be a synonym of *Octomitus intestinalis* Prowazek, 1904 by Kulda and Nohynkova (1978). The species, *Octomitus intestinalis* is a common commensal living in the caecum of laboratory and wild rodents. It has a teardrop-shaped body, measuring 6-10 μm x 3-5 μm , with a broadly

rounded anterior end, and having the length of flagella equals approximately that of the body. The column is of uniform thickness throughout the body extending posteriorly in an elongate sharp spike. However, the species *H. nesocium* is retained herein until further review based on type materials /specimens.

72. *Hexamita pigmentatus* Todd, 1963
(Fig. 68)

1965. *Hexamitus pigmentatus* Todd, *Arch. Protistenk.*, **107** : pp. 106-110.

Diagnosis : Body rounded but variable when alive, measuring 7.05-9.40 (7.52) μm x 5.17-7.52 (6.48) μm in dimensions; anterior end rounded while tapering to a slight extent posteriorly; cytoplasm thin containing a few vacuoles and small, highly siderophilic and deep staining bodies; two ellipsoidal nuclei sometimes forming a girdle at the anterior extremity; two to four dark bodies in the anterior region of the nucleus; blepharoplasts large, rounded and situated in close contact and posterior to either of the nuclei; six anterior flagella, 6.58- 13.16 (10.81) μm in length, third pair usually long, directed posteriorly or anteriorly arising from these blepharoplasts; axial structures consisting of two axial fibrils, arising close to the blepharoplasts, running posteriorly parallel to each other and converging into a pointed end after being connected by the chromatic loop, thus resulting in the formation of a spear-head; lateral and apical basal granules as in *H. nesocium*; caudal spine very delicate or obscure; posterior flagella 5.64-12.22 (9.76) μm , arising from the lateral granules.

Host : *Rattus rattus frugivorous*; site of infection: caecum and upper part of large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : *Hexamita pigmentatus* (= *Hexamitus pigmentatus* Todd, 1963) is considered to be a synonym of *Octomitus intestinalis* Prowazek, 1904 by Kulda and Nohynkova (1978). However, this species *H. pigmentatus* is retained herein until further review based on type materials/specimens.

73. *Hexamita spinulus* Todd, 1963
(Fig. 69)

1963. *Hexamitus spinulus* Todd, *Arch. Protistenk.*, **107** : pp. 97-102.

Diagnosis : Body oval or pyriform, rounded in some, measuring 4.70-9.75 (7.99) μm x 3.29-6.58 (5.17) μm ; periplast very thin and cytoplasm uniform stained; two chromatin masses, rounded or ellipsoidal in shape, lying on each side at the anterior end, projecting as a single mass or disc giving a cap-like appearance; two round blepharoplasts, each posterior to each of the nuclei; six anterior flagella arranged in two lateral sets of three each, arising from the blepharoplast of each side, anterior-most pair directed forward and the others backward, second pair long, intermediate and the first pair short, measuring 3.76-9.93 (7.52) μm in

length; two axostyles, each arising from the blepharoplast of that side, extending posteriorly into a caudal spear-head projection being connected to each other at this region; a chromatic ring, one apical and two lateral basal granules present at this region, caudal spine projecting from the apical granule while a posterior flagellum trailing from each of the lateral granules.

Host : Indian Gerbille, *Gerbillus indicus*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : *Hexamita spinulus* (= *Hexamitus spinulus* Todd, 1963) is considered to be a synonym of *Octomitus intestinalis* Prowazek, 1904 by Kulda and Nohynkova (1978). However, the species *H. spinulus* is retained herein until further review based on type materials/specimens.

Subfamily GIARDIINAE

Diagnosis : Cytostome absent; flagella possessing intracytoplasmic portions of naked axonemes entering the cell membrane sheaths at the site of emergence; parasitic.

Key to the genera

- 1(2) Eight flagella in four pairs, two anterior and two posterior, with a sucking disc in anterior half; parasitic in the intestine of various vertebrates *Giardia*
- 2(1) Parasites having eight flagella but without any sucking disc; harmless commensals of vertebrates *Octomitus*

Genus *Giardia* Kuntzler, 1882

1882. *Giardia* Kuntzler, C. R. Acad. Sci., **97** : p. 755.

Diagnosis : Body pyriform to ellipsoid with anterior end broadly round and posterior end drawn out, bilaterally symmetrical, ventral side with a sucking disc in anterior half, 2 anterior nuclei, 2 slender axostyle and 8 flagella in 4 pairs present.

Remarks : Since diagnosis / description of *Giardia qadrii* is not available, it has not been included in the key to the species of the genus *Giardia* dealt with here.

Key to the species of *Giardia* of mammals

- 1(4) Trophozoites broadly pyriform
- 2(3) Dimensions 9-20 μm x 5-10 μm ; nuclei vesicular and located near anterior margin; parasitic in man, monkeys and other mammals *L. intestinalis*
- 3(2) Dimensions 11.8-20.0 μm x 5.0-12.5 μm , length/breadth ratio 2:1, nucleus located near

the posterior margins of sucking discs, chromatin granules present in the form of a ring in the centre of the nucleus, parasitic in palm civet..... *G. dasi*

4(1) Trophozoites slenderly pyriform

5(6) Dimensions 9-16 μm x 6-11 μm ; L/ B ratio 1.4; nuclei teardrop-shaped, located at the centre of the sucking discs, containing a clear endosome, parasitic in rats
..... *L. indica*

6(5) Dimensions 12.0-20 μm x 5.5-11.5 μm , length/breadth ratio 1.7, nuclei located near the posterior margins of sucking discs, chromatin granules distributed along the periphery of nucleus, parasitic in the Slender Loris *G. wenyoni*

A. *Giardia* of mammals

74. *Giardia dasi* Abraham, 1962

1966. *Giardia dasi* Abraham, *Parasitology*, 52 : pp. 159-164.

Diagnosis : Body 11.8-20.0 (15.5) μm in length and 5.0-12.5 (7.2) μm in breadth; L/B ratio 2.1; distance from anterior end to centre of nucleus 4.7 μm , centre of nucleus to ends of lateral shields 6.0 μm , ends of lateral shields to posterior end 5.4 μm ; breadth across the centre of nucleus 6.6 μm and across ends of lateral shields 3.5 μm ; length of sucker 6.0 μm and ratio of body length to sucker length 2.5; high L/B ratio (2.1) due to great length of tail (5.4 μm); sucking disc (6.0 μm) small in proportion to the length of the body; nucleus located near the posterior margins of the sucking discs, poor in chromatin, chromatin granules present in the form of a ring in the centre of the nucleus; cytoplasm with certain characteristic large granules, lying in front of the nucleus in the form of a cap.

Host : Common Palm Civet, *Paradoxurus hermaphroditus hermaphroditus* (Schreber); site of infection : duodenum.

Distribution : India : Andhra Pradesh (Hyderabad district).

75. *Giardia indica* Saratchandra, Sambasivarao and Kalavati, 1982

(Fig. 70)

1982. *Giardia indica* Saratchandra, Sambasivarao and Kalavathi, *Indian J. Parasitol.*, 6(2) : pp. 281-284.

Material examined : Sev. exs. on slides obtained from the House rat of the residential buildings in Waltair by B. Saratchandra.

Diagnosis : Body pear-shaped, bilaterally symmetrical, measuring 9-16 (11.5) μm x 6-11 (8.5) μm ; cell membrane thin; cytoplasm hyaline and homogenously stained; nuclei teardrop-shaped, 2-3 μm x 1-2 μm , containing a clear endosome; adhesive disc 6.0-10.5 (7.56) μm x 6.0-10.5 (7.50) μm ; length of cell body / length of the disc 1.43-1.80 (1.53); four flagella

originating from the kinetosomal complex situated on the median line in between the nuclei; antero-lateral flagella 11-24 μm , posterolateral flagella 11-17 μm , ventral flagella 12-20 μm and the caudal flagella 16-27 μm in length; median bodies elongate, located in the centre and lying parallel to the longitudinal axis of the body.

Host : *Rattus rattus*; site of infection : small intestine.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

76. *Giardia intestinalis* (Lambl, 1859)

(Figs. 71 & 72)

1859. *Cercomonas intestinalis* Lambl, *Viert. Prakt. Heilk.*, **61** : p. 1.

1966. *Giardia intestinalis* Lambl: Kudo, *Protozoology*, p. 452.

Diagnosis : Trophozoite broadly pyriform, 9-20 μm x 5-10 μm ; axostyle needle-like; two nuclei oval and vesicular and located near anterior margin; eight flagella originating in the kinetosomal complex situated on the midline between the nuclei, two emerging ventrally to be located in the ventrocaudal groove, two anterolaterally, two posterolaterally, and two caudally; a pair of fang-shaped median bodies situated transversly across the body and dorsally to the posterior end of the adhesive disk; length of the adhesive disk less than half the body length.

Host : *Homo sapiens*; site of infection: duodenum, jejunum and upper part of small intestine.

Distribution : India : Andhra Pradesh (in all districts).

Remarks : It is a pathogenic species occurring in man, domesticated mammals, rodents other mammals, birds and reptiles. Hussain *et al.* (1994) reported on the increased risks of giardiasis in persons with haptoglobin in 2-1 phenotypes.

77. *Giardia qadrii*, Navarathnam, 1969

1969. *Giardia qadrii* Navarathnam, *Riv. Parassitol.*, **30** : pp. 1-6.

Diagnosis : Not available.

Host : *Capra hircus*; site of infection.

Distribution : India : Andhra Pradesh (Hyderabad district)

Remarks : According to Kulda and Nohynkova (1978) *Giardia qadrii* Navarathnam, 1969 may be considered to be a synonym of *Giardia caprae* Nieschulz, 1923, a species defined by host having no description or insufficient description. So, this species *G. qadrii* is retained in the present paper until further review based on type materials / specimens.

78. *Giardia wenyoni* Abraham, 1962

1963. *Giardia wenyoni* Abraham, *Parasitology*, **52** : pp. 159-164

Diagnosis : Body 12.0-20.0 (15.6) μm in length and 5.5-11.5 (8.8) μm in breadth; L/B ratio 1.7; distance from anterior end to centre of nucleus 4.5 μm , centre of nucleus to ends of lateral shields 7.0 μm , ends of lateral shields to posterior end 3.6 μm ; breadth across the centre of nucleus 7.7 μm and across ends of lateral shields 4.6 μm ; length of sucker 6.2 μm and ratio of body length to sucker length 2.5; peculiar shape due to great distance (7.0 μm) between centre of nucleus to the ends of lateral shields; comparatively short tail (3.6 μm); sucking disc small compared to size of the body; nuclei situated close to the posterior edge of the sucking discs, containing chromatin granules along the periphery, somewhat pointed at the anterior end and not lying parallel to the axostyles.

Host : Slender Loris, *Loris tardigradus lydekkerianus* Cabrera; site of infection: duodenum.

Distribution : India : Eastern Ghats which includes Andhra Pradesh; exact locality not mentioned.

Remarks : The host was purchased from a dealer in Bangalore, Karnataka State (Abraham, 1962). The geographic distribution of this subspecies of the Slender Loris is within the Eastern Ghats. The Eastern Ghats in Andhra Pradesh pass through the districts of Srikakulam, Vizianagaram, Visakhapatnam, East and West Godavari, and parts of Khammam, Krishna, Guntur, Prakasam, Nellore, Kurnool, Anantapur, Chittoor and Cuddapah.

***Octomitus* Prowazek, 1904**

1904. *Octomitus* Prowazek, *Arb. Kaiserlich. Gesundheitsamte*, **21** : pp. 1-41.

Diagnosis : Eight flagella, six anteriorly directed and two posteriorly directed; nucleus bean-shaped; adhesive disk absent; parasitic in vertebrate hosts.

Remarks : Though this genus is considered to be a synonym of the genus *Hexamita* (= *Hexamitus*) by some investigators (Wenyon, 1926; Kudo, 1966), it is treated herein as valid genus following Kulda and Nohynkova (1978).

**79. *Octomitus rattusi* Saratchandra, Sambasivarao and Kalavati, 1982
(Fig. 73 & 74)**

1982. *Octomitus rattusi* Saratchandra, Sambasivarao and Kalavati, *Indian J. Parasitol.*, **6**(2) : pp. 289-290.

Material examined : Sev. exs. on slides deposited in the Zoology Department, Andhra University, Waltair.

Diagnosis : Body round or oval, 8-11 (8.5) μm x 6-10 (8.0) μm , possessing two karyomastigonts arranged in binary axial symmetry; cytoplasm with a few vacuoles; two nuclei bean-shaped, averaging 1.7 μm x 1.4 μm in diameter, contained a small centrally

placed endosome; each mastigont with 4 flagella arising from a kinetosomal complex; flagella unequal in length, measuring 6-14 (10) μm ; recurrent flagella 9-16 (11.7) μm , continued as free flagella after separation from the columna at the posterior end; columna 5-10 μm in length, uniformly thick, and not extending beyond the cell body.

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

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

Remarks : The species is treated herein under the genus *Octomitus* of the family Hexamitidae and subfamily Giardinae following Kulda and Nohynkova (1978).

Order OXYMONADIDA

Family POLYMASTIGIDAE

(Syn. Monocercomonididae Honigberg, 1963)

Diagnosis : Trophozoites possessing four flagella arranged in two separated pairs; a simple and slender axostyle and an anteriorly located large pelta present; nucleus round vesicular with a large spherical endosome capped anteriorly with a preaxostyle; rostellum, mitochondria and Golgi apparatus absent; all parasitic.

Remarks : The family Polymastigidae includes primitive oxymonads belonging to the genera *Polymastix* and *Monocercomonoides* as reviewed by Kulda and Nohynkova (1978).

Key to the genera

- 1(2) Body pyriform, axostyle inconspicuous, parasitic in insects *Polymastix*
- 2(1) Body round or ovoid, axostyle typically of uniform thickness throughout its length, parasitic in insects as well as vertebrates *Monocercomonoides*

Genus *Polymastix* Butschli, 1884

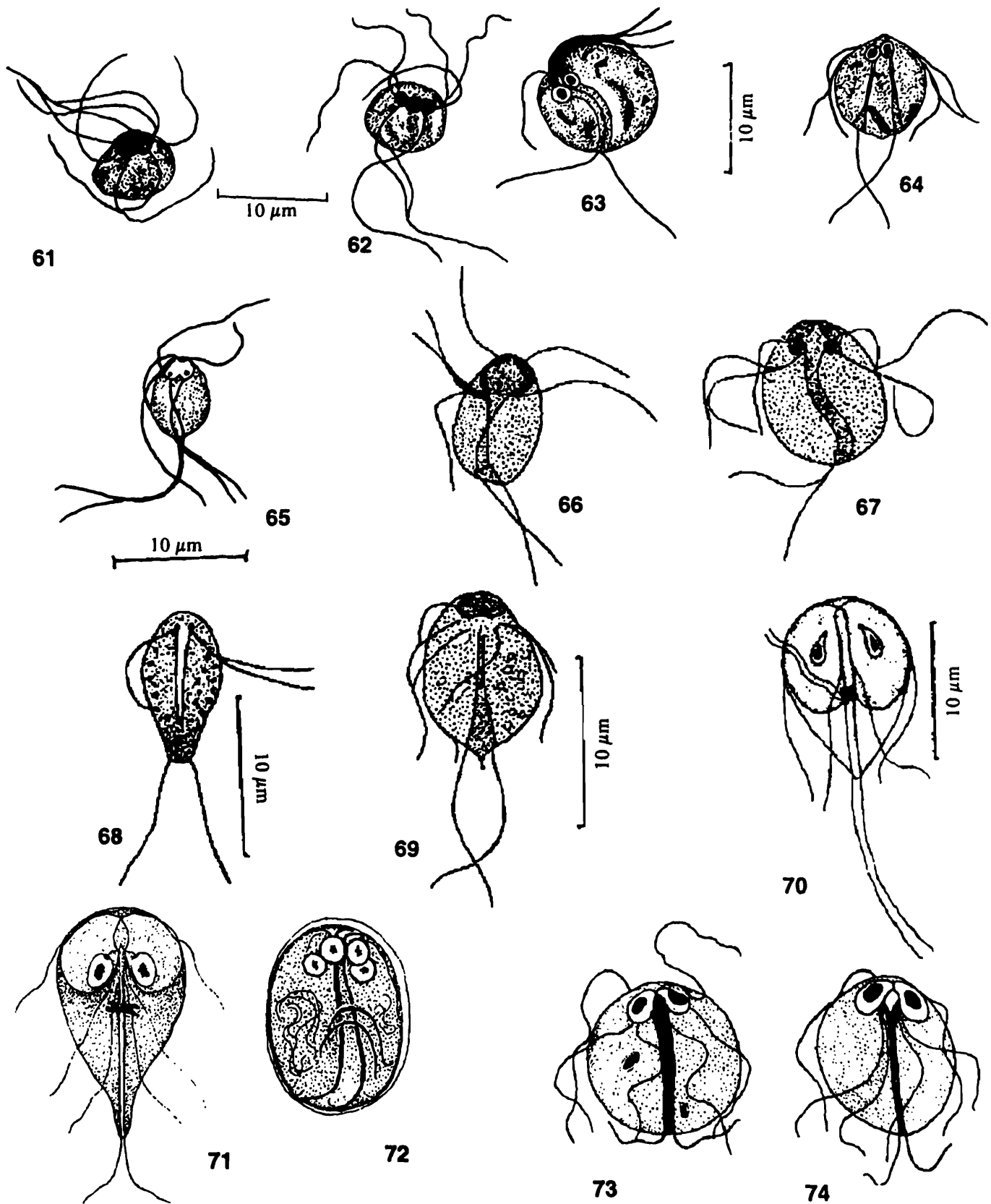
1884. *Polymastix* Butschli, Mastigophora. In: *Klassen und orderungen des Thier-Reichs* (ed. H. G. Bronn), C. F. Winter, Leipzig, 1, 2. Abt. : pp. 785-864.

Diagnosis : Pyriform; four flagella arising from two blepharoplasts located at anterior end; cytostome and axostyle inconspicuous; body often covered by protophyten; commensals in insects.

80. *Polymastix periplanetae* Qadri and Bhaskar Rao, 1963 (Fig. 75 & 76)

1967. *Polymastix periplanetae* Qadri and Bhaskar Rao, *Riv. Parassitol.*, 24 : pp 153-158.

Diagnosis : Body pyriform, elongated and somewhat spindle-shaped, measuring 12.0-24.0 (19.18) μm x 5.5-9.5 (7.5) μm , with rounded anterior end, narrower and tapering posterior



Figs. 61-74. Flagellate parasites of Andhra Pradesh : 61-62. *Hexamita gryllotalpae*; 63-64. *H. honigbergi*; 65. *H. hoarei*; 66-67. *H. nesocium*; 68. *H. pigmentatus*; 69. *H. spinulus*; 70. *Giardia indica*; 71-72. *G. intestinalis*, trophozoite and cyst and 73-74. *Octomitus rattusi*.

end; possessing four flagella arising from two blepharoplasts located at the anterior end and connected behind with the nucleus by thin rhizoplasts; nucleus spherical, ovoid or pyriform with a distinct nuclear membrane and karyosome, situated close to anterior end of the body; all four flagella typically end in fine acronemes about 2-3 μm long; second pair of flagella unequal and the axostyle with long spike, projecting freely at the posterior end to a length of 5-7 μm , arising from the other blepharoplast; cytostome and parabasal body absent.

Host : *Periplaneta americana*; site of infection : lumen of the hind gut.

Distribution : India : Andhra Pradesh (Hyderabad district).

Genus *Monocercomonoides* Travis, 1932

1932. *Monocercomonoides* Travis, *Iowa State Coll. J. Sci.*, 6 : p. 317.

Diagnosis : Small, round or ovoid body; four flagella of the acroneme type terminated by a thin filament, inserted in pairs in two places; two directed anteriorly and the other two posteriorly, one or more flagella recurrent adhering to the body for some distance and the continuing in a free trailing portion; each recurrent flagellum accompanied by a ribbon of funis; axostyle filamentous; parasitic of various animals.

Remarks : Members of the genus *Monocercomonoides* are predominantly parasites living in insects and also inhabit the intestine of vertebrates. None of them is pathogenic.

A. Key to the species of *Monocercomonoides* in insects

- 1(2) Body round or pyriform with a tail-like cytoplasmic projection, axostyle thick in the middle and thread-like at the posterior end; a clear unstained zone around the nucleus present *M. qadrii*
- 2(1) Body spherical, round, oval or irregular, without any tail-like cytoplasmic projection as above
- 3(4) Body round or oval, axostyle uniformly thick projecting outside as an axostylar ring, a definite funis (an accessory filament) present running along the surface of the body or at the base of trailing flagellum or occasionally from either of them, parasitic in mole cricket, *Gryllotalpa africana* *M. ganapatii*
- 4(3) Body spherical or irregular, axostyle not projecting outside the body as above, funis present attaching the trailing flagellum of the body, parasitic in cockroach, *Periplaneta americana* *M. garhami*

B. Key to the species of *Monocercomonoides* in reptiles

- 1(2) Body pear-shaped or elongated, a very thin filamentous axostyle normally not projecting beyond the posterior end of cytoplasm, a cap-like pelta present bordered by two fibrils, parasitic in turtles, *Testudo elegans* *M. filamentum*.

- 2(1) Body ovoid, round, sometimes irregular, axostyle filamentous or thread-like and characteristically J or L-shaped, pelta absent, parasitic in chameleon *M. singhi*

C. Key to the species of *Monocercomonoides* in mammals

- 1(6) Body usually pyriform or egg-shaped
- 2(3) Body usually pyriform, nucleus with a large endosome, axostyle filamentous never projecting outside the posterior end of the body, funis and pelta absent, parasitic in house rat *M. shortti*
- 3(2) Body oval, pyriform or egg-shaped, nucleus with or without karyosome, axostyle filamentous and sometimes projecting outside the posterior end of the body
- 4(5) Body oval or pyriform, nucleus spherical in shape, without any karyosome but with uniformly scattered chromatin granules, pelta broad proximally and gradually narrowed into a sharp point, parasitic in Black-naped hare, *Lepus nigricollis*..... *M. lepusi*
- 5(4) Body egg-shaped, nucleus irregular and containing a central karyosome and extra-karyosomal granules, a cytostome present with an opening to the exterior, parasitic in goat, *Capra hircus* *M. sayeedi*
- 6(1) Body spherical, nucleus small with endosome, axostyle filamentous, extending from the blepharoplast to the posterior end, having J-shaped curve in some individuals ..
..... *M. indica*

A. *Monocercomonoides* in insects

81. *Monocercomonoides ganapatii* Bhaskar Rao, 1969 (Fig. 77)

1967. *Monocercomonoides ganapatii* Bhaskar Rao, *Proc. Indian Acad. Sci.*, **70** : pp. 208-214.

Diagnosis : Body round or oval measuring 6.0-9.0 (7.4) μm in length and 4.5-8.5 (6.63) μm in width; two blepharoplasts present just above the nucleus at the extreme anterior end of the body, close to each other and connected by a thin rhizoplast; flagella four in number, a pair from each blepharoplast, 3 anterior flagella equal measuring 6.0-13.5 (9.73) μm in length and the fourth trailing one much longer than the rest measuring 10.0-22.0 (13.95) μm in length; axostyle uniformly thick, projecting outside with an axostylar ring originating from a blepharoplast responsible for giving rise to one anterior and one long trailing flagellum; nucleus round 1.5-3 (2.33) μm in diameter, situated near the anterior end of the body, cytoplasm granular with or without vacuoles.

Host : *Gryllotalpa africana*; site of infection; rectum.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

Remarks: Sultana (1975) redescribed this species from the type host from Maharashtra. She reported the presence of a definite funis running along the surface of the body or along the base of trailing flagellum or in some cases reported from either of them. Besides this structure, she observed that the posterior tip of axostyle is thickened into a knob-like structure, a feature that was interpreted by Bhaskar Rao (1969) as a periaxostylar chromatic ring.

82. *Monocercomonoides garnhami* Bhaskar Rao, 1969
(Figs. 78 & 79)

1969. *Monocercomonoides garnhami* Bhaskar Rao, *Proc. Indian Acad. Sci.*, **70** : pp. 208-214.

Diagnosis : Spherical or irregular organism, measuring 5.0-12.5 (9.12) μm in length and 4.5-14.5 (8.28) μm in width; a pair of blepharoplast present at the anterior end just above the nucleus, separated from each other but connected by means of a thin rhizoplast; a pair of flagella, unequal in length, possessing acronemes arising from each of the two blepharoplasts; recurrent flagellum longest and directed backwards an accessory filament called funis present attaching the recurrent flagellum to the body; axostyle and trailing flagellum arising from the same blepharoplast; nucleus kidney-shaped, round or irregular; some individuals having pelta-like semi-circular structures below the nucleus.

Host : *Periplaneta americana*, site of infection: rectum.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

83. *Monocercomonoides qadrii* Bhaskar Rao, 1969
(Fig. 80)

1969. *Monocercomonoides qadrii* Bhaskar Rao, *Proc. Indian Acad. Sci.* **70** : pp. 208-214.

Diagnosis : Body round or pyriform with a tail-like cytoplasmic projection; body dimension 4.5-16.5(11.13) μm x 4.5-17.5(10.86) μm ; nucleus large, round 1.5-5.5 (3.5) μm in diameter or oval, situated at the anterior end; two blepharoplasts situated at the anterior end of the nucleus lying either horizontal or perpendicular, having connected by a semi-circular thread-like rhizoplast just above the nucleus; a pair of flagella arising from each blepharoplast, 3 of 4 flagella equal in length measuring 9.5-18.0(12.50) μm and the fourth trailing flagellum slightly longer measuring 9.0-24.5(18.50) μm ; axostyle thick in the middle and thread-like at the posterior end; a clear unstained zone around the nucleus present.

Host : Dung beetle, *Oryctes rhinoceros*; site of infection: rectum.

Distribution : India : Andhra Pradesh (exact locality not mentioned), Maharashtra.

Remarks : Krishnamurthy and Sultana (1977) redescribed this species from the gut of the larvae of the same species of dung beetle, *Oryctes rhinoceros* from Maharashtra and recorded funis which was not described by Bhaskar Rao (1969), while they could not detect the cytostome described by the original author.

B. *Monocercomonoides* in reptiles**84. *Monocercomonoides filamentum* Janakidevi, 1962**

1962. *Monocercomonoides filamentum* Janakidevi, *Arch. Protistenk.*, **106** : pp. 41-50.

Diagnosis : Body pear-shaped or elongated, measuring 7.0-12.5 (9.0) μm in length and 3.0-13.5 (5.6) μm in breadth; organelles consisting of a nucleus, two blepharoplasts, four flagella, a slender axostyle and a pelta; nucleus close to anterior border of the body, containing a central endosome surrounded by a clear halo and with no chromatin granules in the periendosomal area; two blepharoplasts, the ventral giving rise to three flagella and the dorsal to the fourth flagellum, axostyle and pelta; four flagella unequal in length and normally two directed forwards and two backwards of which one acting as a trailing flagellum, adhering to the body for some distance; axostyle remarkably thin and normally not projecting beyond the posterior end of the cytoplasm; pelta cap-like and bordered by two fibrils; cytoplasm often with granules and vacuoles containing ingested bacteria.

Host : *Testudo elegans* Schoepff; site of infection: large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : *Monocercomonoides filamentum* Janakidevi, 1962 is considered to be a synonym of *Monocercomonoides lacertae* (Tanabe, 1933) by Kulda and Nohynkova (1978). However, this species *M. filamentum* is retained herein until further review based on type materials/specimens.

85. *Monocercomonoides singhi* Krishnamurthy, 1967.

(Figs. 81 & 82)

1967. *Monocercomonoides singhi* Krishnamurthy, *Proc. Indian Acad. Sci.*, **66B** : pp. 184-189.

Diagnosis : Body ovoid or round, or irregular in some cases, measuring 6.68-11.31(8.72) μm x 4.11-10.28 (7.25) μm ; two blepharoplasts, dorsal and ventral, situated near the anterior end of the body, dorsal one giving rise to two anterior flagella while the third flagellum, the posterior flagellum and the axostyle originating from the ventral blepharoplast; three anterior flagellum slightly unequal measuring 6.68-14.40 (11.74) μm , 8.74-19.02 (14.42) μm and 8.23-16.97(12.67) μm respectively; posterior flagellum longer ranging from 13.3-30.33(22.52) μm in length; the proximal portion of posterior flagellum attached to the body surface possessing a thick straight or slightly curved rod-like structure corresponding to the funis described by Nie (1950); axostyle filamentous or thread-like typically J or L shaped and peculiar in this species; nucleus round or oval 2.43 μm x 2.56 μm , with a distinct nuclear membrane and a large and conspicuous endosome, and a clear space in between, cytoplasm vacuolated and with rod-like or granular bacteria; pelta and cytostome absent.

Host : Chameleon, *Chameleon zeylanicus*; site of infection: large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : *Monocercomonoides singhi* Krishnamurthy, 1967 is considered to be a synonym of *Monocercomonoides lacertae* (Tanabe, 1933) by Kulda and Nohynkova (1978). However, the species *M. singhi* is retained herein until further review based on type materials / specimens as stated above.

C. *Monocercomonoides* in mammals

86. *Monocercomonoides indica* Navarathnam, 1970

(Figs. 83 & 84)

1970. *Monocercomonoides indica* Navarathnam, *Riv. Parasitol.*, **31** : pp. 251-254.

Diagnosis : Body spherical or oval, 5.5-11.0 (8.4) μm x 4.0-11.0 (7.4) μm ; nucleus small, spherical, 1.5-3.0 μm x 1.5 x 3.5 μm , possessing a small round endosome with granules around it, situated at the anterior end of the body; two blepharoplasts situated at the extreme anterior end of the body, connected by a thin rhizoplast; one blepharoplast giving rise to two anterior flagella and the other the third flagellum, the recurrent flagellum, and the axostyle; three anterior flagella unequal in length, measuring 5.0-11.5 (8.1 μm , 5.5-13.0 μm , and 6.0-16.5 (10.9) μm respectively; fourth flagellum very long, 6.5-20.0 (15.3) μm , running posteriorly along margin of the body; all flagella ending in acronemes; funis and pelta absent; axostyle filamentous, 5.0-9.5 μm , extending from the blepharoplast to the posterior end of the body, curved in the form of J-shape in some individuals; axostylar ring absent.

Host : Indian gerbil, *Gerbillus indicus*; site of infection: caecum and large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

87. *Monocercomonoides lepusi* Todd, 1963

(Fig. 85)

1963. *Monocercomonoides lepusi* Todd, *Arch. Protistenk.*, **107** : pp. 34-40, figs. 1-15.

Diagnosis : Body oval, pyriform or rounded measuring 4.23-9.46 (7.10) μm in length and 3.76-7.52 (4.65) μm in breadth; four flagella 4.70-17.39 (13.08) μm , one of them constantly recurrent, usually applied to the body surface in its anterior portion and longer than the rest of the flagella; three anterior flagella, two equal but shorter than the third one, all uniform in thickness, entirely separated from one another extending in different directions and connected with two blepharoplasts situated on the anterior surface of the nucleus, no terminal filament in any one of the flagella; blepharoplast connected by a transverse filament, one of which giving rise to two anterior flagella while the other to the third one, the recurrent flagellum and the axostyle; costa-like structure known as funis (Nie, 1950) originating from the blepharoplast, running parallel to the recurrent flagellum but separated from it in the posterior part; axostyle filamentous 2.35-7.52 (5.93) μm in a few specimens projecting a little beyond

the posterior end of the body; pelta broad proximally and gradually narrowed into a sharp point; nucleus spherical 0.47-1.88 (0.98) μm in diameter, without any karyosome but with uniformly scattered chromatin granules situated in the anterior part of the body.

Host : Black-naped hare *Lepus nigricollis*; site of infection caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

88. *Monocercomonoides sayeedi* Abraham, 1961

1962. *Monocercomonoides sayeedi* Abraham, *Z. Parasitenk.*, **20** : pp. 558-562

Diagnosis : Body egg-shaped, measuring 4.8-10.0 (7.0) μm in length and 3.5-8.7 (6.3) μm in breadth; nucleus irregular in shape and containing a central karyosome and extra-karyosomal granules; two blepharoplasts present connected by a rhizoplast; dorsal blepharoplast with three basal granules from which arising the posterior flagella and axostyle; ventral blepharoplast with two basal granules giving rise to two anterior flagella; all four flagella short and ending in acronemes; a filamentous axostyle present, sometimes protruding beyond the body-wall; a cytostome with an opening to the exterior present in between the blepharoplasts and under the nucleus.

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

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According to Kulda and Nohynkova (1978) *Monocercomonoides sayeedi* Abraham, 1961 is a synonym of *Monocercomonoides caprae* (Das Gupta, 1935) occurring in the rumen of goats in India, which is, even according to them, an insufficiently described species measuring 5-12 μm x 3.5-8 μm and has relatively short flagella, slightly longer than body and thin axostyle with or without a very short caudal projection. As such, until further review, *M. sayeedi* is considered, herein, as *species inquirenda*.

89. *Monocercomonoides shortti* Navarathnam, 1970 (Figs. 86-88)

1970. *Monocercomonoides shortti* Navarathnam, *Acta Protozool.*, **8** : pp. 155-165.

Diagnosis : Body usually round or pyriform, 5.0-10.5 (6.96) μm x 4.5-9.0 (6.73) μm in dimension; cytoplasm granular and always containing food vacuoles; nucleus with large endosome situated at the anterior end of the body; two blepharoplasts connected by a thin rhizoplast; four flagella, a pair arising from each blepharoplast, three flagella equal in length (3.0-12.0 μm) directed anteriorly, fourth flagellum 6.0-17.0 μm in length, slightly longer than the three and directed backwards, all flagella uniform in thickness but not terminating in knobs or acronemes; accessory filament and pelta absent; axostyle filamentous, uniform in thickness, with an axostylar ring but never protruding outside the body.

Host : Indian rat, *Rattus rattus frugivorous*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Supraorder PARABASALIDEA

Order TRICHOMONADIDA

Family MASTIGAMOEBIDAE

Diagnosis : With one to three or rarely four flagella and axopodia or lobopodia; uninucleate; flagellum arising from a basal granule connected with the nucleus by a rhizoplast; binary fission in both trophic and encysted stages; holozoic or saprozoic; majority free-living and a few parasitic.

Genus *Dientamoeba* Jepps and Dobell, 1918

1918. *Dientamoeba* Jepps and Dobell, *Parasitology*, **10** : p. 352.

Diagnosis : Small amoeba; number of binucleate trophozoites often greater than that of uninucleate forms; nuclear membrane delicate; endosome consisting of several chromatin granules embedded in plasmosomic substances and connected with the membrane by delicate strands.

Remarks : Members of the genus *Dientamoeba* was earlier classified under Amoebida and Family Endamoebidae (Kudo, 1966). Levine *et al.* (1980) placed this genus under Order Trichomonadida.

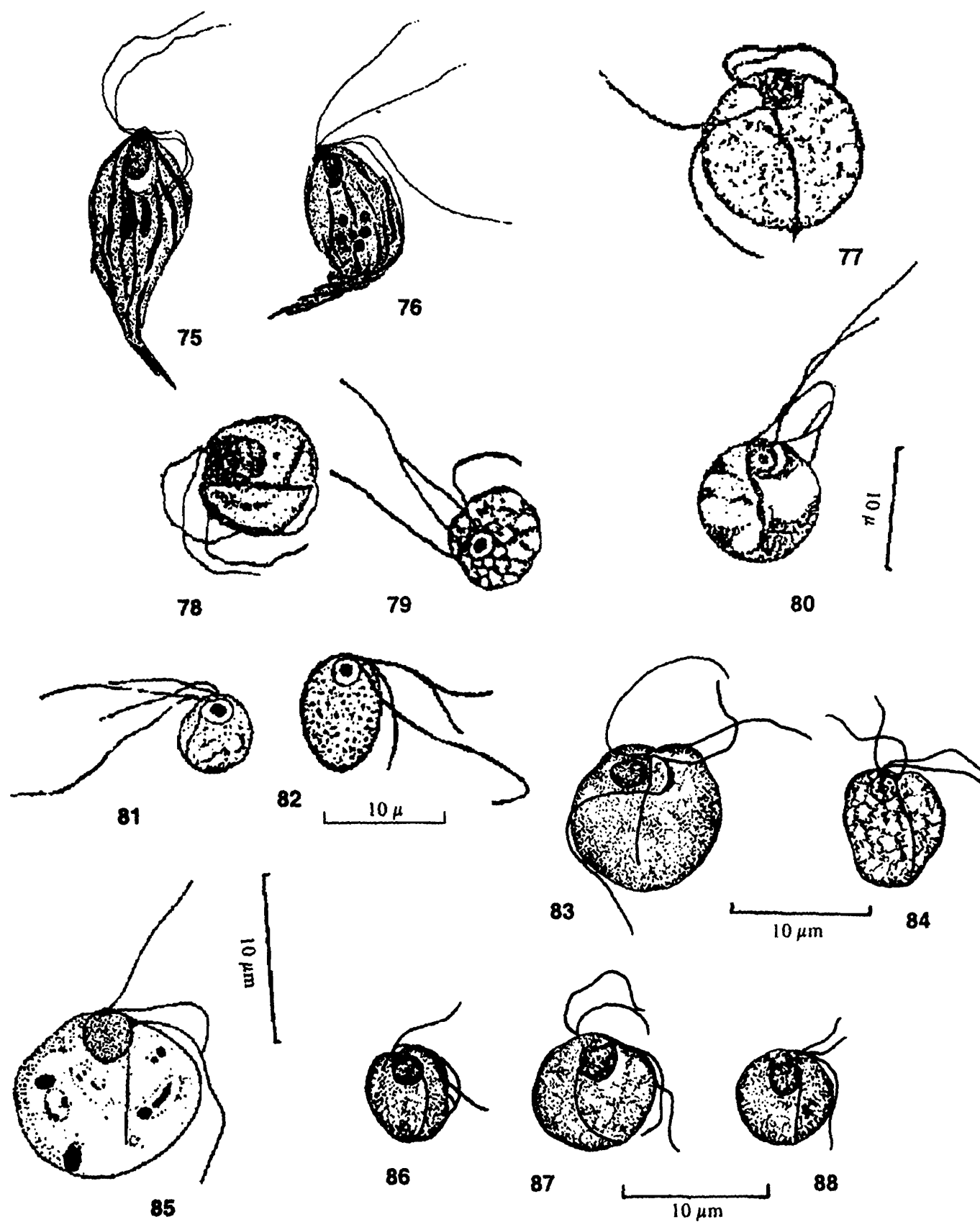
90. *Dientamoeba dobelli* Bhaskar Rao, 1970
(Figs. 89-90)

1970. *Dientamoeba dobelli* Bhaskar Rao, *Curr. Sci.*, **39** : pp. 112-113.

Diagnosis : Round (av. 12.59 μm in diameter) or elongated body, measuring 8.5-33.5 (13.53) μm in length and 8.5-16.0 (11.96) μm in width; clear ectoplasm, thickly granular endoplasm with few vacuoles; few organism with a slightly blunt pseudopodium on one side of the body; usually with two nuclei (av. 4.53 μm in diameter), having large round central or eccentric endosomes; endosome a compact mass (av. 2.30 μm in diameter), with a ring of small chromatin granules arranged in between the nuclear membrane and the endosome; very few with a single nucleus.

Host : Larva of dung beetle, *Oryctes rhinoceros*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).



Figs. 75-88. Flagellate parasites of Andhra Pradesh : 75-76. *Polymastix periplanetae*; 77. *Monocercomonoides ganapatii*; 78-79. *M. garnhami*; 80. *M. qadrii*; 81-82. *M. singhi*; 83-84. *M. indica*; 85. *M. lepusi* and 86-88. *M. shortii*.

Family MONOCERCOMONADIDAE

Diagnosis: Three to five anterior flagella; recurrent flagellum free for its entire length or with proximal part adhering for a greater or less distance to dorsal body surface along accessory filament of diameter about equal to that of flagellum; in some genera low undulating membrane with few undulations extending between recurrent flagellum with accessory filament and body surface; costa absent; capitulum of axostyle usually extending anteriorly into distinct pelta; trunk of axostyle often relatively slender, occasionally quite stout, with or without periaxostylar rings; parabasal apparatus with rod-, or V-shaped body.

Subfamily MONOCERCOMONADINAE Kirby, 1944

Diagnosis : Generally with characters of family; no undulating membrane; body ellipsoidal or ovoidal; terminal segment of axostyle projecting beyond posterior body surface.

Key to the genera

- 1(2) Three anterior flagella; recurrent flagellum equal to or longer than anterior flagella
..... ***Monocercomonas***
- 2(1) Five anterior flagella; recurrent flagellum nearly equals anterior flagella in length..
..... ***Hexamastix***

Genus *Monocercomonas* Grassi, 1879

Diagnosis : Three anterior flagella; recurrent flagellum equal to or longer than anterior flagella (not over 2x longer), free for its entire length or with proximal part adherent for some distance to dorsal body surface along accessory filament; capitulum of axostyle typically continuing into pelta; trunk of axostyle often relatively slender, occasionally quite stout, without or less frequently with well-defined peri-axostylar ring(s); parabasal body rod-, disc-, or V-shaped.

Remarks : Krishnamurthy (1968) classified the genus *Monocercomonas* into different subgenera such as *Alimonas*, *Monocercomonas* and *Qadrimonas* based on size differences as well as presence or absence of certain characters which include accessory filament, axostyle, pelta, etc. But the subgeneric treatment is not taken into consideration in conformity with entire text of the present document. Key to all the species of the genus *Monocercomonas* reported from Andhra Pradesh is given excepting *M. kakatiyae* and *M. cutleri* from reptilian and mammalian hosts respectively since description / diagnosis of these species could not be consulted due to lack of concerned literature.

A. Key to the species of *Monocercomonas* of insects

- 1(4) Accessory filament present

- 2(3) Anterior flagella almost equal in length, cytostome present, nucleus with central endosome and scattered granules *M. corydiae*
- 3(2) Anterior flagella unequal, cytostome absent, nucleus with dense chromatin
..... *M. osmaniae*
- 4(1) Accessory filament absent
- 5(6) Axostyle with a long posterior spike, trailing flagellum very long about two and a half times body length *M. laccotrephis*
- 6(5) Axostyle with a short spike, trailing flagellum short, almost as long as anterior flagella *M. leucophaeae*

B. Key to the species of *Monocercomonas* of reptiles

- 1(14) Accessory filament present
- 2(9) Accessory filament very short, periaxostylar chromatic rings absent
- 3(6) Pelta cone-like
- 4(5) Body pyriform or oval, usually 12-14 μm in length including free projection of the axostyle *M. colubrorum*
- 5(4) Body oval with a rounded anterior end and round or bluntly pointed posterior end, 6.5-15.0 μm in length *M. waltirensis*
- 6(3) Pelta crescentic
- 7(8) Body pyriform or rounded, nucleus large and ovoidal *M. garhami*
- 8(7) Body pear-shaped, nucleus horseshoe-shaped *M. rayi*
- 9(2) Accessory filament long, periaxostylar chromatic rings present
- 10(11) Parasitic in snake (*Eryx johni*); body fusiform, 8.2-14.9 μm in length excluding the posterior axostylar spike; *M. eryxi*
- 11(10) Parasitic in lizards
- 12(13) Body pyriform, round oval or even irregular in shape, 6.7-10.8 μm in length excluding the posterior axostylar spike; nucleus rounded, ovoidal or kidney-shaped, with a central endosome, parasitic in *Varanus* sp. *M. varani*
- 13(12) Body oval or pear-shaped, 8-14 μm in length, nucleus oval, containing several deep-stained, irregular chromatin masses, parasitic in *Calotes versicolor*
..... *M. srikakulamensis*
- 14(1) Accessory filament absent

- 15(16) Parasitic in snake (*Dryophis mycterizans*); body ovoid, pyriform, occasionally rounded or irregular, 6.1-12.8 μm in length excluding spike *M. gopali*
- 16(15) Parasitic in lizards
- 17(18) Capitulum present; body oval with rounded ends, 8-11 μm in length; nucleus elongate; parasitic in *Hemidactylus prashadi* *M. prashadi*
- 18(17) Capitulum absent
- 19(20) Body round or oval, 9-16.5 μm in length; nucleus oval; axostyle highly curved; parasitic in *Calotes versicolor* *M. calotesi*
- 20(19) Body elongate with rounded ends, 8-13 μm in length; nucleus round or oval with chromatin materials in the form of irregular clumps; axostyle straight or slightly curved; parasitic in *Hemidactylus prashadi* *M. ganapatii*

C. Key to the species of *Monocercomonas* of birds

- 1(2) Body spherical or pyriform, nucleus spherical without endosome, axostyle not projecting outside the body *M. anasae*
- 2(1) Body elongated or pear-shaped with snout-like anterior end, axostyle sharply tapering and projecting outside the body *M. qadrii*

D. Key to the species of *Monocercomonas* of mammals

- 1(2) Axostyle projecting beyond the body forming a short spike *M. andhrae*
- 2(1) Axostyle filamentous, either projecting or not projecting beyond the body
- 3(4) Blepharoplasts one, axostyles filamentous and never projecting outside the body
..... *M. hoarei*
- 4(3) Blepharoplasts one or two, filamentous axostyle projecting outside the body
- 5(6) Body round, oval or pyriform, anterior end round and posterior end converging into a cone, blepharoplast large and single, nucleus oval, elongated or triangular without any chromatin plaques *M. gerbili*
- 6(5) Body oval, blepharoplasts two in number, nucleus oval or ellipsoidal with four chromatin plaques *M. lori.*

A. *Monocercomonas* in insects

91. *Monocercomonas corydiae* Bhaskar Rao, 1970 (Fig. 91)

1970. *Monocercomonas corydiae* Bhaskar Rao, *Riv. Parassitol.*, **31** : pp. 91-98.

Diagnosis : Body typically oval or pear-shaped, measuring 6.5-12.0 (8.5) μm x 5.0-9.5 (8.5) μm ; anterior end drawn out into a projection that demarcated from rest of the body by a notch; blepharoplast at the vicinity of the notch; three anterior flagella almost equal in length, uniform in thickness, not ending in acroneme; fourth flagellum directed backwards, attached to the body to some extent, attached portion (3.0-8.0 μm) thick due to accessory filament present along the base of the trailing flagellum; trailing flagellum ending in acroneme of 2.0-6.5 μm in length; nucleus round, situated below the blepharoplast, consisting of a central endosome with scattered granules at the periphery of the nucleus; axostyle stout, tapering posteriorly, generally curved, measuring 4.0-10.0 (6.5) μm ; cytostome present.

Host : *Corydia petiveriana*; site of infection: rectum.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

92. *Monocercomonas laccotrephis* Bhaskar Rao, 1970
(Fig. 92)

1970. *Monocercomonas laccotrephis* Bhaskar Rao, *Riv. Parassitol.*, **31** : pp. 91-98.

Diagnosis : Body round or oval, measuring 5.5-9.0 (7.5) μm x 4.0-7.5 (5.9) μm ; accessory filament absent; blepharoplast very small of single granule; axostyle hyaline rod-like, well developed with a calyx, stem and with a long posterior spike (6.7 μm) as long as the body, calyx well developed; nucleus at the anterior third of the body on the calyx of axostyle, usually oval or elongated, with a small endosome and irregularly scattered chromatin granules; four flagella unequal, originating from the blepharoplast, three anterior flagella, 8.9, 11.8 and 13.4 μm respectively, uniformly thick and not ending in acronemes or knobs and one trailing flagellum, two anterior flagella nearly equal attached at the base; trailing flagellum very long (17.6 μm) about 2 ½ times body length and with a very long acroneme 4.0-8.0 μm .

Host : *Laccotrephes maculatus*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

93. *Monocercomonas leucophaeae* Bhaskar Rao, 1970.
(Fig. 93)

1964. *Monocercomonas leucophaeae* Bhaskar Rao, *Riv. Parassitol.*, **31** : pp. 91-98.

Diagnosis : Body round or oval, 5.5-9.5 (7.3) μm x 4.0-7.0 (5.3) μm ; blepharoplast very small of single granule, situated at the extreme anterior end of the body; axostyle arising from the blepharoplast, measuring 3.0-7.3 (4.8) μm , slightly thick at the anterior end, posteriorly tapering and projecting as a short spike, 1.0-2.0 μm outside the body; four approximately equal flagella (5.8-10.5 μm av. 8.8 μm), three anteriorly directed, trailing flagellum short, almost as long as anterior flagella; nucleus oval or reniform, located at the anterior end of the body a little behind the blepharoplast; cytoplasm coarsely granular; accessory filament absent.

Host : *Leucophaea sinninamensis*; site of infection : rectum.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

94. *Monocercomonas osmaniae* Bhaskar Rao, 1970
(Fig. 94)

1965. *Monocercomonas osmaniae* Bhaskar Rao, *Riv. Parasitol.*, **31** : pp. 91-98.

Diagnosis : Body pear-shaped or round or oval, 6.5 – 10.0 (8.2) μm x 3.5 – 8.0 (5.2) μm ; accessory filament present; four unequal flagella from a single blepharoplast, 7.5, 10.4, 12.6 and 16.7 μm respectively, three flagella anteriorly directed, fourth one longer, trailing and directed backwards, trailing flagellum attached to the body by accessory filament in a few individuals and some with terminal acroneme; cytostome absent; nucleus at the anterior third of the body, usually oval or round, with dark and densely scattered chromatin granules; mastigont element originating from blepharoplast situated in front of nucleus; axostyle hyaline and stout, wide at the anterior end and gradually tapering to a point emerging outside the body for a considerable distance (4.5-10.5 μm).

Host : *Cryptocercus* sp.; site of infection: rectum.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

B. *Monocercomonas* in reptiles

95. *Monocercomonas calotesi* Saratchandra, 1979
(Figs. 95 & 96)

1979. *Monocercomonas calotesi* Saratchandra, *Indian J. Parasitol.*, **3** : pp. 73-74.

Diagnosis : Body round or oval, 9.0-16.5 μm x 12.5-15.0 μm ; cytoplasm vacuolated, vacuoles containing bacteria; nucleus nearer to the anterior end, oval, 4.5 μm x 2.4 μm ; blepharoplast small in front of nucleus; flagella four in number, unequal, one trailing flagellum 18.0-36.0 μm , other three anterior flagella, 10.0-28.0 μm ; a slender curved axostyle, extending from nucleus to the posterior end; capitulum, spike, pelta, accessory filament, periaxostylar chromatic rings and endoaxostylar granules absent.

Host : *Calotes versicolor*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Andhra University Campus, Waltair, Visakhapatnam district).

Remarks : This species is placed under the subgenus *Alimonas* because it lacks pelta, accessory filament, periaxostylar chromatic rings and endoaxostylar granules (Krishnamurthy, 1968).

96. *Monocercomonas colubrorum* (Hammerschmidt, 1844)
(Fig. 97 & 98)

1844. *Bodo colubrorum* Hammerschmidt, *Arch. Physiol. Pathol. Chem. Mikr.*, 1 : pp. 83-84.

1951. *Monocercomonas colubrorum*: Moskowitz, *J. Morph.*, 89 : pp. 257-321.

1968. *Monocercomonas colubrorum*: Krishnamurthy, *Riv. Parassitol.*, 29(1) : pp. 14-15, figs. 1-7.

Diagnosis : Body pyriform or oval, 9-20 μm (mostly 12-14 μm) in length including free projection of the axostyle, 5-10 μm in width; possessing organelles like flagella, blepharoplast, axostyle, pelta, parabasal body, nucleus and cytostome; blepharoplast spheroidal located at the anterior part of the body; flagella 4 in number, all arising from the blepharoplast, 3 anteriorly directed and the 4th one trailing posteriorly; 3 anterior ones closely associated at their bases, one conspicuously shorter than the other two; axostyle usually hyaline tube-like structure without any chromatic ring, but with a spoon-like structure called calyx near the nuclear region; pelta at the most anterior portion of the body; nucleus ellipsoidal, lying dorsal to the axostyle; cytoplasm granular or vacuolated; cytostome lying ventral to the nucleus.

Host : *Zamenis mucosus*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district). Elsewhere: cosmopolitan.

Remarks : *Monocercomonas colubrorum* inhabits the large intestine and cloaca of squamate reptiles (Moskowitz, 1951; Honigberg, 1963). Krishnamurthy (1968) reports this species from the above-mentioned Indian host. But it is a common flagellate of a large number of snakes and lizards (Moskowitz, 1951). According to Krishnamurthy (1968) Indian forms are similar to that described by Moskowitz (1951) except for minor differences, particularly in the structure of the pelta and the axostyle. The pelta is generally short, thick and triangular as compared with conical pelta described by Moskowitz (1951). The axostyle projects outside the body for a distance and tapers sharply to a point while it is short with rounded tip in the original description.

97. *Monocercomonas eryxi* Krishnamurthy, 1968
(Fig. 99)

1968. *Monocercomonas eryxi* Krishnamurthy, *Riv. Parassitol.*, 29(1) : pp. 2-5, figs. 1-8.

Diagnosis : Body fusiform, measuring 8.2-14.9(11.0) μm in length excluding the posterior axostylar spike and 5.7-12.9(8.5) μm in breadth; blepharoplast small lying at the anterior end, giving rise to three anterior flagella, a trailing flagellum with its accessory filament, the axostyle and the pelta; three anterior flagella closely associated at their basal portions, one of them conspicuously short, measuring 9.8-16.4(12.5) μm , other two slightly unequal measuring 10.8-20.6(16.6) μm and 13.4-21.6(17.7) μm in length, all uniform in their thickness; posterior flagellum much longer than the anterior flagella measuring 17.5-33.9(25.9) μm , basal portion attached to the body for some distance, the attached portion showing the

presence of an accessory filament of same thickness as the flagellum; axostyle hyaline tubular structure slightly broad anteriorly but a distinct capitulum lacking, with a small bulb-like structure at the point of its emergence from the posterior end then suddenly tapering into a fine spine of 1.0-6.7(3.5) μm in length, no endoaxostylar granules but periaxostylar chromatic granules present around the swelling in the form of one or two rings; pelta half-sickle shaped short and thick lying over the blepharoplast; nucleus large spherical or elliptical, 2.1 μm in diameter with a central endosome, lying behind the blepharoplast.

Host : *Eryx johni*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

98. *Monocercomonas ganapatii* Saratchandra and Narasimhamurti, 1982
(Figs. 100 & 101)

1982. *Monocercomonas ganapatii* Saratchandra and Narasimhamurti, *Indian J. Parasitol.*, **6**(2) : pp. 189-190.

Diagnosis : Body elongate with rounded ends, 8.0-13.0 μm x 2.6-5.3 μm ; cytoplasm containing vacuoles; nucleus round or oval, 2.5-3.5 μm x 1.0-2.6 μm , situated near the anterior end; four unequal flagella, measuring 10-20 μm , originated from a single basal body situated near the anterior end; trailing flagellum posteriorly directed; axostyle slender, straight or slightly curved, situated along the central axis, narrow at the anterior region, broad at the posterior end and not extending beyond the cell body; capitulum, spike, peri-axostylar chromatic rings, endoaxostylar granules, pelta and accessory filament absent.

Host : *Hemidactylus prashadi*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

99. *Monocercomonas garnhami*, Krishnamurthy, 1968
(Figs. 102 & 103)

1968. *Monocercomonas garnhami* Krishnamurthy, *Riv. Parassitol.*, **29**(1) : pp. 8-11, figs. 1-8.

Diagnosis : Body typically pyriform in living condition but tending to become rounded on fixation; cytoplasm with no cytoplasmic granules or bacteria and no cytostome; 3 anterior flagella unequal in length, shortest one 9.8-8.5(14.5) μm and the other two longer but subequal measuring 14.9-22.6 (17.6) μm and 16.5-22.6(18.7) μm respectively; trailing flagellum quite long, 19.5-37.0 (30.4) μm in length, a short accessory filament associated with its proximal portion, distal end of the flagellum with an acroneme of 1.0-5.7 μm in length; axostyle slender and tubular, with no distinct capitulum at posterior end projecting out of the body to a thin filament or fine point, with no endoaxostylar granules or periaxostylar chromatic rings; pelta slender long and crescent-shaped; nucleus large and ovoidal measuring 1.5-3.6 (2.6) μm x 1.0-3.6 (2.2) μm , situated behind the blepharoplast.

Host : *Lycodon aulicus*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Hyderabad district) and Maharashtra.

100. *Monocercomonas gopali*, Krishnamurthy, 1967
(Fig. 104)

1967. *Monocercomonas gopali* Krishnamurthy, *Riv. Parassitol.*, **28**(3) : pp. 8-11, figs. 1-8.

Diagnosis : Body usually ovoid or pyriform, occasionally rounded or irregular, measuring 6.1-12.8 (9.9) μm in length excluding spike and 3.1-9.2 (6.0) μm in width; cytoplasm uniformly stained devoid of any bacteria or other inclusion; no cytostome; blepharoplast situated near the anterior end giving rise to the three anterior flagella, the posterior flagella and the axostyle; three anterior flagella unequal, measuring 10.3-16.4 (12.4) μm , 12.3-18.5(12.6) μm and 13.9-20.6(17.3) μm respectively; posterior flagellum longer, 20.6-35.5 (28.1) μm , free from the body surface throughout its length, with a terminal acroneme of 3.4 μm in length, accessory filament absent; axostyle slender slightly broad at the anterior end but a distinct calyx absent, posterior end sharply tapering and projecting out of the body as free spike of 3.1-10.5 (6.1) μm in length, no endoaxostylar granules and periaxostylar chromatic rings; pelta small and sickle-shaped lying over the blepharoplast; nucleus large and ovoidal situated a little anterior to the middle of the body.

Host : *Dryophis mycterizans*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

101. *Monocercomonas kakatiyae* Dayakar, Devi,
Bhaskar Rao and Bhaskar Rao, 1978

1978. *Monocercomonas kakatiyae* Dayakar, Devi, Bhaskar Rao and Bhaskar Rao, *Acta protozool.*, **16**(3-4) : pp. 225-229.

Diagnosis : Not available.

Host : *Varanus indica*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Warangal district).

101. *Monocercomonas prashadi* Saratchandra, 1981
(Figs. 105 & 106)

1981. *Monocercomonas prashadi* Saratchandra, *Indian J. Parasitol.*, **5**(1) : pp. 65-66.

Diagnosis : Body oval with rounded ends, 8-11 x 5-8 μm , with thin cell membrane; cytoplasm containing vacuoles; nucleus elongate, situated at anterior end, slightly curved round the capitulum of the axostyle, measuring 3.0-5.0 μm x 1.5-2.5 μm ; axostyle and four flagella originating from the basal body situated at the anterior end; trailing flagellum,

19-31 μm , posteriorly directed; other three anteriorly directed flagella, unequal in length, 10-19 μm ; axostyle 10-17 μm long, slightly curved and extended beyond the cell body at the posterior end to form a short pointed spike measuring 1-3 μm , anterior end of axostyle in the form of an ovate capitulum, bending on the nucleus; pelta, accessory filament, periaxostylar chromatic rings and endoaxostylar granules absent.

Host : *Hemidactylus prashadi*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

103. *Monocercomonas rayi* Saratchandra and Narasimhamurti, 1982
(Figs. 107 & 108)

1982. *Monocercomona rayi* Saratchandra and Narasimhamurti, *Sci. & Cult.*, 48(3) : pp. 106-108.

Diagnosis : Body pear-shaped, with rounded anterior end and pointed posterior end, measuring 7-12 μm in length excluding spike and 2.4 μm in breadth; cytoplasm non-vacuolated; cell membrane thin; nucleus horseshoe-shaped with two limbs measuring 3-5 μm , chromatin materials concentrated at its anterior part; four flagella of unequal length originated from a single blepharoplast situated at the anterior end of the nucleus; trailing flagellum 17-23 μm in length, supported by an accessory filament of 1.5-1.8 μm in length; anterior flagella 8-16 μm , 9-18 μm and 12-19 μm respectively; pelta slender, curved, 1.5-2.0 μm ; axostyle slender, with a bulb-like capitulum; posterior end projected to form a sharp pointed spike of 2.0-4.5 μm ; periaxostylar chromatic rings and endoaxostylar granules present.

Host : *Hemidactylus prashadi*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

Remarks : This species is placed under the subgenus *Monocercomonas* by Krishnamurthy (1968).

104. *Monocercomonas srikakulamensis* Saratchandra
and Narasimhamurti, 1979
(Figs. 109 & 110)

1979. *Monocercomonas srikakulamensis* Saratchandra and Narasimhamurti, *Indian J. Parasitol.*, 3(2) : pp. 167-168.

Diagnosis : Body oval or pear-shaped, 8-14 μm x 5-8 μm ; anterior end broadly rounded and posterior end either rounded or bluntly pointed; cytoplasm with a few vacuoles containing bacteria; nucleus oval, 2-4 μm x 1.3-2.0 μm , situated at the anterior end containing several deep stained irregular chromatic masses; four unequal flagella ranging from 9 to 29 μm , arising from a single kinetoplast, one of them trailing flagellum directed posteriorly and supported by an accessory filament of 2-3 μm , remaining 3 flagella directed anteriorly, supported by a short curved pelta of 2.5-4 μm in length; a slender curved axostyle extending

from the nucleus to the posterior end; capitulum, spike, periaxostylar chromatic rings and endoaxostylar granules absent

Host : *Calotes versicolor*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Srikakulum district).

Remarks : This species is placed under the subgenus *Qadrimonas* by Krishnamurthy, (1968) because the accessory filament is relatively long and the ratio of accessory filament/ trailing flagellum is 0.03-0.22.

105. *Monocercomonas varani* Krishnamurthy, 1968
(Figs. 111 & 112)

1968. *Monocercomonas varani* Krishnamurthy, *Riv. Parassitol.*, 29(2) : pp. 82-84, figs. 1-7.

Diagnosis : Body pyriform or round or oval or even irregular in shape, measuring 6.7-10.8 (8.9) μm in length excluding the axostylar spike and 4.1-8.2 (5.8) μm in width; nucleus rounded, ovoidal or kidney-shaped, 1.5-3.1 (2.9) μm x 1.5-2.6 (2.0) μm , with a central endosome and situated just behind the blepharoplast at anterior end of the body; blepharoplast giving rise to three unequal anterior flagella, 10.3-14.9 (13.1) μm , 10.8- 18.5 (16.5) μm and 14.9-20.1 (18.1) μm respectively, and a trailing flagellum of 20.1-36.5 (25.2) μm in length having an accessory filament of same thickness as the flagellum at its basal part; axostyle hyaline, tubular and apparently robust, anterior two-thirds of uniform thickness, posterior third first bulb-like and having distinct periaxostylar granules in the form of two rings surrounding the bulb and then suddenly tapering to a fine spine, projecting outside the body; pelta inverted semi-crescentic structure.

Host : *Varanus* sp.; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

106. *Monocercomonas waltirensis* Narasimhamurti and Saratchandra, 1980
(Figs. 113 & 114)

1980. *Monocercomonas waltirensis* Narasimhamurti and Saratchandra, *Indian J. Parasitol.*, 4(2) : pp. 217-219.

Diagnosis : Body oval, 6.5-15.0 μm x 4.8—9.5 μm , with a rounded anterior end and round or bluntly pointed posterior end; cell membrane thin; cytoplasm with vacuoles containing bacteria and food materials; nucleus 2.0-4.5 x 2.0-3.5 μm , homogenously deep, situated at anterior end; four unequal flagella originated from blepharoplast situated at anterior end of the nucleus; trailing flagellum 12-31 μm , longer than the others, supported by an accessory filament of 1-4 μm , ratio of accessory filament/ trailing flagellum 0.06-0.2; remaining three flagella 7-21 μm , 10-22 μm and 11-24 μm respectively; pelta broad at the base and pointed at the tip; axostyle slightly curved and extended posteriorly beyond the cell body to form a

short pointed spike, anterior part of axostyle expanded in the form of a calyx; periaxostylar chromatic rings and endoaxostylar granules absent.

Host : *Hemidactylus prashadi*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

Remarks : This species is placed under the subgenus *Monocercomonas* by Krishnamurthy (1968).

107. *Monocercomonas* sp.

Host : *Hemidactylus giganteus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

108. *Monocercomonas* sp.

Host : *Varanus* sp.; site of infection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

C. *Monocercomonas* in birds

109. *Monocercomonas anasae* Navarathnam, 1971
(Fig. 115)

1971. *Monocercomonas anasae* Navarathnam, *Proc. Indian Acad. Sci. (B)*, **74** : pp. 301-306.

Diagnosis : Body spherical or pyriform, measuring 4.5-10.0 (7.45) μm in length and 2.5-7.5 (4.5) μm in breadth; cytoplasm finely granulated; nucleus spherical, 1.0-4.0 (2.3) μm in diameter, with no definite endosome, situated at the anterior end below the blepharoplast; blepharoplast small, giving rise to three anterior unequal flagella and a longer trailing flagellum, all of uniform thickness; axostyle tubular, originating from the blepharoplast, characterised by bulbous capitulum, uniform trunk and the pointed tip, not projecting outside the body and not having chromatic ring at the posterior region; pelta and cytostome absent.

Host : *Anas* sp.; site of infection: intestine.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

110. *Monocercomonas qadrii* Navarathnam, 1971
(Fig. 116)

1971. *Monocercomonas qadrii* Navarathnam, *Proc. Indian Acad. Sci. (B)*, **74** : pp. 301-306.

Diagnosis : Body elongated and pear-shaped with snout-like anterior end, 3.5-9.5 (6.66) μm x 3.0-9.0 (4.72) μm ; nucleus oval or elongated, 1.5-4.0 (2.3) μm x 1.0-3.0(1.4) μm , situated at the anterior part of the body, possessing a small central endosome; blepharoplast situated at the extreme anterior end of the body or a little distance away, giving rise to four flagella and an axostyle; three anterior unequal flagella usually directed backward in the form of a bundle measuring 10.0-8.5 μm , 10.0-21.0 μm , 9.0-18.5 μm , trailing flagellum independent varying from 10.5-24.5 μm in length; axostyle tubular slender and almost uniform in diameter measuring 4.5-11.0 μm in length, anterior part slightly expanded but no definite caputulum, posteriorly end sharply tapering and projecting outside the body, axostylar ring absent; cytoplasm finely granular.

Host : *Gallus gallus domesticus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

D. Monocercomonas in mammals

111. *Monocercomonas andhrae* Kalavati, Saratchandra and Sambasivarao, 1983

1983. *Monocercomonas andhrae* Kalavati, Saratchandra and Sambasivarao, *Riv. Parassitol.*, **46**(2) : pp. 157-161.

Material examined : Sev. exs., from Visakhapatnam.

Diagnosis : Body oval, 6-11 μm x 3-8 μm , with thin body wall, rounded anterior end and usually pointed posterior end; axostyle expanded and curved at the anterior end while narrow and pointed at posterior end, projecting beyond the cell body forming a short spike of 0.5 μm ; pelta sickle-shaped, measuring 2.0-3.5 μm ; accessory filament, periaxostylar chromatic rings, endoaxostylar granules and siderophilic bodies absent.

Host : *Rattus rattus*; site of infection : rectal content.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

112. *Monocercomonas cutleri* Navarathnam, 1971

1968. *Monocercomonas cutleri* Navarathnam, *Acta Protozool.*, **8** : pp. 299-308.

Diagnosis : Not available.

Host : *Cavia cutleri*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

113. *Monocercomonas gerbilli* Todd, 1963 (Fig. 117)

1963. *Monocercomonas gerbilli* Todd, *Arch. Protistenk.*, **107** : pp. 41-44, figs. 1-15.

Diagnosis : Body round, oval or pyriform, measuring 4.23-10.36 (7.38) μm in length and 2.82-7.62 μm in width; anterior end round and posterior end converging into a cone from which axostyle, a filamentous rod-shaped structure, gaining prominence from the cytoplasm beyond the posterior end of the nucleus and projecting about 0.94-3.76 μm outside the body; 4 flagella arising from a large spherical blepharoplast, 0.23-0.94 (0.53) μm in diameter, situated at the anterior end of the body; 3 anterior flagella, 5.17-8.93 (7.33) μm , usually free from one another; fourth flagellum, 10.34-17.39 (12.69) μm , recurrent, longer than the anterior three; cytoplasm granular with a few vacuoles; nucleus oval, elongated or triangular, averaging 1.79 μm x 0.94 μm , situated posterior to blepharoplast.

Host : Indian Gerbille, *Gerbillus indicus* (Hardw.): site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

114. *Monocercomonas hoarei* Navarathnam, 1970

(Fig. 118)

1970. *Monocercomonas hoarei* Navarathnam, *Acta Protozool.*, 8 : pp. 155-165.

Diagnosis : Body spherical, irregular or oval, measuring 5.0-8.5 μm in length and 4.0-7.5 μm in breadth; cytoplasm filled with many granules; nucleus bean-shaped or oval, 1.0-3.5 μm x 1.0-5.0 μm , containing large and fine chromatin granules; two blepharoplasts, three equal anterior flagella and a long trailing flagellum present; flagella neither terminating in knobs nor in acronemes; axostyle, slightly broad at the anterior region and tapering towards the posterior end, never projecting outside the body, usually curving inside the cytoplasm.

Host : *Rattus rattus frugivorous*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : This species differs from *M. gerbilli* Todd, 1963 in having two blepharoplasts and conspicuous axostyle never projecting outside the body. Unlike this species *M. gerbilli* has a single blepharoplast and the axostyle is filamentous. It also differs from *M. lori* Abraham, 1962 in the absence of four plaques in the nucleus, the trailing flagellum not terminating in acroneme and the axostyle not projecting beyond the body.

115. *Monocercomonas lori* Abraham, 1961

(Figs. 119-121)

1961. *Monocercomonas lori* Abraham, *Arch. Protistenk.*, 105 : pp. 445-449.

Diagnosis : Body oval in shape in typical form measuring 6.2-10.0 (8.4) μm x 5.2-9.0(6.8) μm ; blepharoplasts two in number without any connection between them; flagella four in number, three anterior flagella originating from anterior or secondary blepharoplasts and one posterior flagellum (av. 21.5 μm), 2.5 times the length of the body arising from the posterior or primary blepharoplast, two of 3 anterior flagella equal in length (av. 10.7 μm) and tending

to adhere together the third anterior flagellum shorter (av. 8.2 μm) and solitary; nucleus oval or ellipsoidal with four chromatic plaques; axostyle single, hyaline and rod-shaped divisible into capitulum, stem and conical tip-projecting beyond the body.

Host : Indian slender loris, *Loris tardigradus lydekkerianus* Cobbera, 1908; site of infection : intestine. (in 4 out of 6 hosts).

Distribution : India : Eastern Ghats, probably from Andhra Pradesh (exact locality not mentioned).

Remarks : The geographic distribution of this subspecies of mammalian host is within Eastern Ghats, which pass through several districts of Andhra Pradesh.

Genus *Hexamastix* Alexeieff, 1912

1912. *Hexamastix* Alexeieff, *Zool. Anz.*, **39** : pp. 674-680.

Diagnosis : Five anterior flagella in fully developed organisms (in some species a few young individuals with three and in larger numbers with four such flagella); recurrent flagellum nearly equal to anterior flagella in length and diameter; capitulum of axostyle continuing into pelta in many species; trunk of axostyle varying from very slender to quite stout; parabasal apparatus with rod- or disc- or V-shaped body, with long filament in some species.

Remarks : As stated earlier, key to the species of the genus *Hexamastix* is given for those species only whose descriptions are available. Accordingly, *H. hyderabadensis* from a mammalian host is not included in the key.

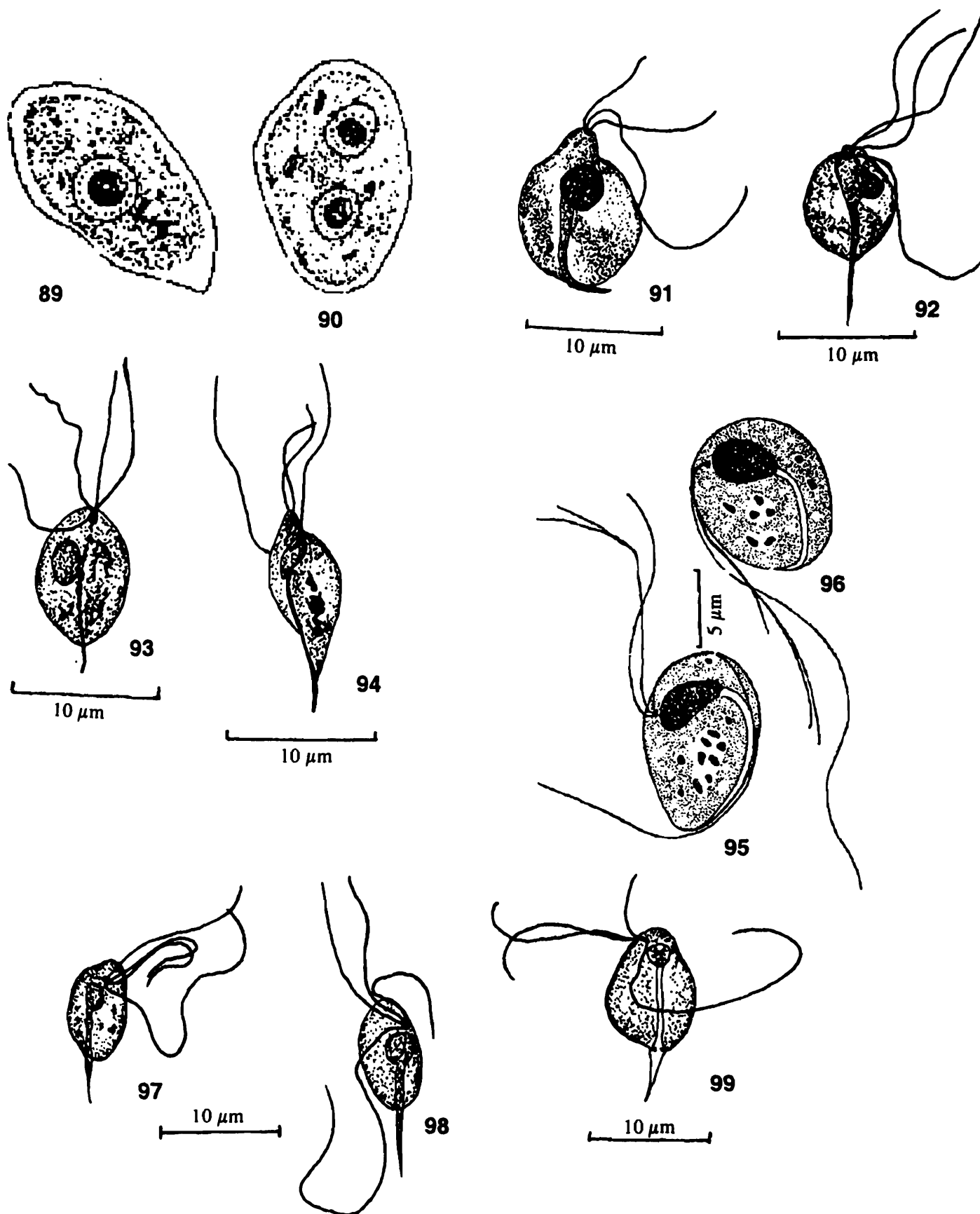
A. *Hexamastix* in insects

A. Key to the species of *Hexamastix* in insects

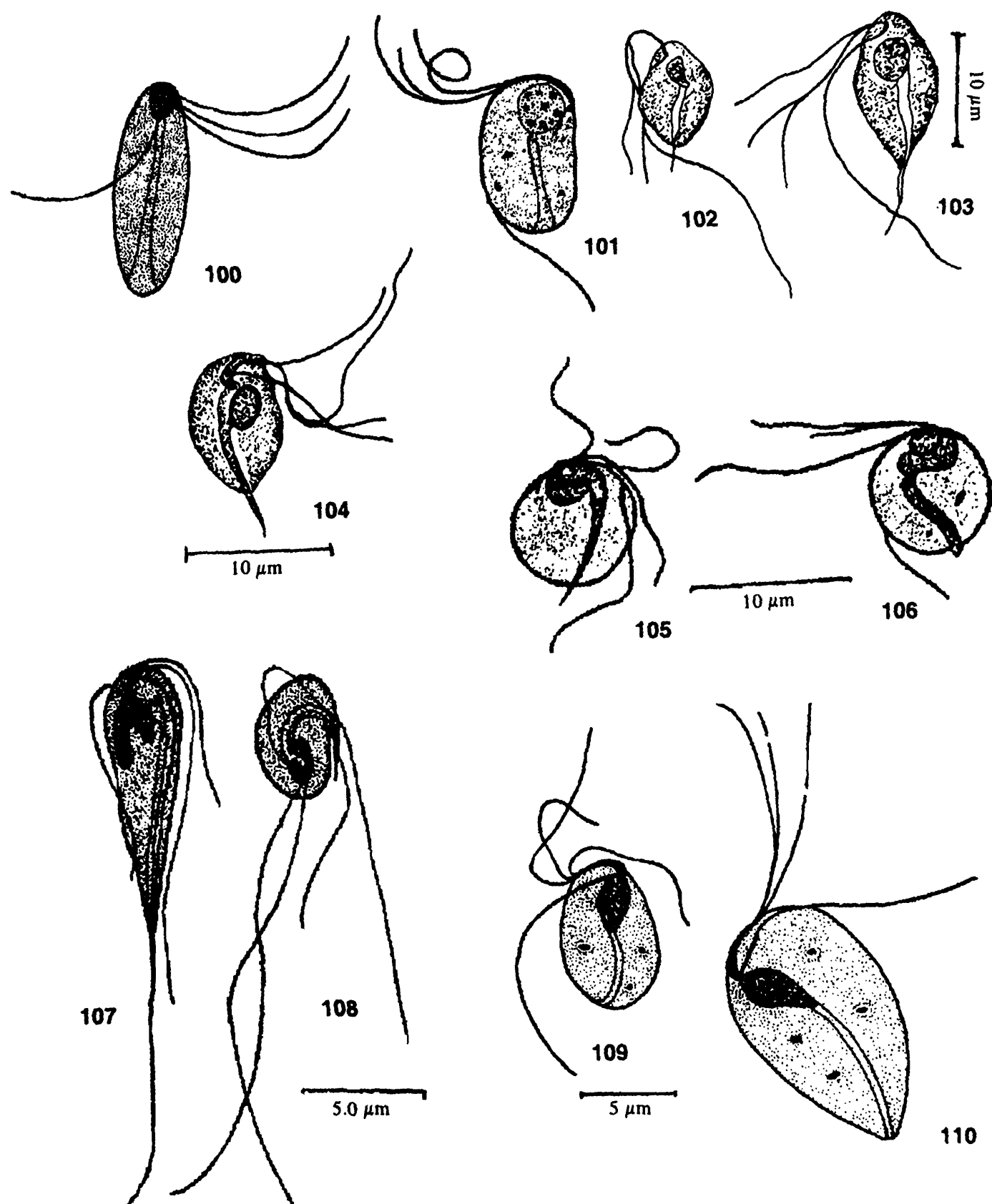
- 1(2) Body round or pyriform, axostyle hyaline and ribbon-like with broad spoon-like calyx, twisted middle portion and tapering posterior part, ultimately projecting outside the body, pelta and cytostome present..... *M. singhi*
- 2(1) Body pyriform or oval, axostyle stout rod-like and projecting outside the body, pelta and cytostome absent *M. periplanetae*

B. Key to the species of *Hexamastix* in mammals

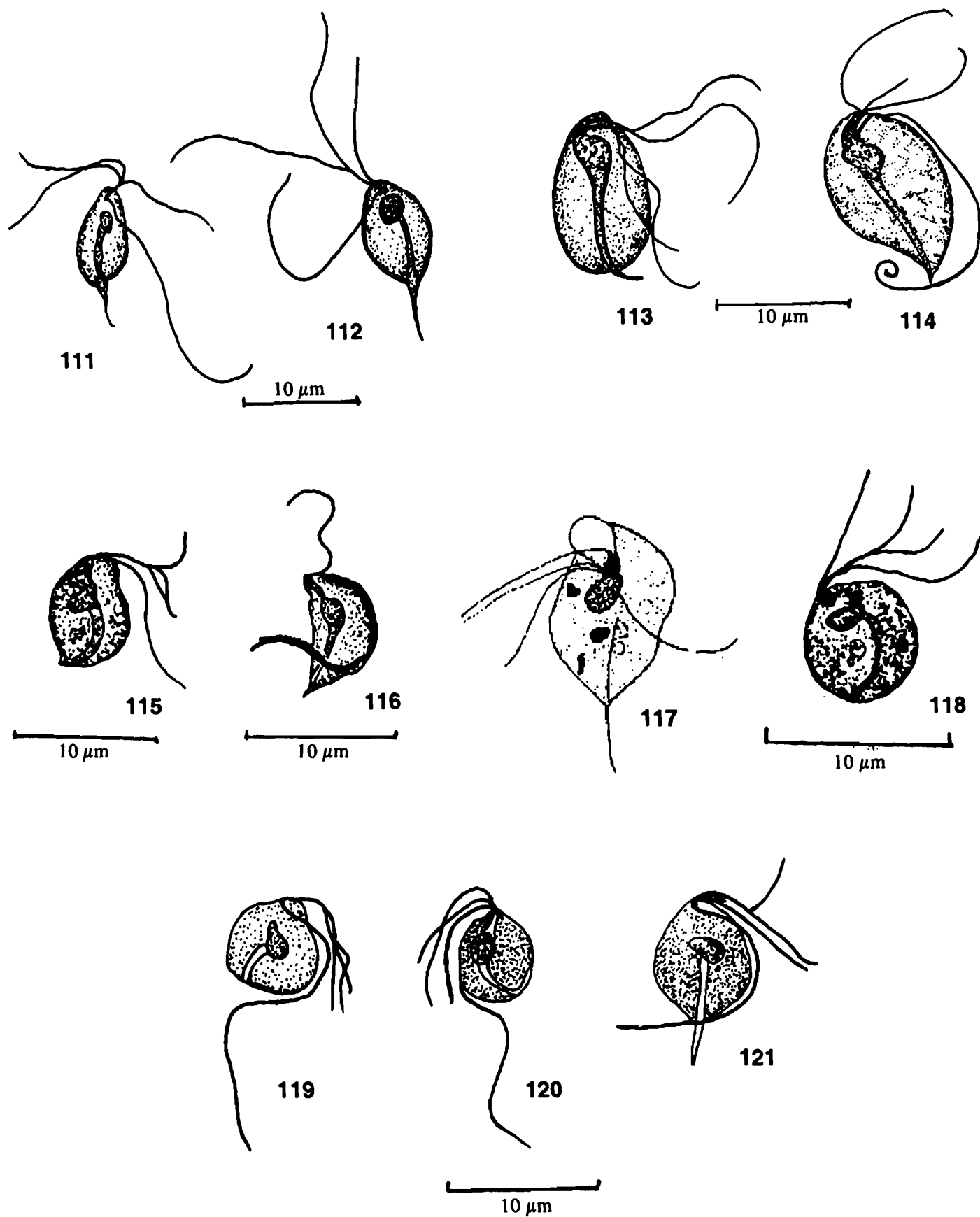
- 1(2) Body ovoid, pyriform or in various shape, axostyle filamentous, a crescentic or sickle-shaped pelta present *H. sciuri*
- 2(1) Body shape more or less as above, axostyle thick rod-like
- 3(4) Axostyle crescent-shaped with spoon-shaped capitulum, cytostome 'V'-shaped pelta absent *H. gopali*
- 4(3) Axostyle typically rod-like, its anterior portion broad



Figs. 89-99. Flagellate parasites of Andhra Pradesh : 89-90. *Dientamoeba dobelli*; 91. *Monocercomonas corydiae*; 92. *M. laccotrephes*; 93. *M. leucophaeae*; 94. *M. osmaniae*; 95-96. *M. calotesi*; 97-98. *M. colubrorum* and 99. *M. eryxi*.



Figs.100-110. Flagellate parasites of Andhra Pradesh : 100-101. *Monocercomonas ganapatii*; 102-103. *M. garnhami*; 104. *M. gopali*; 105-106. *M. prashadi*; 107-108. *M. rayi* and 109-110. *M. srikakulamensis*.



Figs.111-121. Flagellate parasites of Andhra Pradesh : 111-112. *Monocercomonas varani*; 113-114. *M. waltirens*; 115. *M. anasae*; 116. *M. qadrii* ; 117. *M. gerbilli* ; 118. *M. hoarei* and 119-121. *M. lori*.

- 5(6) Axostyle tapering posteriorly to a thin filament, pelta obscure... *H. spheroides*
 6(5) Terminal tip of axostyle projecting outside the body, pelta distinct *H. gerbilli*

A. *Hexamastix* in insects

116. *Hexamastix periplanetae* Bhaskar Rao, 1970 (Figs. 122 & 123)

1970. *Hexamastix periplanetae* Bhaskar Rao, *Proc. Indian Acad. Sci.(B)*, 71 : pp. 13-18.

Diagnosis : Body pyriform or oval, measuring 4.0-13.0 (11.69) μm in length and 3.5-8.5 (7.25) μm in width; single blepharoplast situated at the anterior end, giving rise to six flagella and an axostyle; nucleus round, oval or bean-shaped, containing granules of uniform size, located behind the blepharoplast; axostyle stout, rod-like, 7.5-15.0 (12.58) μm in length, gradually tapering posteriorly, usually projecting outside the body; flagella (av. 12.32 μm) usually as long as the body and normally directed forwards; parabasal body, pelta and cytostome absent.

Host : *Periplaneta americana*, site of infection; faecal content.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

117. *Hexamastix singhi* Bhaskar Rao, 1970 (Figs. 124 & 125)

1970. *Hexamastix singhi* Bhaskar Rao, *Proc. Indian Acad. Sci.(B)*, 71 : pp. 13-18.

Diagnosis : Body generally round or pyriform, measuring 6-13.5 μm x 5-11.5 μm ; a fairly large blepharoplast situated at the extreme end of the body, giving rise to six flagella of more or less equal length of 7.5-17.0 (12.62) μm ; axostyle hyaline and ribbon-like, 8.0-15.5 (11.58) μm in length, divisible into three parts, viz., broad spoon-like calyx encircling the nucleus, uniformly wide and spirally twisted middle portion and tapering posterior part projecting outside the body; pelta, a transverse crescent-shaped membrane present anterior to the nucleus, appearing to be continuous with the axostyle; nucleus round, 2.5 μm in diameter, containing a massive central or eccentric endosome, situated on the calyx of the axostyle; cytostome extending as a long cleft-like structure from the anterior end to posterior border of the nucleus.

Host : *Gryllotalpa africana*; site of infection : faecal content.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

B. *Hexamastix* in reptiles

118. *Hexamastix dobelli* Janakidevi, 1961 (Figs. 126 & 127)

1961. *Hexamastix dobelli* Janakidevi, *J. Protozool.*, 8 : pp. 294-296, figs. 1-13.

Diagnosis : Body usually oval, sometimes pyriform and round, 6.0-16.5 (9.4) μm x 2.0-10.3 (5.8) μm ; nucleus oval, 2.5 μm in diameter, situated in the anterior third of the body, not having endosome or peripheral chromatin; a fairly large blepharoplastic complex, situated in front of the nucleus, giving rise to six flagella, a thin filamentous axostyle and a curved rod-like parabasal body in a few cases; anterior flagella five, three short, two long, and one trailing or recurrent flagellum of about the same length as the anterior short flagella; pelta crescent-shaped situated at the anterior end of the body; forms without axostyle larger in size, spheroidal in shape, loaded with granules and with variable number (5-2) of anterior flagella.

Host : Starred Tortoise, *Testudo elegans* Schoepff; site of infection: large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

C. *Hexamastix* in. mammals

119. *Hexamastix gerbilli* Navarathnam, 1970 (Figs. 128 & 129)

1970. *Hexamastix gerbilli* Navarathnam, *Riv. Parassitol.*, **31** : pp. 251-254.

Diagnosis : Body pyriform, measuring 3.5-8.5 (6.1) μm x 3.5-8.0 (5.5) μm ; nucleus large, spherical 2-4 (2.6) μm x 2.0-3.5 (2.4) μm , with a large endosome, situated on the capitulum at the anterior part of the body or in the middle of the body in a few forms; a conspicuous blepharoplast situated very close to nucleus, giving rise to six flagella of which five anterior flagella of equal in size, 5.0-11.5 (8.7) μm and usually united at their base forming a bundle or remaining separate; trailing flagellum, 6-14 (10.1) μm , longer than the anterior ones; all flagella neither terminating in knobs nor in acronemes; axostyle very long 5-12 (7.7) μm , with broad and bulbous capitulum trunk and terminal tip projecting outside the body up to a length of 6.5 μm , originating from the blepharoplast, broad at the anterior end and posteriorly terminating to a point; pelta broad at the proximal end and pointed distally, present an an extension of the axostyle; cytostome long slit-like, extending up to 3 μm , situated at the anterior-lateral side of the body.

Host : *Gerbillus indicus*; site of infection: caecum and large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

120. *Hexamastix gopali* Navarathnam, 1970 (Figs. 130-132)

1970. *Hexamastix gopali* Navarathnam, *Acta Protozool.*, **8** : pp. 155-165.

Diagnosis : Body round, angular or pyriform, measuring 6.75-14.0 (9.58) μm in length and 3.0-12.5 (8.33) μm ; anterior end broader than the posterior end; cytoplasm granular containing many food particle; nucleus spherical or elongated, 1.5-5.0 μm x 1.5-4.0 μm , situated at the anterior end close to the capitulum; two large blepharoplasts, five equal

anterior flagella, one trailing flagellum (6.0-14.0 μm), a crescent-shaped axostyle and a 'V' shaped cytostome present; five anterior flagella originating from one blepharoplast while the trailing flagellum arising from the other; all anterior flagella (4.0-14.0 μm) equal or shorter than the length of the body; axostyle with three distinct regions such as spoon-shaped capitulum, uniform trunk and terminal tip ending in a fine point; pelta absent.

Host : *Rattus rattus frugivorus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

121. *Hexamastix hyderabadensis* Navarathnam, 1971

1971. *Hexamastix hyderabadensis* Navarathnam, *Acta Protozool.*, 8 : pp. 299-308.

Diagnosis : Not available.

Host : *Cavia cutleri*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

122. *Hexamastix sciuri* Todd, 1963

1963. *Hexamastix sciuri* Todd, *Arch. Protistenk.*, 107 : pp. 44-48, figs. 1-15.

Diagnosis : Body ovoid, pyriform or in various shape, 6.11-9.40 (7.99) μm x 3.76-4.70 (4.34) μm ; cytoplasm vacuolated; nucleus hemispherical or conical, averaging 1.65 μm x 1.35 μm , with uniformly distributed chromatin granules; one blepharoplast, 0.56 μm in diameter, giving rise to all the flagella, the axostyle and a crescentic or sickle-shaped pelta; axostyle very delicate and filamentous, 5.17-8.46 (6.58) μm in length, projecting 0.47-1.88 μm outside the body as a pointed structure; anterior flagella 3-5 in number, 3.76-10.86 (7.64) μm , *i.e.*, as long as or longer than the body; posterior recurrent flagellum 4.23-12.80 (8.80) μm in length, always longer than the body.

Host : Palm Squirrel, *Sciurus palmarum*; site of infection : caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

123. *Hexamastix spheroidis* Todd, 1963

(Figs. 133 & 134)

1963. *Hexamastix spheroidis* Todd, *Arch. Protistenk.*, 107 : pp. 48-52, figs. 1-12.

Diagnosis : Body mostly ovoid or elongated in a few cases, measuring 5.17-11.98 (9.37) μm x 5.17-11.75 (7.63) μm ; cytoplasm dense with a few large vacuoles; nucleus normally spherical or elongated, without karyosome, 1.88-3.05 (2.44) μm x 1.88-2.93 (2.20) μm , situated posterior to blepharoplast; anterior flagella 2-4 or 5 in some, nearly equal, 5.58-15.27 (10.95) μm , usually united proximally in columnar groups of two or three separated at their origin;

recurrent flagellum 9.40-15.51 (11.60) μm in length; blepharoplast round 0.94 μm in average diameter, situated on one side at the anterior end of the body; axostyle thick rod-like, 3.76-9.87 (6.71) μm in length, jutting from the posterior-lateral surface of the nucleus, usually limited to the posterior end of the body, projecting 2.35-3.29 μm in some, anterior portion broad and tapering off into a thin filament, a few lacking an axostyle; pelta obscured by the darkly stained proximal part of the flagella.

Host : Bandicoot, *Nesokia bandicota* (Bechst. 1880); site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district)

Subfamily HYPOTRICHOMONADINAE Honigberg, 1963

Diagnosis : Three anterior flagella; proximal part of, or entire recurrent flagellum incorporated along accessory filament into margin of shallow undulating membrane; membrane typically shorter than body; costa absent; trunk of axostyle slender to quite stout, not surrounded by rings in any known species, with terminal segment projecting for some distance beyond posterior body surface.

Genus *Hypotrichomonas* Lee, 1960

1960. *Hypotrichomonas* Lee, *J. Protozool.* : p. 393.

Diagnosis : Three anterior flagella; undulating membrane shallow, typically shorter than body; free posterior flagellum present; costa absent; capitulum of axostyle with ventro-lateral extensions, continuing anteriorly into well-developed pelta; trunk of axostyle relatively stout, often more or less twisted; parabasal apparatus studied in one species where it consisting of rod-or often V-shaped body and filament or filaments.

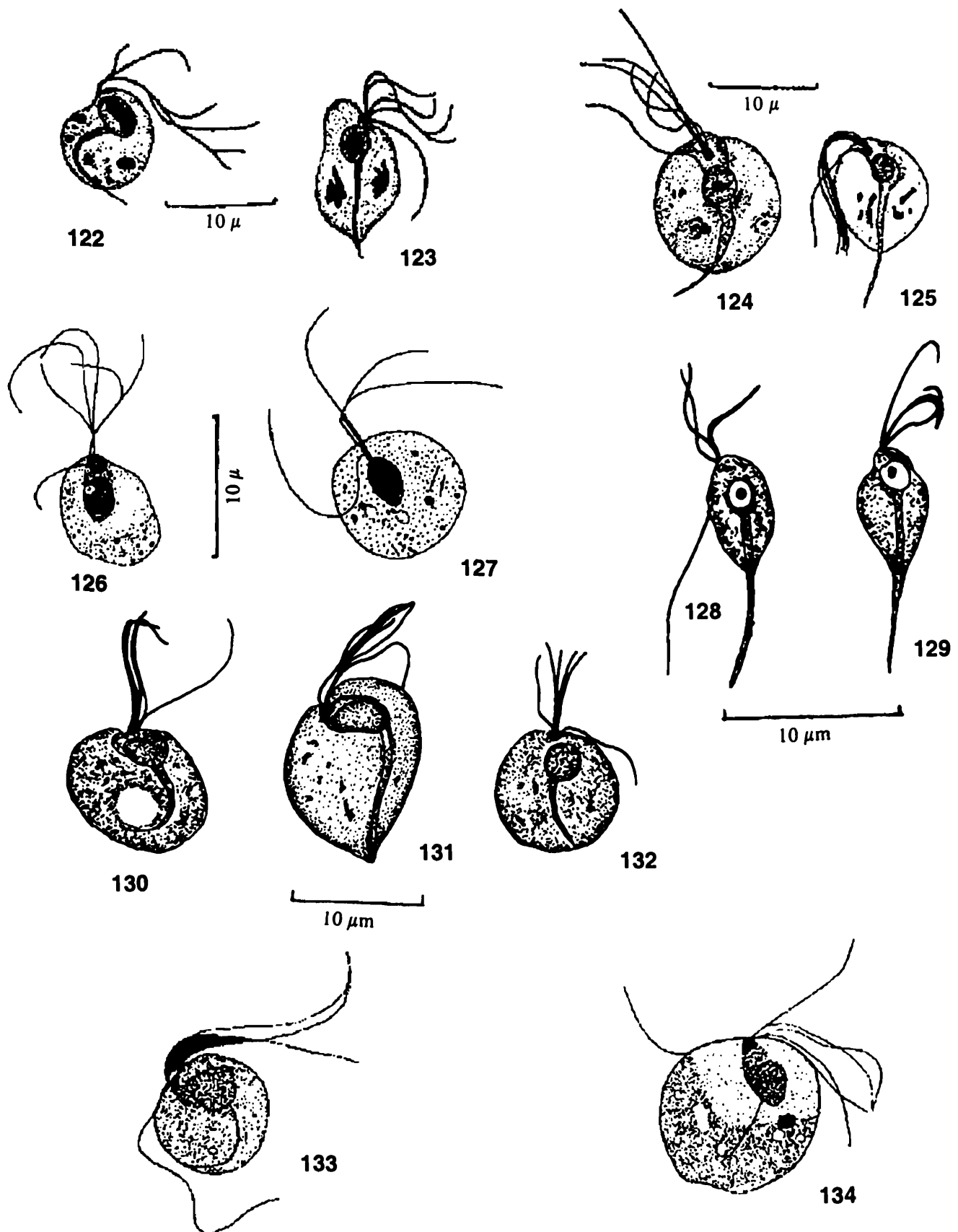
Remarks : The species, *Hypotrichomonas venkataramiahii* is not included in the following key since its diagnosis is not available.

Key to the species of the genus *Hypotrichomonas*

1(4) Parasitic in lizards

2(3) Body pear-shaped or fusiform, dimensions 7.20-13.88 μm . x 4.11-12.85 μm , attached portion of posterior flagellum covering $\frac{1}{2}$ to $\frac{2}{3}$ the body length thrown in 1 or 2 undulatory folds, axostyle tubular and straight projecting outside from posterior end of the body *H. osmaniae*.

3(2) Body almost round, 5.9-10.9 μm in diameter, posterior flagellum running attached to the body surface as shallow undulating membrane, axostyle tubular and curved and



Figs.122-134. Flagellate parasites of Andhra Pradesh : 112-123. *Hexamastix periplanetae*; 124-125. *H. singhi*; 126-127. *H. dobelli*, 128-129. *H. gerbilli*; 130-132. *H. gopali* and 133-134. *H. spheroides*.

posterior part with distinct periaxostylar granules, tapering abruptly to a conical projection *H. hemidactyli*

4(1) Parasitic in birds, body spherical or pear-shaped, 4.5-9.5 μm x 3.5-7.5 μm in dimensions *H. avium*

A. Hypotrichomonas in reptiles

124. *Hypotrichomonas hemidactyli* Bhaskar Rao, Bhaskar Rao and Devi, 1976
(Figs. 135 & 136)

1976. *Hypotrichomonas hemidactyli* Bhaskar Rao, Bhaskar Rao and Devi, *Curr. Sci.*, 45(7) : pp. 263-264, figs. 1-8.

Diagnosis : Body almost round, measuring 5.9-10.9 (8.2) μm in diameter; blepharoplast at the anterior end giving rise to four flagella, three anterior subequal flagella measuring 5.0-15.4 (10.0) μm , 5.0-12.9 (9.6) μm and 5.0-12.3(9.1) μm respectively and one posterior flagellum running attached to the body surface as shallow undulating membrane, trailing flagellum measuring 5.0-18.1 (12.0) μm in length; nucleus spherical at the anterior end of the body, measuring 1.0-3.1(2.0) μm in diameter and containing conspicuous central endosome; axostyle tubular and curved, anterior part obscured and the posterior part equipped with distinct periaxostylar granules and abruptly tapering to a conical projection; pelta inverted comma-shaped; parabasal body bilobed extending on either side of the nucleus.

Host : *Hemidactylus* sp; site of infection: not mentioned.

Distribution : India : Andhra Pradesh (Warangal district).

125. *Hypotrichomonas osmaniae* Krishnamurthy, 1967
(Figs. 137 & 138)

1967. *Hypotrichomonas osmaniae* Krishnamurthy, *Curr. Sci.*, 36(21) : pp. 583-584, figs. 1-7.

Diagnosis : Body pear-shaped, spherical or fusiform, measuring 7.20 – 13.88 (9.94) μm x 4.11–12.85 (6.65) μm ; nucleus large ellipsoidal, 2.03 μm x 1.94 μm ; possessing organelles, viz., a blepharoplast, 3 anterior flagella, a trailing flagellum with a poorly developed undulating membrane, an axostyle, pelta and a nucleus; three anterior flagella unequal, measuring 9.25–16.97 (13.41) μm , 12.85–22.11 (17.76) μm and 14.40–24.1 (19.95) μm respectively; the attached portion of the posterior flagellum, covering $\frac{1}{2}$ to $\frac{2}{3}$ the body length, thrown in 1 or 2 undulatory folds and supported by a thin membrane, free part ranging from 12.85-30.85 (20.63) μm in length; axostyle tabular and straight, almost of uniform thickness excepting the spine-like posterior part outside the body, nucleus ellipsoidal, 2.03 μm x 1.94 μm ; cytoplasm containing granules and bacteria; pelta curved and comma-shaped; costa and cytostome absent.

Host : *Varanus* sp. ; site of infection : rectum.

Distribution : India: Andhra Pradesh (Hyderabad district).

126. *Hypotrichomonas venkataramiahii* Dayakar, Devi,
Bhaskar Rao and Bhaskar Rao, 1977

1977. *Hypotrichomonas venkataramiahii* Dayakar, Devi, Bhaskar Rao and Bhaskar Rao, *Acta Protozool.*,
16(3-4) : pp. 225-229.

Diagnosis : Not available.

Host : *Varanus* sp.; site of infection : rectum.

Distribution : India : Andhra Pradesh (Warangal district).

B. *Hypotrichomonas* of birds

127. *Hypotrichomonas avium* Navarathnam, 1970
(Fig. 139)

1970. *Hypotrichomonas avium* Navarathnam, *Riv. Parassitol.*, **31** : pp. 251-254.

Diagnosis : Body spherical or pear-shaped, 4.5-9.5 (6.4) μm x 3.5-7.5 (5.5) μm ; nucleus ellipsoidal or spherical, 1.5-3.5 (2.5) μm , with a large endosome and a distinct nuclear membrane, situated at the anterior part of the body; blepharoplast giving rise to three anterior and one posterior flagellum also situated at the anterior part of the body near the nucleus; three anterior flagella without acronemes or knobs, unequal in length and longer than the body, 7-14 (10.8) μm , 7-17 (13.7) μm , and 7-20.5 (16.2) μm respectively; trailing flagellum attached to the surface of the body for $\frac{1}{2}$ or $\frac{3}{4}$ of the body by a shallow undulating membrane with one or two folds, free portion 2.5-10.0 μm in length; axostyle curved crescent-shaped, 3-7 μm in length, tapering type and slightly projecting out at the posterior end into a fine point; distinct capitulum and pelta absent; cytostome V-shaped, slightly curved at the posterior tip, extending upto the anterior third of the body and situated lateral to the nucleus.

Host : *Cryptoplecton erythrorhynchum*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Family TRICHOMONADIDAE Chalmers & Pekkola, 1918

Diagnosis : Four to six flagella of which one is recurrent; proximal part of, or entire recurrent flagellum incorporated into margin of undulating membrane along one or more accessory filaments; undulating membrane supported by costa; axostyle of varying structure; parabasal apparatus consisting of body associated with one or more filaments.

Subfamily TRICHOMONADINAE Chalmers & Pekkola, 1918

Diagnosis : Three to five anterior flagella; full flagellar complement usually restored in late in division, occasionally after cytokinesis; proximal part of, or entire recurrent flagellum

incorporated along accessory filament into margin of undulating membrane; membrane varying in length and degree of development; costa usually rather slender; capitulum of axostyle of varying complexity, continuing anteriorly into typical pelta; trunk of axostyle hyaline rod usually slender or of moderate diameter, not tube-like in appearance, without axostylar granules and typically without periaxostylar rings, projecting for some distance from posterior body surface, with terminal segment of projecting part tapering to a point; parabasal apparatus with body of varying structure and filament or filaments.

Key to the genera

- 1(2) Three anterior flagella; undulating membrane of varying in length, height and number of undulation; with free posterior flagella ***Trichomitus***
- 2(1) More than three anterior flagella; undulating membrane well developed or shorter than the length of body; with or without free posterior flagella
- 3(4) Four anterior flagella; undulating membrane typically shorter than the body; no free posterior flagellum.....***Trichomonas***
- 4(3) Four or five anterior flagella; undulating membrane well developed; free posterior flagella present
- 5(6) Four anterior flagella; costa of varying width; parabasal body typically disc-shaped ***Tetratrichomonas***
- 6(5) Five anterior flagella; costa relatively well developed; parabasal body elliptic or circular area ***Pentatrichomonas***

Genus *Trichomonas* Donne, 1836

1836. *Trichomonas* Donne, C. R. Acad.Sci., Paris, 3 : p.385.

Diagnosis : Four anterior flagella; in fully grown organisms undulating membrane typically shorter than body; no free posterior flagellum; costa relatively slender; capitulum of axostyle spatulate of moderate width, continuing anteriorly into slender pelta; trunk of axostyle typically slender; parabasal body rod-or V-shaped, associated with filament or filaments.

A. Key to the species of *Trichomonas* in birds

- 1(2) Body pyriform, 7-15 μm x 5-11 μm in dimensions, parabasal body absent ***T. bramae***
- 2(1) Body pyriform or round-shaped, 6-19 μm x 2-4 μm in dimensions, parabasal body sausage-shaped ***T. gallinae***

B. Key to the species of *Trichomonas* in mammals

- 1(4) Axostyle with conspicuous capitulum, stem and the conical tip
- 2(3) Body pear-shaped or lozenge-shaped, posterior end generally bilobed with the axostyle projecting between them, axostyle hyaline and rod-shaped, parasitic in Indian porcupine *T. leucuri*
- 3(2) Body pyriform or oval, posterior end not bilobed, axostyle with a band-like chromatic ring at the junction of its stem and conical tip, parasitic in house rat.... *H. frugivori*
- 4(1) Axostyle delicate hyaline and rod-like, its origin near blepharoplast not distinct
- 5(6) Body very small (7.05-8.64 μm in length); parasitic in Indian Gerbil *T. singhi*
- 6(5) Body size variable, smaller ones 6.5 μm x 3.0 μm and larger ones 15 μm x 12 μm ; parasitic in Indian horse *T. caballi*

A. *Trichomonas* in birds**128. *Trichomonas brahamae* Sambasivarao and Narasimhamurti, 1982**

(Fig. 140)

1982. *Trichomonas brahamae* Sambasivarao and Narasimhamurti, *Proc. Indian Acad. Parasitol.*, 3(1&2) : pp. 65-68.

Diagnosis : Body pyriform, measuring 7-15 μm x 5-11 μm , with rounded anterior end and pointed posterior end; cytoplasm alveolated, containing a few food vacuoles; nucleus rounded or oval, 2-4 μm x 1.5-3.0 μm , surrounded by thin nuclear membrane; cytostome absent; a large blepharoplast giving rise to five flagella and a costa, situated in front of the nucleus; four anterior flagella unequal in length, ranging from 6 to 15 μm ; trailing flagellum thicker, attached to the body wall by an undulating membrane, no free posterior flagellum; costa thick and 4-10 μm in length, paracostal granules absent; axostyle rigid, 5-10 μm , extending beyond the cell body as a pointed spike of about 1-2 μm ; parabasal body absent.

Host : Spotted owl, *Athene brahamae*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

129. *Trichomonas gallinae* (Rivolta, 1878)

(Fig. 141)

1878. *Cercomonas gallinae* Rivolta, *Giorth, Anat. Fisiol. Pat Anim.*, Pissa, 10 : p. 220.

1966. *Trichomonas gallinae* : Kudo, *Protozoology*, : p. 469.

Diagnosis : Body pear-shaped or round-shaped measuring 6-19 μm x 2-9 μm ; parabasal body sausage-shaped, 4 μm long; nucleus ovoid, located at anterior part; axostyle protruding a little out of the body.

Host : Love bird (*Budgerigars*); site of infection : oesophagus.

Distribution : India : Andhra Pradesh (Hyderabad district); cosmopolitan.

Remarks : Sampurnanand *et al.* (2002) reported this species in two love birds from this state, which had died with symptoms of obstruction in oesophagus. On post mortem examination they found that the mucous membrane of oesophagus had ulcers and the lumen was occluded at crop region.

130. *Trichomonas* sp.

Diagnosis : Pyriform, measuring 9-13.5 μm x 6.75-11.25 μm ; nucleus single at the anterior part; a blepharoplast composed of one or two rounded mass, giving rise to four anterior flagella of 6.5-7.2 μm long and a posterior flagellum; undulating membrane extending up to $\frac{2}{3}$ to $\frac{3}{4}$ of the body, exhibiting 2-3 folds; no free flagellum extending beyond its posterior end; an accessory filament present in some specimens; axostyle slender without any capitulum and chromatinic ring; parabasal body 6.75-7.5 μm long and filamentous; cytoplasm inconspicuous.

Host: Love bird, Budgerigars; site of infection: necrotic lesions in the oesophagus.

Distribution : India : Andhra Pradesh (possibly Hyderabad district, exact locality not mentioned).

Remarks : Mukherjea *et al.* (1970) reported this undetermined trichomonad species based on stained smears sent to the Department of Protozoology, School of Tropical Medicine, Calcutta, by the Deputy Director, Veterinary Biological and Research Institute, Hyderabad for specific identification. The species description bears close morphologic resemblance with *T. gallinae* but differs from the latter in the absence of sausage-shaped component in the parabasal body.

B. *Trichomonas* in mammals

131. *Trichomonas caballi* Abraham, 1961

(Fig. 142)

1961. *Trichomonas caballi* Abraham, *Z. Parasitenk.*, 21 : pp. 164-168.

Diagnosis : Body pyriform, 6.5-15.0 (9.4) μm x 3.0-12.0 (6.0) μm , with blunt anterior end and pointed posterior end; greatest width at the anterior third region; cytoplasm crowded with fairly large granules and bacterial inclusions; two blepharoplasts present; primary blepharoplast giving rise to a rod-like hyaline axostyle, and the undulating membrane with its associated filaments as well as the posterior flagellum of a little more than double the body length; a robust oblong rod-like cresta and an oblong pelta present; secondary blepharoplast giving rise to two occasionally three anterior flagella; parabasal body made up of a single ramus ending in a loop-like structure, and a fibril; nucleus irregular containing diffused chromatin granules.

Host : Horse, *Equus caballus*, site of infection: colon.

Distribution : India : Andhra Pradesh (Hyderabad district).

132. *Trichomonas frugivori* Todd, 1963
(Fig. 143)

1963. *Trichomonas frugivori* Todd, Arch. Protistenk. 107 : pp. 59-62, figs. 1-9.

Diagnosis : Body pyriform or oval, 11.75-21.15 (16.60) μm x 7.05-18.80 (12.50) μm ; two blepharoplasts, one giving rise to three anterior flagella and from the other originating the undulating flagellum and the costa of 10.34- 17.39 (14.64) μm ; three anterior flagella, almost equal in length, smaller than the body, measuring 4.70-9.87 (7.39) μm , arising as a bundle and free eventually; undulating flagellum, thick with an accessory filament and a well developed undulating membrane usually thrown into 4-6 folds, arising posterior to free flagellar bundle, running along the margin, free at the out-projecting region of axostyle and trailing behind a few microns only or as long as the body; axostyle with conspicuous capitulum, stem and the conical tip; a broad, band-like chromatic ring located at the junction of the stem and the conical tip; nucleus oval or conical, 3.29-10.81 (7.08) μm x 1.88- 3.52 (2.68) μm , situated practically embedded in the capitulum; cytostome claw-like.

Host : *Rattus rattus frugivorus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

133. *Trichomonas leucuri* Todd, 1963
(Fig. 144)

1964. *Trichomonas leucuri* Todd, Arch. Protistenk. 107 : pp. 52-59, figs. 1-9.

Diagnosis : Body pear-shaped or oval or lozenge-shaped, size variable from a small tiny one to huge giant form, measuring 8.10- 36.24 (30.42) μm in length and 4.05-16.45 (12.32) μm at its widest region; anterior end broader than posterior end; posterior end generally bilobed with the axostyle projecting between them; blepharoplast situated a little distance from the anterior end, giving rise to four flagella, 13.60- 49.69 (37.24) μm in length, nearly twice the length of the body, all of them posteriorly directed, following the course of undulating membrane, one of these flagella acting as relatively thick trailing flagellum; undulating membrane conspicuous, thrown into 2-10 distinct sub-equal folds; costa prominent, rod-like, 14.73-32.90 (27.58) μm in length, situated at the base of the undulating membrane arising from the blepharoplast; axostyle hyaline and rod-shaped, 8.11-30.55 (21.71) μm in length, arising slightly anterior to or in juxtaposition to the blepharoplast, divisible into three distinct regions, capitulum, stem and conical tip.

Host : Indian Porcupine, *Hystrix leucura* Sykes; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

134. *Trichomonas singhi* Todd, 1963
(Fig. 145)

1963. *Trichomonas singhi* Todd, *Arch. Protistenk.* **107** : pp. 62-67, figs. 1-9.

Diagnosis : Body very small, measuring 7.05-9.87 (8.64) μm in length; cytostome periodically opened and closed slit-like structure, extending from the anterior end to one-third the length of the body; single, comparatively large, usually rounded or rod-shaped blepharoplast giving rise to four unequal anterior flagella of 5.17-8.93 μm in length, one short, two intermediate and one relatively long of 8.46-8.93 μm in length; undulating membrane along with its flagellum arising from the blepharoplast thrown into 2-6 distinct humps; costa filamentous, resembling the flagella, usually terminates a short distance beyond the undulating membrane after arising from the blepharoplast; axostyle delicate and rod-like, 4.23-7.99 (5.89) μm in length, origin not distinct, with a chromatic ring at the posterior tip of the body and posteriorly projecting beyond the body as a spike.

Host : Indian Gerbille, *Gerbillus indicus*; site of infection: caecum and intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Trichomitus Swezy, 1915
(Syn. *Tritrichomonus*)

1915. *Trichomitus* Swezy, *Univ. Calif. Publ. Zool.*, **16** : p. 89.

Diagnosis : Three anterior flagella; undulating membrane of varying in length, height, and number of undulations among and within species; free posterior flagellum; costa relatively slender in most, very weakly developed in some species; capitulum of axostyle spatulate or spoon-shaped often with conspicuous ventro-lateral extensions, continuing anteriorly into well developed pelta; trunk of axostyle variable, but usually moderate diameter; parabasal body in most species predominantly V-shaped with arms varying from nearly straight rods to broad almost discoid structures, associated with parabasal filaments.

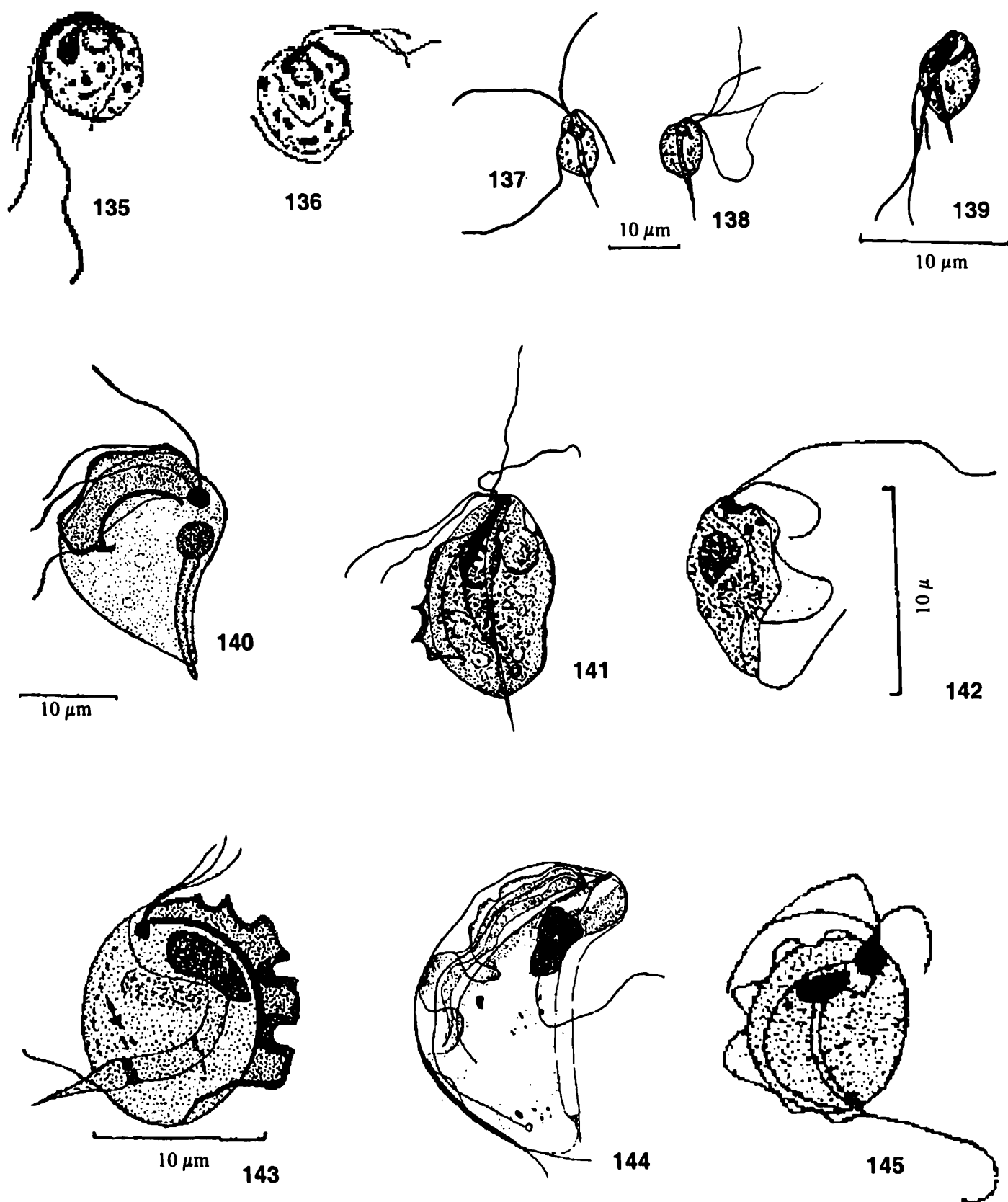
Key to the species of *Trichomitus* in amphibians and reptiles

- 1(2) Body, spherical, ovoidal or pyriform, 8-16 μm x 5-12 μm in dimensions; occurring in wide range of hosts (both amphibians and reptiles) *T. batrachorum*
- 2(1) Body fusiform, 12-22 μm x 5-13 μm in dimensions; occurring in frogs, *Rana tigerina* *T. hyderabadensis*

A. *Trichomitus* of insects

135. *Trichomitus corydiae* Bhaskar Rao and Todd, 1968
(Fig. 146 & 147)

1968. *Trichomitus corydiae* Bhaskar Rao and Todd, *Riv. Parassitol.*, **29** : pp. 91-95.



Figs.135-145. Flagellate parasites of Andhra Pradesh : 135-136. *Hypotrichomonas hemidactyli*; 137-138. *H. osmaniae*; 139. *H. avium*; 140. *Trichomonas bramae*; 141. *T. gallinae* ; 142. *T. caballi*; 143. *T. frugivori*; 144. *T. leucuri* and 145. *T. singhi*.

Diagnosis : Body round or pyriform, 8-14 (10.2) μm x 7.5-12.5 (9.6) μm ; nucleus round or bean-shaped, 3.0-5.5 μm in diameter, located at the anterior end of the body, possessing a central endosome with extra-endosomal chromatin grains; a large and conspicuous single blepharoplast situated at the extreme anterior end of the body; blepharoplast giving rise to three unequal anterior flagella (9.4 μm , 12.5 μm and 14.8 μm respectively), a trailing flagellum (having a short free portion measuring 5.9 μm in average) and the prominent costa (4-10 μm in length); undulating membrane feebly developed and extending to half the length of the body; axostyle well developed and rod-shaped, 7-13 (9.4) μm in length, with broad calyx, uniform middle part and the abruptly tapering spike usually extending beyond the posterior extremity of the body or curving upwards in some forms; cytostome distinct and claw-shaped.

Host : *Corydia petiveriana*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

B. *Trichomitus* of amphibians and reptiles

136. *Trichomitus batrachorum* (Perty, 1852)

(Figs. 148 & 149)

1852. *Trichomonas batrachorum* Perty, *Zur Kenntniss kleinster Lebensformen*, Jent und Reinert, Bern, p. 170, pl. 14, fig. 14.

1965. *Trichomitus batrachorum* (Perty) Krishnamurthy, *Curr. Sci.*, 36(24) : pp. 672-674, figs. 1-15.

Diagnosis : Body spherical, ovoidal or pyriform, measuring 8.74-16.45 (12.22) μm x 5.4-11.82(8.47) μm in the strain from *Eryx johni*; blepharoplast large and conspicuous granule, situated very near the anterior end, giving rise to various mastigont elements; three anterior flagella unequal measuring, on the average, 11.25 μm , 14.40 μm and 16.30 μm in the strain from *Eryx*; posterior flagellum running along outer border of the undulating membrane and free posteriorly; undulating membrane extending almost up to the posterior end of the body and thrown into 3-5 folds; costa thin, thread-like and running below the base of the undulating membrane for its whole length; axostyle well developed, possessing a spoon-shaped capitulum, free spike-like part 4.67 μm in length and very conspicuous; nucleus oval or spherical, 2.28 μm x 2.57 μm , lateral to capitulum and having a small eccentric endosome; rhizoplast well developed running forward from the nuclear membrane to the blepharoplast; peri-axostylar chromatic rings, pelta and cytostome absent.

Indian Host : *Eryx johni* and *Varanus* sp.; site of infection; intestine.

Distribution : India : Andhra Pradesh (Hyderabad district) and Maharashtra.

Remarks : *Trichomitus batrachorum* (Perty, 1852) is a common rectal parasite of numerous species of amphibian and reptiles. Honigberg (1953) gave a comprehensive account of its structure, synonymy and host list, under the name *Tritrichomonus batrachorum*. Later,

Honigberg (1963) distinguished the 'batrachorum' type from 'augusta' type of trichomonads and placed the former in the genus *Trichomitus* Swezy, 1915. In India, Krishnamurthy (1967) recorded this parasite from two squamate reptiles, *Eryx johni* and *Varanus* sp. from Hyderabad region. The organisms described by him agree with the description of Honigberg (1953), except for the absence of the pelta and minor variation in the body dimension. Krishnamurthy and Madre (1975) recorded this species from Maharashtra State.

137. *Trichomitus hyderabadensis* Krishnamurthy, 1968
(Figs. 150-151)

1968 *Trichomitus hyderabadensis* Krishnamurthy, *J. Bombay nat. Hist. Soc.*, **65**(2) : pp. 513-516, figs. 1-5.

Diagnosis : Body fusiform, having a broad and round anterior end and a somewhat narrower tapering posterior end, measuring 12.85-22.11 (16.45) μm in length excluding spike and 5.14-13.88 (8.56) μm in maximum width; blepharoplast, a large and conspicuous granules, about 1-2 μm behind the anterior extremity, giving rise to the mastigont elements comprising of three unequal anterior flagella, a posterior flagellum, two accessory filaments, a costa and an axostyle; an additional filament running between the costa and the accessory filament in some; undulating membrane extending almost up to the posterior end of the body, thrown into 4-7 folds; costa thicker than flagellum running a somewhat curved course; axostyle well developed with its anterior portion expanded to form a spoon-shaped capitulum; nucleus large and ovoidal (av. 3.13 μm x 2.44 μm), lateral to spoon-shaped capitulum, having a central endosome; longest flagellum (av. 20.81 μm) a little more than the body length; pelta and cytostome absent.

Host : *Rana tigrina* (Daud); site of infection; intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1969) recorded an acostate strain of interesting trichomonad forms without the secondary accessory filament from the rectal content of the same host with similar general features, shape and dimensions, co-existing with *Trichomitus hyderabadensis*. Pending further studies he considered the acostate form as a strain of *T. hyderabadensis*.

138. *Trichomitus* sp.

Host : *Chameleon zeylanicus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Krishnamurthy (1968) reported this unnamed species from the aforesaid host.

C. *Trichomitus* of mammals

139. *Trichomitus honigbergi* Navarathnam, 1971

1971. *Trichomitus honigbergi* Navarathnam, *Acta Protozool.*, **8** : pp. 299-308.

Diagnosis : Not available.

Host : *Cavia cutleri*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

***Tetratrichomonas* Parisi, 1910**

1910. *Trichomonas* (*Tetratrichomonas*) Parisi, *Arch. Protistenk.*, **19** : p. 232.

Diagnosis : Four anterior flagella (in fully developed organisms); undulating membrane well developed, extending for about entire length of body; free posterior flagellum; costa of varying width, but more often rather slender; capitulum of axostyle spatulate, of moderate width, without conspicuous ventro-lateral extensions, continuing anteriorly into usually narrow pelta; trunk of axostyle more often quite slender, relatively stout in some species; parabasal body typically disc-shaped with well-defined constant central granule (V-shaped in at least one and granule-shaped in another known species), associated with one or two filaments.

140. *Tetratrichomonas garnhami* Navarathnam, 1971

1971. *Tetratrichomonas garnhami* Navarathnam, *Zool. Anz.*, **186** : pp. 301-306.

Diagnosis : Body fusiform or oval, 7.5-14.0 (10.5) μm x 3.0-12.0 (8.5) μm ; nucleus large oval or elongated, at the anterior part of the body, 2.5-5.0 (3.3) μm x 1.5- 3.5 (2.0) μm , containing a small central endosome with fine chromatin granules around it; two distinct blepharoplasts at the anterior extremity of the body, equal in size, located away from the nucleus, one of which giving rise to four anterior flagella of equal size, 5-9 (7.2) μm , united at the base, while the other giving rise to the costa, the marginal and the accessory filaments of the undulating membrane; undulating membrane, with 3-6 folds, extending up to the posterior end of the body bordered by a thick marginal filament continuing as a short free flagellum of 2-6 (4) μm in length; costa very thick as thick as axostyle, conspicuous, 9-16 (11) μm in length; axostyle slender with no distinct capitulum, uniform in thickness throughout, only slightly pointed at the posterior tip; cytostome conspicuous, 'V'-shaped, at the anterior part of the body, extending $\frac{1}{2}$ the length of the body.

Host : *Coturnix coturnix*; site of infection: intestine and caecum.

Distribution : India : Andhra Pradesh (exact locality not mentioned).

***Pentatrichomonas* Mesnil, 1914**

1914. *Pentatrichomonas* Mesnil, *Bull. Inst. Pasteur*, **12** : p. 968.

Diagnosis : Five anterior flagella in normal fully developed organisms; flagella of two types; four grouped together in their basal portion and exhibiting synchronous movement, one originating and moving independently of others; well-developed undulating membrane

extending for entire length of body; free posterior flagellum; costa relatively well developed; capitulum of axostyle spatulate, of moderate width, with some ventro-lateral extensions and large pelta; trunk of axostyle generally of moderate diameter, parabasal apparatus composed of filament and one or more granules, which may be surrounded by clear, rather faintly outlined, elliptic or circular area.

A. Key to the species of *Pentatrichomonas* in birds

- 1(2) Body spherical or pear-shaped, 8.5-13.5 μm x 4.0-9.0 μm ; nucleus spherical or slightly oval, 1.5-2.5 μm in diameter; axostyle massive with spoon-shaped capitulum; cytostome V-shaped cleft-like *P. capellae*
- 2(1) Body generally pear-shaped or irregular, 7-13.5 μm x 5-11.5 μm ; nucleus spherical or oval, averaging 3.4 x 2.7 μm ; axostyle with bulbous capitulum, extending from anterior to posterior end of the body; cytostome narrow slit-like *P. centropi*

B. Key to the species of *Pentatrichomonas* in mammals

- 1(2) Cytostome absent, body usually spherical or ovoid, 8-12 μm x 7-11 μm ; nucleus spherical or oval, 2-4 μm x 2-3 μm ; axostyle long, with broad spatulate capitulum *P. smithi*
- 2(1) Cytostome present
- 3(4) Cytostome comma-shaped, body pyriform, sometimes oval or rounded, 7-12 μm ; nucleus usually spherical, occasionally spherical or oval, averaging 2.2 μm x 1.7 μm ; axostyle filamentous or rod-like, projecting beyond the body as axostylar spike *P. vulpi*
- 4(3) Cytostome V-shaped, body spherical or pyriform, 6-11 μm x 5-12 μm ; nucleus spherical or transversely elongated 2-4 μm x 2-3.5 μm ; axostyle very short, narrow tube-like *P. tardigardi*

141. *Pentatrichomonas capellae* Navarathnam, 1970 (Fig. 152)

1970. *Pentatrichomonas capellae* Navarathnam, *Riv. Parassitol.*, 31 : pp. 99-106.

Diagnosis : Body spherical or pear-shaped, 8.5-13.5 (11.1) μm x 4.0-9.0 (6.5) μm ; nucleus spherical or slightly oval, 1.5-2.5 μm in diameter, with a small endosome surrounded by chromatin granules, lying on the spoon-shaped capitulum just behind the single blepharoplast situated at the extreme end of the body; five flagella, as long as or longer than the body, four remaining grouped together and the other isolated, all originating from the blepharoplast, unequal, ranging from 4-21 μm in length; costa rod-like, 7.0-11.5 μm , arising from the blepharoplast, extending along the base of the undulating membrane; axostyle massive, hyaline, tubular in structure, 10-15 μm in length, extending up to the posterior end or projecting a

short distance beyond the body, without any endoaxostylar granules or periaxostylar chromatic ring; cytostome crescentic or slightly curved V-shaped cleft-like structure, located at the side of the nucleus.

Host : *Capella gallinago*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

142. *Pentatrichomonas centropi* Navarathnam, 1970
(Figs. 153 & 154)

1970. *Pentatrichomonas centropi* Navarathnam, *Riv. Parassitol.*, 31 : pp. 99-106.

Diagnosis : Body generally pear-shaped or occasionally irregular, 7.5-13.5 (11.0) μm x 5.5-11.5 (9.1) μm ; nucleus spherical or oval, averaging 3.4 μm x 2.7 μm , containing a large irregular, spherical or eccentric endosome, situated at the anterior part of the body; a single large blepharoplast also situated at the anterior part of the body, giving rise to all the mastigont elements; five anterior flagella, four in a group and equal in size (6-14 μm), fifth one short (5-11 μm) and isolated, undulating membrane well developed with 2-5 broad, subequal folds, followed by a marginal filament terminating as a free flagellum (averaging 4.6 μm) at the posterior end of the body; a well developed costa, broad at its origin and gradually tapering to a fine point, arising from the blepharoplast, extending along the undulating membrane up to the posterior end; axostyle with distinct bulbous capitulum, tubular trunk and terminal fine tip, extending from the anterior to the posterior end of the body; cytostome very small, forming a narrow slit.

Host : *Centropus sinensis*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

***Pentatrichomonas* in mammals**

143. *Pentatrichomonas smithi* Navarathnam, 1970
(Fig. 155)

1970. *Pentatrichomonas smithi* Navarathnam, *Riv. Parassitol.*, 31 : pp. 99-106.

Diagnosis : Body usually spherical, sometimes ovoid, 8-12 (10) μm x 7-11 (8.9) μm ; nucleus spherical or oval, 2-4 μm x 2-3 μm , situated at the anterior end of the body, containing a central endosome; two blepharoplasts, equal in size, close to each other and located at the anterior end of the body, one giving rise to four short and unequal (6.5-12.0 μm) anterior flagella, undulating membrane and costa, while the fifth flagellum also very short (6-12 μm), arising from the other; flagella without acronemes or terminal thickenings; undulating membrane with 3-5 folds, extending up to the posterior end of the body and continued as free flagellum; costa running beneath the undulating membrane; axostyle hyaline and broad, with spatulate capitulum two or three times as broad as trunk; cytostome absent.

Host : *Herpestes smithi*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

144. *Pentatrichomonas tardigardi* Navarathnam, 1970
(Figs. 156 & 157)

1970. *Pentatrichomonas tardigardi* Navarathnam, *Riv. Parassitol.*, **31** : pp. 99-106.

Diagnosis : Body spherical or pyriform, 6-11 (8.8) μm x 5-12 (7.8) μm ; nucleus spherical or transversely elongated, 2-4 μm x 2-3.5 μm , situated at the anterior part of the body, with a small endosome in the centre surrounded by fine granules; two blepharoplasts located at the extreme anterior end of the body, equal in size, situated away from each other, one giving rise to four anterior flagella, while the independent flagellum, the marginal filament and the costa arising from the other; all flagella without acronemes, out of four anterior flagella, two long and two short, fifth anterior flagellum equal to the short flagella; undulating membrane poorly developed, extending up to half or three fourths of the body length, bordered by marginal filament up to its posterior end and then continued as short free flagellum (1.5-8.0 μm); costa filamentous and inconspicuous, running below the undulating membrane; axostyle very short and narrow tube-like, projecting out only 0.5-1.0 μm in a few individuals; cytostome V-shaped, broad cleft-like structure, situated on the antero-lateral side of the body, originating near the blepharoplasts and extending up to the posterior end of the nucleus.

Host : *Loris tardigradus*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

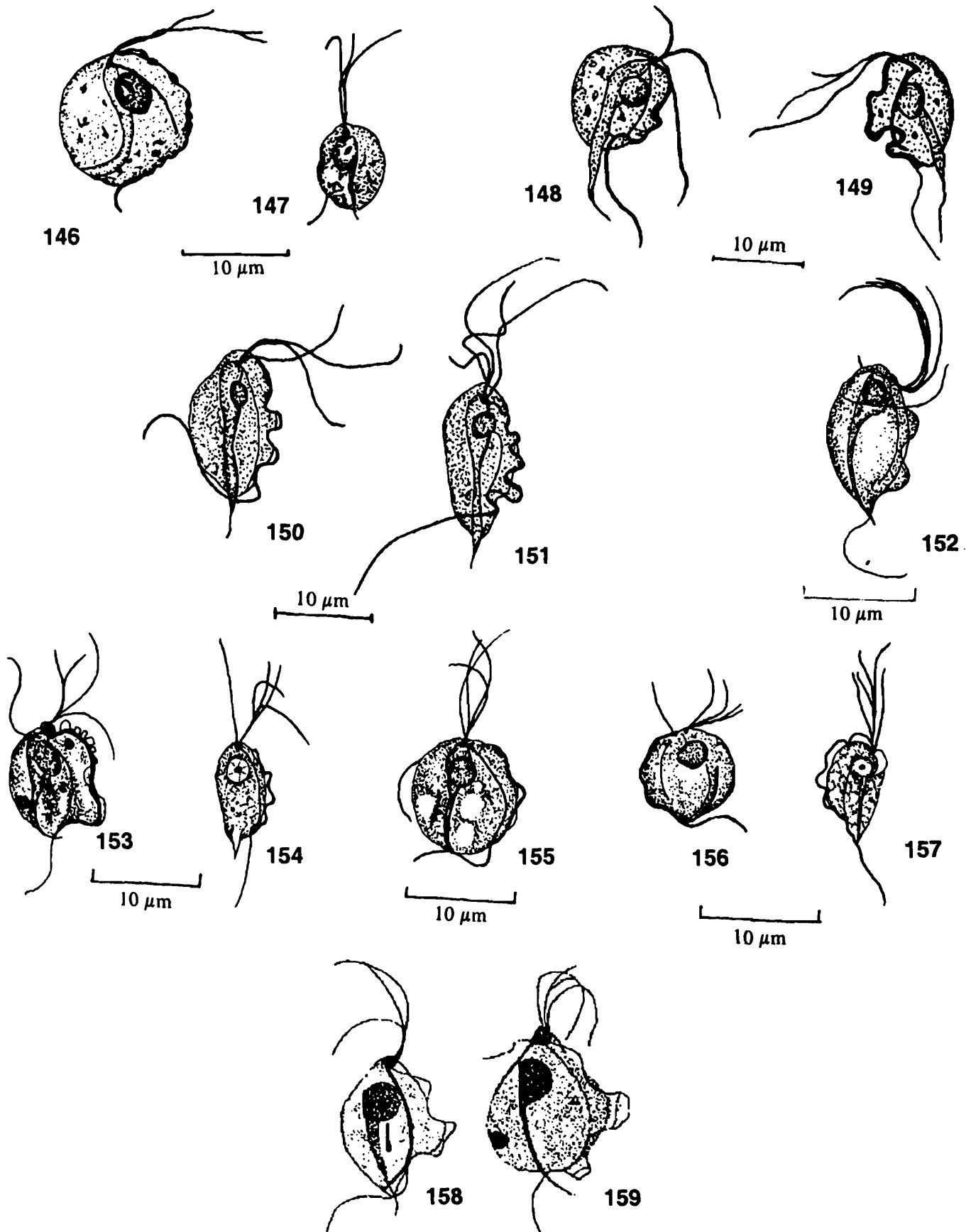
145. *Pentatrichomonas vulpi* Todd, 1963
(Figs. 158 & 159)

1963. *Pentatrichomonas vulpi* Todd, *Arch. Protistenk.*, **107** : pp. 67-71.

Diagnosis : Body pyriform, conch shell-like, round or oval, measuring 7.52-12.28 (9.87) μm in length and 4.23-4.93 (4.37) μm at its widest region; posteriorly tapering while anteriorly slightly asymmetrically tapering; five anterior flagella forming two units—one comprising a cluster of four while the other consisting of a single independent flagella, measuring 9.40-13.16 (10.99) μm in length, as long as the length of the body; cytoplasm containing vacuoles and bacteria; nucleus usually spherical or oval or triangular, located in the anterior region at a distance from the blepharoplasts; cytostome short and comma-shaped and never extending beyond 3-5 μm ; curved rod-like or filamentous costa and short independent flagellum arising from a blepharoplast while four anterior longer flagella unequal in some individuals originating from a second blepharoplast; axostyle filamentous or rod-like, 6.99-10.10 (8.66) μm in length, projecting as a blunt point beyond the posterior extremity of the body.

Host : *Vulpes bengalensis*; site of infection: caecum and alimentary canal.

Distribution : India : Andhra Pradesh (Hyderabad district).



Figs.146-159. Flagellate parasites of Andhra Pradesh : 146-147. *Trichomitus corydiae*; 148-149. *T. batrachorum*; 150-151. *T. hyderabadensis*; 152. *Pentatrichomonas capellae*; 153-154. *P. centropi*; 155. *P. smithi*; 156-157. *P. tardigardi* and 158-159. *P. vulpi*.

Subfamily TRITRICHOMONADINAE Honigberg, 1963

Diagnosis : Three or four typically equal or subequal flagella; full flagellar complement restored relatively early in division (usually before formation of daughter nuclei); proximal part of, or entire recurrent flagellum incorporated along usually two accessory filaments into margin of well developed undulating membrane, extending for entire length of body; costa from relatively slender to very stout; capitulum of axostyle spatulate, often with one or more ventro-lateral and or anterior extensions, but not continuing anteriorly into typical pelta; trunk of axostyle typically of large diameter, tube-like in appearance; terminal segment of trunk tapering abruptly to a point immediately after leaving body or enlarging into pointed bulbous expansion (of moderate diameter, non tube-like, and with very slight posterior projection in one genus); parabasal apparatus consisting of rod-, sausage-, or band-shaped body (branched in some species) and of filament.

Geuns *Tritrichomonas* Kofoid, 1920

1920. *Tritrichomonas* Kofoid, *Univ. Calif. Publ. Zool.*, **20** : p. 145.

Diagnosis : Typically three anterior flagella (four in one species); recurrent flagellum equalling or exceeding anterior flagella in diameter, continuing beyond end of well developed undulating membrane as free posterior flagellum; costa relatively slender or stout; capitulum of axostyle often with ventro-lateral and/ or anterior extensions; trunk of axostyle stout, tube-like in appearance, tapering abruptly to a point forming conical projection upon emerging from posterior body surface, surrounded by one or more periaxostylar rings near site of emergence; parabasal body rod- or sausage-shaped, associated with filament.

Remarks : Key to the species is not given as the two species occur in widely separated hosts, aquatic reptiles and birds.

A. *Tritrichomonas* in reptiles146. *Tritrichomonas lissemysi* Janakidevi, 1961

1961. *Tritrichomonas lissemysi* Janakidevi, *Ann. Mag. Nat. Hist.*, **13**(4) : pp. 411-414.

Diagnosis : Body elongate-oval or fusiform, 16.0-23.5 (20.8) μm in length including axostylar projection of 3.5-8.5 (7.0 μm ; length and breadth of cell body proper 10-17 (14.4) μm x 6-14 (10.3) μm ; nucleus oval, situated in the anterior third of the body, possessing a distinct nuclear membrane and usually central but sometimes eccentrically located endosome; mastigont elements consisting of the anterior flagella, posterior flagellum, accessory filament, thin costa, stout hyaline rod-like axostyle, small crescent-shaped pelta and the parabasal apparatus, arising from a blepharoplastic complex situated near the anterior tip of the body; anterior flagella three in number, unequal in length, two long (av. 20 μm and 17 μm) and one short (av. 13.8 μm); undulating membrane well developed and extending along almost the

entire length of the body; paracostal granules often arranged in a zigzag manner; axostyle with a spoon-shaped calyx, uniform stem and axostylar projection but without achromatic ring and endoaxostylar granules; parabasal apparatus sac-like or rod-shaped; cytostome long, conical, cleft-like, situated on the ventral side of the body.

Host : *Lissemys punctata granosa*; site of infection: large intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

B. *Tritrichomonas* in birds

147. *Tritrichomonas gigantea* Navarathnam, 1970 (Figs. 160 & 161)

1970. *Tritrichomonas gigantea* Navarathnam, *Riv. Parassitol.*, 31 : pp. 9-14

Diagnosis : Body variable, pyriform or elongated, 7.5-21.5 (12.1) μm x 3.5-9.5 (6.6) μm ; nucleus spindle-shaped, oval or pyriform, 3-7 (3.9) μm x 1.5-2.5 (2.0) μm , with distinct nuclear membrane, situated at the anterior third or in the middle of the body, containing large as well as fine granules; single large blepharoplast at the extreme anterior end of the body; three anterior flagella, equal in length 20-38.5 (26.0) μm , originating from the blepharoplast, following the course of undulating membrane in the form of a bundle; posterior flagellum running backwards as an extension of the marginal filament, free portion (1.5-10.5 μm) of it shorter than the anterior flagella; undulating membrane with 4-8 folds, measuring 17.5-29.0 μm in length; a well developed costa, uniform in thickness, measuring 12-29.6 μm ; axostyle tube-like, 14.5-27.0 μm , with spatulate capitulum, typically large tube-like trunk and terminal bulbous expansion ending into a fine point, having no anterior extensions or pelta but with axostylar rings and posterior bulbous axostylar portion always projecting beyond the body.

Host : *Coturnix coturnix*; site of infection: caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Incertae sedis to class Zoomastigophorea

Genus *Rhizomastix* Alexeieff, 1911

1911. *Rhizomastix* Alexeieff, *Arch. Zool. Exp. Gen.*, 46(5,6) : pp. 491-527.

Diagnosis : Body amoeboid; nucleus central; blepharoplast located between nucleus and posterior end; a long fibre running from it to anterior end and continued into the flagellum; without contractile vacuole; division in spherical cyst.

Key to the species of the genus *Rhizomastix*

1(4) Parasitic in insects

- 2(3) Body typically oval or round, periplast well developed with many cytoplasmic granules, flagellum thick but short (average 7.78 μm) and continued backward with a rhizostyle, parasitic in mole cricket..... *R. gryllotalpae*
- 3(2) Dimorphic elongated and ovoid or irregular and amoeboid, a thick rhizostyle occasionally forming a loop around nucleus; free flagellum 4 times as long as body, average (31.5 μm) parasitic in cockroach *R. periplanetae*
- 4(1) Parasitic in amphibia, body elongated, anterior end rounded, posterior end somewhat conical, a well defined rhizostyle arising from blepharoplast measuring $\frac{1}{2}$ to $\frac{3}{4}$ length of the body (average 16.81 μm) *R. ranae*.

A. *Rhizomastix* in insects

148. *Rhizomastix gryllotalpae* Bhaskar Rao, 1970 (Figs. 162-165)

1970 *Rhizomastix gryllotalpae* Bhaskar Rao, *Curr. Sci.*, 39(1) : pp. 21-22.

Diagnosis : Body typically oval or round, measuring 5.0-11.0 (7.58) μm x 4.5-8.0(6.75) μm ; periplast well developed with many cytoplasmic granules; nucleus large and almost round-shaped with a large or small endosome; a blepharoplast, a flagellum and a rhizostyle present; flagellum thick but short (av. 7.78 μm) and continued backward with a rhizostyle (av. 7.5 μm).

Host : *Gryllotalpa africana*; site of infection; intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

149. *Rhizomastix periplanetae* Bhaskar Rao, 1963 (Figs. 166 & 167)

1963 *Rhizomastix periplanetae* Bhaskar Rao, *Riv. Parassitol.*, 24 : pp. 159-162.

Diagnosis : Dimorphic, elongated and ovoid or irregular and amoeboid, measuring 5.5-13.5 (9.6) μm x 5.0- 7.5 (7.3) μm ; a well defined flagellum continuous with a long rhizostyle occasionally forming a loop around the nucleus; free flagellum measuring 20.0-40.5 (31.5) μm , three times as long as body; nucleus large (2.5-4.5 μm x 1.5-3.0 μm) and varying in shape (oval, bean-shaped or round) and position (lying at either side of the anterior end or in the centre of the body in a few forms) with a distinct nuclear membrane and a large karyosome.

Host : *Periplaneta americana*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

A. *Rhizomastix* in amphibians**150. *Rhizomastix ranae* Krishnamurthy, 1969
(Fig. 168)**

1969. *Rhizomastix ranae* Krishnamurthy, *Marathwada Univ. J. Sci.*, 8(1) : pp. 133-136, figs. 1-10.

Diagnosis : Body elongated, measuring 7.20-20.05 (11.67) μm in length and 4.11-11.82 (6.89) μm in width; anterior end rounded while posterior end somewhat conical; nucleus fairly large, spherical or ovoid, 1.54-4.3 (2.47) μm , situated near the middle of the body, having a thin nuclear membrane enclosing a conspicuously large endosome, about 1 μm in diameter; cytoplasm uniformly stained without any bacteria or granules; blepharoplast single situated a little behind the nucleus; a well defined rhizostyle arising from the blepharoplast, measuring about $\frac{1}{2}$ to $\frac{3}{4}$ of the body length; free flagellum, measuring 10.28-25.71 (16.81) μm , i.e., less than twice the body length.

Host : *Rana tigrina*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Genus *Sphaeromonas* Liebetanz, 1910

1910. *Spheromonas* Liebetanz, *Arch. Protistenk.*, 19 : p. 19.

Diagnosis : Uniflagellate and spherical organisms; flagellum long, springing from its narrow anterior end.

Remarks : This genus is a synonym of *Oikomonas* Kent (see Wenyon, 1926).

**151. *Sphaeromonas anteronucleatus* Todd, 1963
(Figs. 169 & 170)**

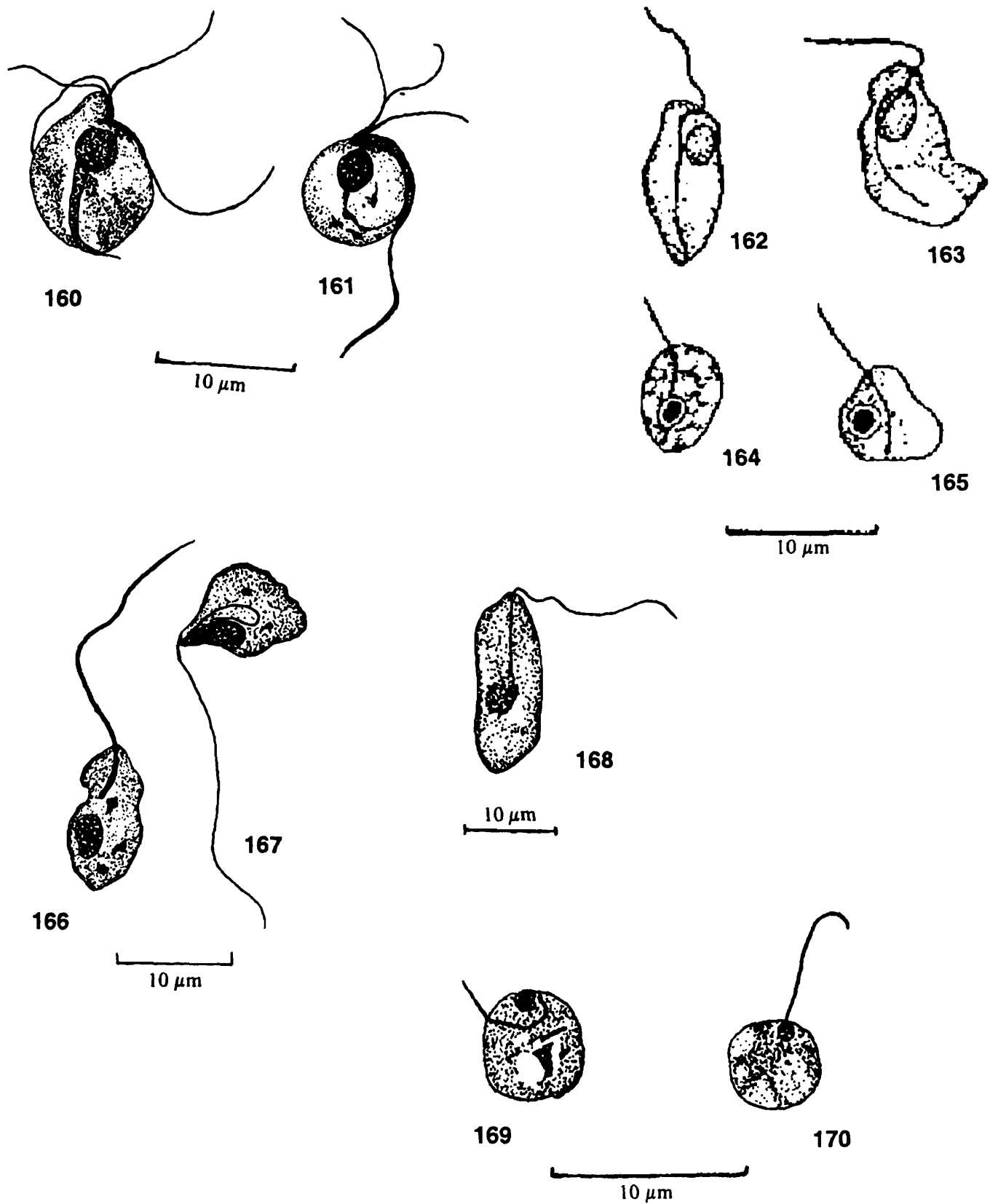
1966. *Sphaeromonas anteronucleatus* Todd, *Arch. Protistenk.*, 107 : pp. 28-30, figs. 1-15.

Diagnosis : Body small round, oval or pyriform, measuring 3.76-5.17 (4.05) μm in diameter; periplast well developed; cytoplasm granular, containing a few large vacuoles with bacteria; nucleus round, situated at the anterior end; flagellum single, thick, generally twice the diameter of the body, measuring 7.05-14.57 (10.24) μm in length, arising from a small blepharoplast situated just in front of the nucleus.

Host : Black-naped hare, *Lepus nigricollis*; site of infection : caecum.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : According Orpin (1976) *Spheromonas communis* Liebetanz, 1910 is actually the zoospore stage of aquatic phycomycetous fungi and as such the species, *S. anteronucleatus* needs taxonomic review.



Figs.160-170. Flagellate parasites of Andhra Pradesh : 160-161. *Tritrichomonas gigantea*; 162-165. *Rhizomastix gryllotalpae*; 166-167. *R. periplanetae*; 168. *R. ranae* and 169-170. *Spheromonas anteronucleatum*.

Subphylum	OPALINATA
Class	OPALINATEA
Order	OPALINIDA
Family	OPALINIDAE

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

Genus *Cepedea* Metcalf, 1920

1920. *Cepedea* Metcalf, *Science*, **52** : p. 135.

Diagnosis : Body cylindrical or pyriform; multinucleate; circular in cross section.

152. *Cepedea hylae* Khan, 1962

1962. *Cepedea hylae* Khan, *Trans. Amer. Micr. Soc.*, **81** : pp. 205-207.

Diagnosis : Body elongated and fusiform, visible with the unaided eye but varying considerably in size; anterior end broad and somewhat round but a little compressed; posteriorly the body gradually tapering and ending bluntly; ectoplasm or pellicle thin and somewhat hyaline, endoplasm alveolar; cytoplasmic inclusions absent; nuclei numerous, 2.3-5.1 μm in diameter, spherical or slightly oval and appearing compact with evenly distributed chromatin; cilia 15-17 μm long, ciliary lines quite uniformly 1 μm apart over the whole body.

Host : *Hyla arborea*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Medak district).

Subphylum	SARCODINA
Superclass	RHIZOPODA
Class	LOBOSEA
Subclass	GYMNAMOEBIA
Order	AMOEBIDA
Suborder	TUBULINA
Family	ENDAMOEBIDAE

Diagnosis : Parasitic amoebae; trophozoites usually relatively small; occurring in the alimentary canal of various host animals; multiplication by binary fission; encystment common.

Genus *Entamoeba* Casagrandi and Barbagallo (1895)

1895. *Amoeba* Casagrandi and Barbagallo, *Bull. Accad. Gioenia Sci. Nat.*, Catania, **39** : p. 4.

Diagnosis : Nucleus vesicular, with a comparatively small endosome, located in or near the centre and with varying number of peripheral nonchromatic granules attached to nuclear membrane; chromatin in the endosome and in periendosomal region.

153. *Entamoeba histolytica* Schaudinn, 1903
(Figs. 171-173)

1903. *Entamoeba histolytica* Schaudinn, *Arb. K. Gasundheitsamie*, 19 : p.547.

1966. *Entamoeba histolytica*: Kudo, *Protozoology* : p. 531.

Diagnosis : Trophozoites of pathogenic race large, 22-30 μm in diameter and those of small race 12-15 μm in diameter, with clear ectoplasm and granular endoplasm; nucleus with a small central endosome, a ring of small peripheral granules and a few scattered chromatin granules in between; mature cysts of both races 10-12 μm in diameter and with 4 nuclei.

Host : Man, *Homo sapiens*; site of infection: large intestine, sometimes liver and rarely brain, etc. Khan *et al.* (1983) encountered *E. histolytica* cysts in faeces of the following species of primates such as Mandreln monkey (*Mandrillus sphins*), Mona monkey (*Cyanocephalus mona*), Olive baboon (*Chaeropithecus* sp.), Yellow baboon (*Papio cyanocephalus*), Mangaby monkey (*Cercocebus torquatus*), Spider-monkey (*Atles geoffroyi*) and Chimpanzee (*Pan troglodytes*) at Zoological Park, Hyderabad.

Distribution : India : Andhra Pradesh (all districts), cosmopolitan.

Remarks : This species is pathogenic to man, causing amoebic dysentery, and may occur in primates and domestic pets.

Suborder FLABELLINA

Family ?

Genus *Rosculus* Hawes, 1963

1963. *Rosculus* Hawes, *J. Morphol.*, 113 : pp. 139-147.

Diagnosis : Trophozoites small, flattened broad to discoid, more or less fan-shaped, granular mass at the posterior or region, margin clear, formed eruptive along edge of the body, changing shape; nucleus with conspicuous nucleolus and hyaline ectoplasmic pseudopodia.

Key to the species

- 1(2) Trophozoites large 40-50 μm in size, parasitic in prawn larvae *R. macrobrachii*
- 2(1) Trophozoites small, 9.6-12.6 μm x 3.8-5.4 μm in size, parasitic in fresh water snake
..... *R. tropidonoti*

154. *Rosculus macrobrachii* Aravindan, Kalavati and Sheeja, 2002

2002. *Rosculus macrobrachii* Aravindan, Kalavati and Sheeja, *J. Exp. Zool. India*, **5** : pp. 17-24.

Material examined : Sev. exs. on slides from Gambeergedda estuary, Andhra Pradesh.

Diagnosis : Trophonts irregular, 40-50 μm in size; ectoplasm hyaline and endoplasm granular; typical limax type of pseudopodia, one or two, blunt eruptive, ectoplasmic; nucleus spherical, endosome central, extraendosomic chromatin material near periphery; cysts spherical, small, smooth, 8-10 μm in size, covering a thick membrane, with nuclear structure same as in trophozoite.

Host : *Macrobrachium rosenbergii* post larvae; site of infection: muscle tissue.

Distribution : India: Andhra Pradesh (Gambeergedda estuary, Visakhapatnam district).

155. *Rosculus tropidonoti* Kalavati and Lakshminarayana, 1982

(Figs. 174 & 175)

1982. *Rosculus tropidonoti* Kalavati and Lakshminarayana, *Proc. Indian Acad. Parasitol.*, **3**(1&2) : pp. 4-7.

Material examined : Sev exs. on slides from Krishna district, Andhra Pradesh.

Diagnosis : Trophozoites irregular in outline, measuring 9.6-12.6 μm x 3.8-5.4 μm ; protoplasm divisible into an outer hyaline area and an inner granular portion containing the nucleus and numerous food vacuoles; movement typically "limax type", by putting forth a single ectoplasmic pseudopodium, fully extended form with granular endoplasm appearing as a spherical body at the time of locomotion reaching a maximum of 28.0 μm ; nucleus spherical, 1.0-1.5 μm in diameter and containing a single nucleolus; binary fission by spherical forms measuring 8-10 μm with finely alveolated endoplasm devoid of food vacuoles; cysts spherical, 6-8 μm in diameter, with an outer thick refringent cyst wall.

Host : Fresh water snake, *Tropidonotus piscator*; site of infection: rectum.

Distribution : India : Andhra Pradesh (Krishna district).

Incertae sedis to Subphylum Sarcodina

Genus *Malamoeba* Taylor and King, 1937

1937. *Malamoeba* Taylor and King, *Trans. Am. Microsc. Soc.*, **56** : pp. 172-176.

Diagnosis : Amoebae showing more than two nuclei presumably due to binary fission; endosome disintegrated before chromosomes and fibril formation.

156. *Malamoeba indica* Narasimhamurti and Ahmed, 1980
(Figs. 176-182)

1980. *Malamoeba indica* Narasimhamurti and Ahmed, *Proc. Indian Acad. Sci. (Anim. Sci.)*, **89** : pp. 141-145.

Diagnosis : Trophozoites reaching a maximum size of 13.5 μm x 7.0 μm (range 4.2-13.5 μm x 4.0-8.0 μm ; average 9.27 μm x 5.78 μm), with a single large pseudopodium and a few other pseudopodia present; cytoplasm alveolated and sometimes containing a few refringent granules scattered all over the cytoplasm; nucleus rounded, with a well-defined nuclear membrane and a single large deeply-stained centrally-placed endosome; division by binary fission through breaking down of the endosome into chromatin masses; cysts ellipsoid, measuring 14.5 μm x 8.6 μm in fresh condition and 13.5 μm x 7.5 μm in the fixed and stained condition, with an outer thin refractile wall.

Host : The painted grasshopper, *Poecilocera picta*; site of infection : malpighian tubules.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Phylum	APICOMPLEXA
Class	SPOROZOEAE
Subclass	GREGARINIA
Order	EUGREGARINIDA
Suborder	ASEPTATINA

Key to the families

- 1(2) Gamonts sphaeroidal to cylindrical and solitary, anterior end not differentiated, oocysts biconical with out spines, octozoic MONOCYSTIDAE
- 2(1) Gamonts solitary or associated early in pairs, oocysts round or oval, octozoic DIPLOCYSTIDAE

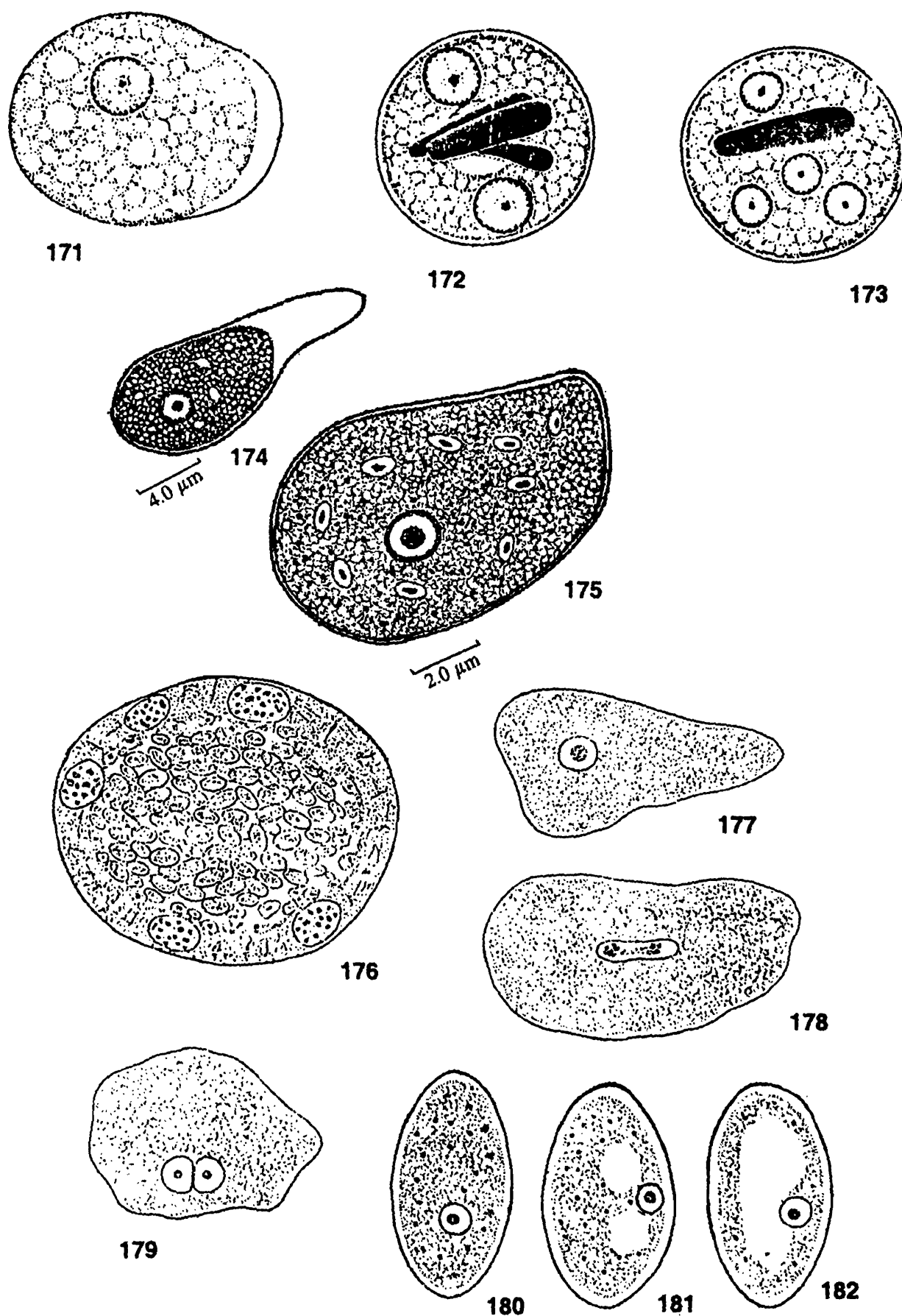
Family MONOCYSTIDAE Butschli, 1882

Diagnosis : As in the key.

Subfamily MONOCYSTINAE Bhatia, 1930

1930. Bhatia, *Parasitology*, **22** : pp. 56-167.

Diagnosis : Gamonts nematoid, cylindrical, ovoid or spherical without mucron or with an inconspicuous one, syzygy late, ends of oocysts thickened.



Figs.171-182. Amoeboid parasites of Andhra Pradesh : 171-173. *Entamoeba histolytica* (different stages); 174-175. *Rosculus tropidonoti* and 176-182. *Malamoeba indica* (different stages).

Genus *Monocystis* Stein, 1848

1848. *Monocystis* Stein, *Apch. Anat. Physiol.*, 1848 : pp. 182-223.

Diagnosis : Gamonts variable, motile, sporulation not completed in the cyst, oocysts biconical and symmetrical, parasites in the coelome or seminal vesicle of oligochaetes.

Key to the species

1(2) Trophozoites spherical or oval, mucron deeply stained *M. odontotermis*

2(1) Trophozoites elongate, mucron crescent-shaped *M. pontodrili*

157. *Monocystis odontotermis* Kalavati, 1979

(Syn. *Monocystis odontotermi* Kalavati, 1979)

(Figs. 183 & 184)

1979. *Monocystis odontotermi* Kalavati, *Indian J. Parasitol.*, 3 (1) : pp. 71-72.

Material examined : Sev. exs., C. Kalavati, August–December 1975, Visakhapatnam Visakhapatnam district.

Diagnosis : Trophozoites solitary, spherical or oval, 45-750 μm , mucron deeply stained, cysts spherical, 1008-1178 μm , gametes oval with round ends, 8.0 μm x 4.2 μm . oocysts boat-shaped with button-shaped enlargement at poles, 10.2 μm x 4.8 μm in size

Host : *Odontotermes obesus* (Rambur) : site of infection: haemocoel.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

Remarks : Levine (1988) emended *Monocystis odontotermi* as *M. odontotermis*.

158. *Monocystis pontodrili* Subba Rao, Kalavati and Narasimhamurti, 1978

(Figs. 185-187)

1978. *Monocystis pontodrili* Subba Rao, Kalavati and Narasimhamurti. *Acta Protozool.*, 18 (2) : pp. 259-264.

Material examined : Sev. exs., C. Kalavati and B.V.S.S.R. Subba Rao, March and April 1976.

Diagnosis : Fully grown trophozoites, solitary, elongate 350.0 μm x 150.0 μm in dimension, both ends rounded, mucron crescent-shaped, deeply stained, cysts oval, 350.0 μm x 160.0 μm , ectocyst 10-12 μm , gametes isogamous, spherical, 4.0-4.5 μm in diameter, oocysts typically boat-shaped, 8.0-3.2 μm .

Host : *Pontodrilus bermudensis* (Beddard); site of infection : coelomic fluid and between the body muscles.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

Subfamily STOMATOPHORINAE Bhatia, 1930

Diagnosis : Gamonts highly variable in shape, solitary, mucon transformed into a sucker, myocyte complex, oocysts navicular with truncated ends.

Genus *Chakravartiella* Misra and Raychaudhury, 1973

1973. *Chakravartiella* Misra and Raychaudhury. *Arch. Protistenk.*, **115** : pp. 363-369.

Diagnosis : Gamonts solitary, elongated and circular with an anterior immobile circular, sucker-like organelle bearing tooth-like structure, sucker on short neck, myonemes present.

159. *Chakravartiella krishnamurthyi* Sailaja, 1995, emend
(Figs. 188-190)

1995. *Chakravartiella krishnamurtye* Sailaja, *Nat. Symp. Environmental Implications of Freelifving and Parasitic Protozoa*, Aurangabad, India, 29-31 March; Abs. 2.13, p. 18.

Diagnosis : Trophozoites of different sizes; smallest trophozoites elongated, 100 μm x 32 μm , widest about $\frac{1}{3}$ rd the distance from the anterior end, gradually tapering bluntly at the posterior end; younger forms with dense coarsely alveolar cytoplasm containing large disc-like refringent bodies of the nature of carbohydrate food reserve scattered throughout the cytoplasm; spherical anterior portion of the parasite, probably acting like a "sucker" for attachment with the host, separated from rest of the body, the central part of anterior portion elevated and disc-like having 20-25 papillae-like elevations; nucleus situated at the anterior $\frac{1}{5}$ th part of the body, containing a single deeply stained centrally placed endosome, extra-endosomic chromatin material absent; fully grown forms, 416 μm x 50 μm , with oval sucker, 16 μm x 24 μm ; cytoplasm and nuclear characters of fully grown forms same as in younger forms; sporadins solitary; stages leading to formation of cysts not detected, fully formed cysts, present in the faecal matter of the infected hosts, oval, 200-275 μm in diameter, with a thin mucus ectocyst about 18 μm thick around the cyst; cysts at early stage of development with one nucleus in each of the two associated gametocytes passed out along with the faeces of the host; gametes isogamous, without locomotor organelle, formed in about 72 hours after passing out of the cysts from host; gametes spherical 6.5 μm in diameter, with alveolar cytoplasm and deeply stained nucleus without a clear nuclear membrane located towards one side of the gamete; oocysts boat-shaped, 16 μm x 8 μm ; sporulation completed in about 24 hours after the formation of gametes *i.e.*, 96 hours after the formation of cysts; spores with 2, 4 and 8 nuclei at different stages of development and on completion 8 nuclei arranged in two groups of 4 each at each pole; sporozoites spindle-shaped.

Host : *Thyropagus* sp., (Myriopoda); site of infection : intestine.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

Remarks : Sailaja (1995) described this species without any illustration and its name *Chakravartiella krishnamurtyei* appears to be proposed in honour of late Prof. R. Krishnamurthy,

a renowned protozoologist from Marathwada University, Aurangabad. This name is emended here as *C. krishnamurthyi* as per International Code of Zoological Nomenclature. This species is also redescribed here with illustration. It is compared with *C. sugereiformes*, the type species and the only species of the genus *Chakravartiella* described by Misra and Raychaudhury (1973). *C. sugereiformes* is characterised in having cylindrical body, ranging in size from $315.4\ \mu\text{m} \times 90.5\ \mu\text{m}$ – $365.2\ \mu\text{m} \times 125\ \mu\text{m}$, indicating relatively smaller and broader species in comparison to *C. krishnamurthyi*. The present species *C. krishnamurthyi* can be differentiated from the type species *C. sugereiformes* in having a spindle-shaped body, broadest in the center, much larger in size and having a sucker which has 20-25 papillae scattered irregularly.

Family DIPLOCYSTIDAE, Bhatia, 1930

Diagnosis : As in the key.

Genus *Diplocystis* Kunstler, 1887

1887. *Diplocystis* Kunstler, *Tabl. zool.*, 2 : pp. 25-66.

Diagnosis : Gamonts spherical to oval, association beginning early in spherical forms, oocysts round or oval, parasitic in the intestine and coelom of insects.

160. *Diplocystis horni* Kalavati, 1977 (Figs. 191-193)

1977. *Diplocystis horni* Kalavati, *Indian. J. Parasitol.*, 1(2) : pp. 155-157.

Material examined : Sev. exs, C. Kalavati, March to August 1974, Visakhapatnam, Visakhapatnam district; K. Rajakumari, March to August 1980, Rajhamundry, East Godavari District, Andhra Pradesh.

Diagnosis : Trophozoites oval, $120.0\ \mu\text{m} \times 80.0\ \mu\text{m}$ in size, sporadins bioassociative, $400.0\text{-}580.0\ \mu\text{m} \times 176.0\text{-}250.0\ \mu\text{m}$, cysts elongated, $540.0\text{-}580.0\ \mu\text{m} \times 320.0\text{-}360.0\ \mu\text{m}$, gametes spherical, $3.6\text{-}4.0\ \mu\text{m}$ in diameter, oocysts arranged in chains, ovoidal, tapering towards poles and measuring $8.2\ \mu\text{m} \times 4.0\ \mu\text{m}$.

Host : *Odontotermes horni*; site of infection : adipose tissue.

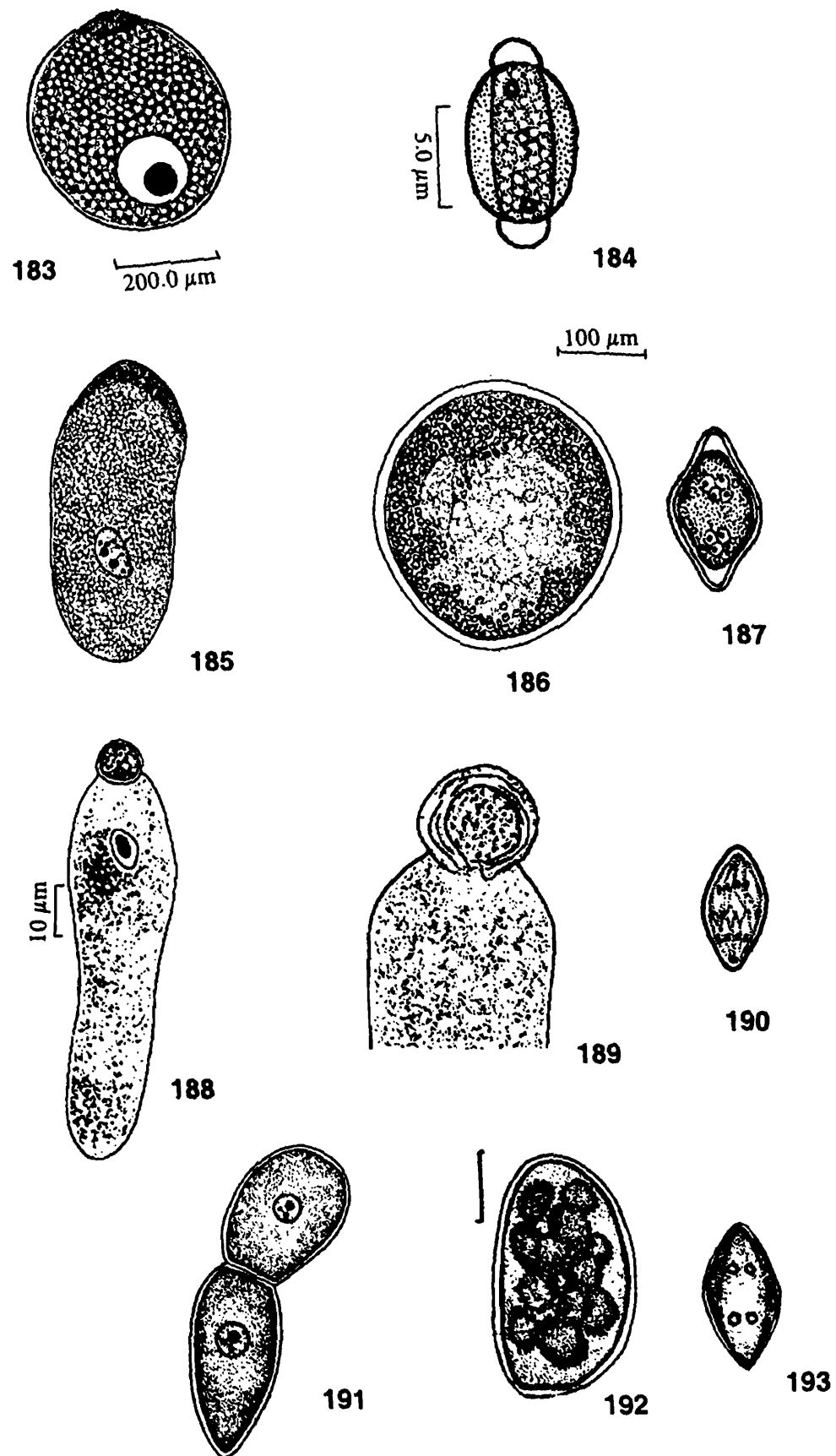
Distribution : India. Andhra Pradesh, (Visakhapatnam, Visakhapatnam district, Gajapathinagaram, Vizianagaram district, Rajhamundry, East Godavari district).

Suborder SEPTATINA Lankester, 1885

Superfamily GREGARINICAE Chakravarty, 1960

1960. *Gregarinicae* Chakravarty, M. M., *Proc. zool. Soc. Bengal.*, 12 : pp. 71-81.

Diagnosis : Homoxenous, syzygy early.



Figs.183-193. Gregarine parasites of Andhra Pradesh : 183-184. *Monocystis odontotermis*; 185-187. *M. pontodrili*; 188-190. *Chakravartiella krishnamurthyi* and 191-193. *Diplocystis horni*.

Key to the families

1. Early development intracellular, mucron present, syzyzy caudofrontal, primate different from satellite, gametes anisogamous, anisogamy marked, dehiscence by simple rupture, oocyst ovoid or spherical with protruding equatorial ridge
..... CEPHALOIDOPHORIDAE
2. Trophozoites septate, protomerite dilated as a sucker forming lobes, syzyzy precocious, composed of 1-2 satellites with lateral association CEPHALOLOBIDAE
3. Early development extracellular, mucron simple and cylindrical or composed of head and neck, syzyzy caudofrontal, protomerite of satellite compressing deutomerite of primate, gametes anisogamous, dehiscence simple rupture URADIOPHORIDAE
4. Early development intracellular, epimerite simple, syzyzy early, caudofrontal, gametocysts with sporoducts, oocysts clearly elongate or cylindrical, symmetrical
..... GREGARINIDAE
5. Gamonts with secondary segmentation of protomerite and deutomerite
..... METAMERIDAE
6. During syzyzy septum of satellite is reabsorbed more or less slowly, gametocysts spherical or some what elongate, oocyst with loose epispore discharged initially into pockets enveloped by their membranes, dehiscence by single sporoduct.. DIDYMOPHYIDAE
7. Epimerite papilla-like or simple knob-like, gametocysts without sporoducts, dehiscence by simple rupture, oocysts ellipsoidal HIRMOCYSTIDAE

Family CEPHALOIDOPHORIDAE Kamm, 1922

1922. Cephaloidophoridae Kamm, M.W., *Illinois Biol. Monogr.*, 7 : pp. 1-104.

Diagnosis : As in the key.

Genus *Caridohabitans* Ball, 1959

1959. *Caridohabitans* Ball, G.H., *J. Protozool.*, 6(1) : pp. 8-13.

Diagnosis : Epimerite functional, transparent, crescent-shaped.

161. *Caridohabitans macrobrachii* Kalavati and Aravindan, 1998 (Figs. 194-196)

1998. *Caridohabitans macrobrachii* Kalavati and Aravindan, *Riv. Parasitol.*, 15(59)(1) : pp. 9-16.

Material examined : Sev. exs., Aravindan, August 1996, Godavari estuarine system near Kakinada and Rajamundry. Gosthani estuary, Bhimunipatnam, Visakhapatnam district.

Diagnosis : Intracellular stages spherical, 10-15 μm in diameter, non-septate; young cephalonts 25.0-30.0 μm , septate; epimerite crescent-shaped, hyaline; protomerite indistinct,

often sunk in deutomerite; deutomerite long and cylindrical, with 8-10 epicytic striations; mature cephalonts 65.0-180.0 μm x 25.0-60.0 μm ; syzyzy motile, linear with 1 or 2 satellites; gametocyst spherical or oval, 100-150 μm x 80-120 μm , gametes isogamous; spores biconical with thickened corners, 12-16 μm in size.

Host : *Macrobrachium rosenbergi*; site of infection : midgut.

Distribution : India : Andhra Pradesh (Visakhapatnam and East Godavari districts).

Remarks : The first observation on the gametocysts and oocysts of the genus *Caridohabitan* was made by Kalavati and Aravindan (1998).

Family CEPHALOLOBIDAE Theodorides and Desportes, 1975

1975. Cephalolobidae Theodorides, J and Desportes, I., *Protistologica*, **11** : pp. 205-220.

Diagnosis : As in the key.

Genus *Cephalolobus* Kruse, 1959

1959. *Cephalolobus* Kruse, D.N., *Tulane Studies Zool.*, **7** : pp. 123-144.

Diagnosis : Early development extracellular, true epimerite absent, anterior end of protomerite modified into a holdfast, a subcylindrical cone with irregular lobe-like processes at the anterior edge, syzyzy caudofrontal, while attached to gut epithelium, 1-3 satellites smaller than primite.

162. *Cephalolobus andhrae* Kalavati and Aravindan, 1998 (Figs. 197-199)

1998. *Cephalolobus andhrae* Kalavati and Aravindan, *Riv. Parassitol.*, **15** (59) : pp. 9-16.

Material examined : Sev. exs., C. Kalavati, July, 1995, Gautami Godavari estuarine system, Kakinada, East Godavari District.

Diagnosis : Trophozoites ovocylindrical or elongated, 50-80 μm x 15-25 μm ; protoepimerite expanded, hyaline with a wavy rim, true epimerite absent; protomerite is rectangular with a convex septum; deutomerite elongated; sporonts bioassociative, robust, 80-140 μm x 25-56.5 μm ; cysts spherical, 78-102.6 μm , found attached to rectal wall, containing rosettes of cells, free gymnosporos not described.

Host : *Penaeus indicus*; site of infection : pyloric stomach.

Distribution : India, Andhra Pradesh (East Godavari district).

Family URADIOPHORIDAE Grasse, 1953

1953. Uradiophoridae Grasse, *Traite de zoologie*, Vol I, Fasc II, pp. 550-690.

Diagnosis : As in the key.

Genus *Heliospora* Goodrich, 1949

1949. *Heliospora* Goodrich, *Quart. J. Micr. Sci.*, **90** : pp. 27-35.

Diagnosis : Syzyzy caudofrontal, gametocysts oval, oocysts with 6 radiating processes formed by epispor.

163. *Heliospora* sp.
(Figs. 200-203)

1981. *Heliospora* sp. Narasimhamurti and Sailaja, *Proc. All India sym. Perspectives in Protozoa* (Abstracts) p. 60.

Material examined : Sev. exs., N. Sailaja, Oct.-Dec. 1976, Dairy farm stream, Visakhapatnam.

Diagnosis : Cephalonts 19.0-108 μm x 4.0-10.0 μm ; epimerite tongue-like; sporonts 44-250 μm x 8.0-12.0 μm ; association caudo-frontal, satellite usually smaller than primite; cysts oval, 45 x 95 μm ; gametes anisogamous, microgamete 4.0 μm x 3.5 μm with a flagellum, macrogamete oval, 5.0 μm x 4.5 μm ; spores round, 8.0-9.0 μm in diameter with epispor folding into 6 rays, 12.0 μm long.

Host : *Caridina laevis* (Helle); site of infection : intestine.

Distribution : India : Andhra Pradesh (Stream near Dairy farm Visakhapatnam, Visakhapatnam district).

Remarks : Narasimhamurti and Sailaja (1981) reported a species of *Heliospora* as new to science from the above host. Sailaja (1978) earlier in the unpublished thesis recorded a new species of *Heliospora* from the same host. Both the species are morphologically alike but these are treated herein, being unpublished, as unnamed species as per International Code of Zoological Nomenclature.

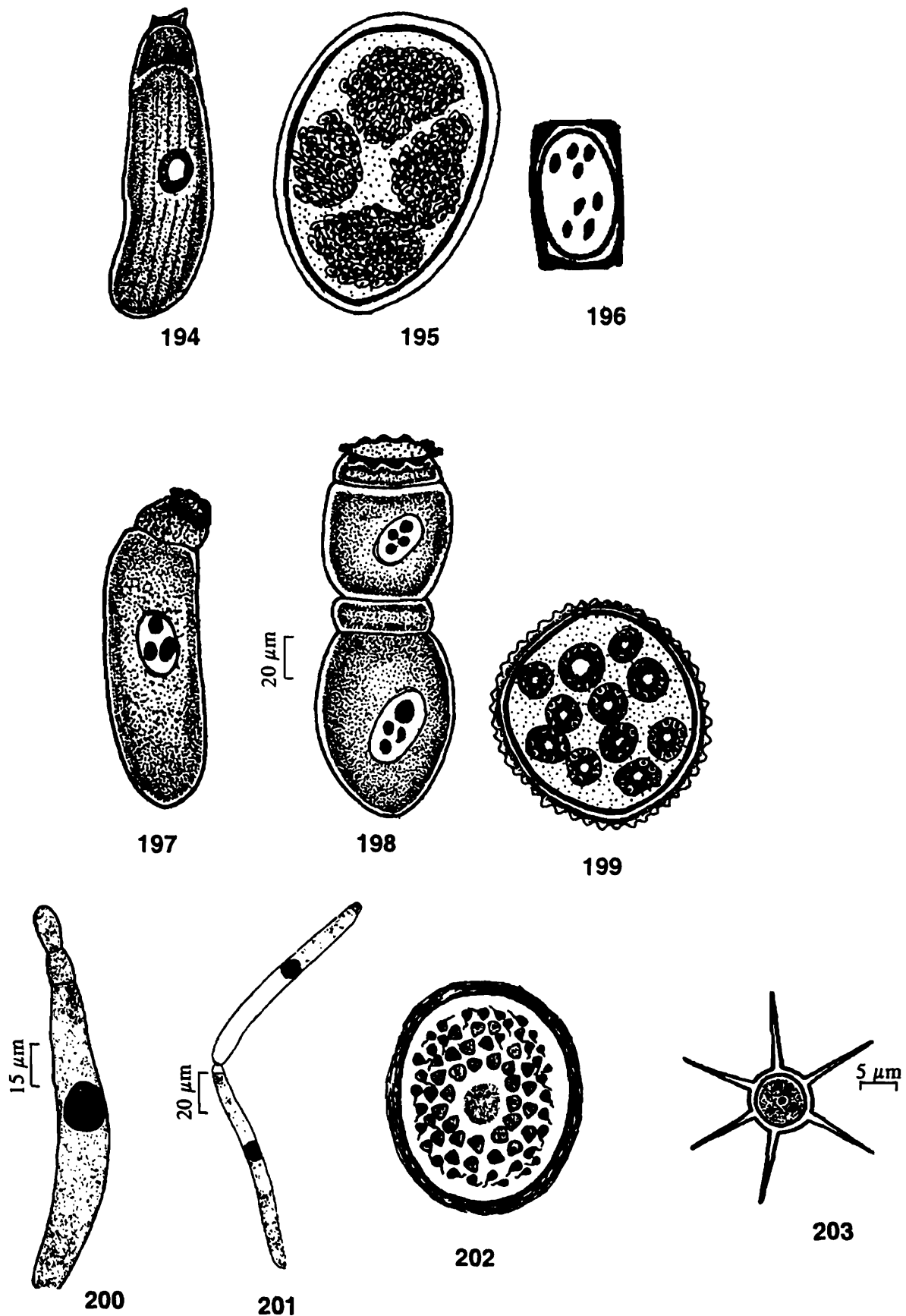
Family GREGARINIDAE Labbe, 1899
(Syn. Clepsidrinidae Leger, 1892)

1899. *Gregarinidae* Labbe, A., *Sporozoa in das Tierreich*, **5** : 196 pp.

Diagnosis : As in the key.

Key to the genera

1. Epimerite conical, early development intracellular, syzyzy early caudofrontal, gametocyst with sporoducts, oocysts symmetrical clearly elongate or cylindrical *Gregarina*
2. Epimerite apparently absent, protomerite forming a strong sucker, syzyzy early, gametocysts ellipsoidal with thick wall. 6-8 sporoducts, oocysts doliform emitted in chains *Anisolobus*



Figs.194-203. Gregarine parasites of Andhra Pradesh : 194-196. *Caridohabitans macrobrachii*; 197-199. *Cephalolobus andhrae* and 200-203. *Heliospora goodrichi*.

Genus *Gregarina* Dufour, 1828

1828. *Gregarina* Dufour, L., *Ann. Sci. Nat.* 13 : pp. 366-368.

Diagnosis : As in the key.

Key to the species

1. Epimerite knob-like; oocysts doliform, $8.0\ \mu\text{m} \times 7.1\ \mu\text{m}$ *G. crescentica*
2. Epimerite simple, knob-like; oocysts oval, $7.2\ \mu\text{m} \times 3.6\ \mu\text{m}$ *G. macrotermis*
3. Epimerite simple, button-shaped surrounded by a hood and connected to protomerite by a short neck; oocysts barrel-shaped with truncated ends, $7.6\ \mu\text{m} \times 5.8\ \mu\text{m}$
..... *G. poecilocerum*

164. *Gregarina crescentica* Halder, and Chakraborty, 1978
(Figs. 204-207)

1978. *Gregarina crescentica* Halder, D.P and Chakraborty, N. *Acta Protozool.*, 30 : pp. 233-244.

Material examined : Sev.exs., C. Kalavati, September 2001, Visakhapatnam, Visakhapatnam district.

Diagnosis : Early development intracellular; cephalonts $70\text{--}380.0\ \mu\text{m}$, elongated; epimerite knob-like $7.5\text{--}10.0\ \mu\text{m}$; protomerite subspherical; deutomerite long and straight; syzygy caudofrontal, biassociative; gametocyst oval, $340\text{--}360\ \mu\text{m} \times 190\text{--}220\ \mu\text{m}$ in size, gametes isogamous; oocysts doliform $8.0\ \mu\text{m} \times 7.1\ \mu\text{m}$.

Host : *Raphidopalpa stevensi* and *Amblyrhinus* sp. (Coleoptera, Insecta); site of infection : midgut.

Distribution : India, Andhra Pradesh, (Visakhapatnam district) and West Bengal.

Remarks : Halder and Chakraborty (1978) reported this species from *Amblyrhinus* sp. in West Bengal. *Raphidopalpa stevensi* is a new host parasite record.

165. *Gregarina macrotermis* Kalavati and Narasimhamurti, 1978
(Figs. 208-210)

1978. *Gregarina macrotermis*, Kalavati and Narasimhamurti, *Proc. Indian Acad. Sci.*, 87 (12) : pp. 397-404.

Material examined : Sev. exs., Jan–Dec, 1970, C. Kalavati, from Visakhapatnam; June–Dec., 1980, K. Rajakumari, from Masulipatnam.

Diagnosis : Early cephalont $26\ \mu\text{m} \times 20\ \mu\text{m}$; epimerite simple, knob-like; sporonts $200.0\text{--}220.0\ \mu\text{m} \times 85.0\text{--}95.0\ \mu\text{m}$; sporadins bio-associative, primite and satellite of equal size; cysts spherical or slightly oval, $150.0\text{--}250.0\ \mu\text{m}$ in size, ectocyst, $10.0\ \mu\text{m}$ in thickness and gelatinous, gametes isogamous, spherical, $3.0\text{--}3.6\ \mu\text{m}$ in diameter; oocysts oval, $7.2 \times 3.6\ \mu\text{m}$.

Host : *Macrotermes estherae*; site of infection : foregut of workers of this termite.

Distribution : India : Andhra Pradesh, (Visakhapatnam and Krishna districts).

166. *Gregarina poeciloceri* Ganapati and Mrutyumjaya Devi, 1954
(Syn. *Gregarina poecilocerum* Ganapati and Mrutyumjaya Devi, 1954)
(Figs. 211-214)

1954. *Gregarina poecilocerum* Ganapati and Mrutyumjaya Devi, *J. Zool. Soc. India, Calcutta*, 6(2) : pp. 101-122.

Material examined : Sev. exs., July–November, 1954, C.S, Mrutyumjaya Devi, Visakhapatnam, Visakhapatnam district; July–November, 1974, S. Nazeer Ahmed, Guntur and Repalle, Guntur district; July–Sep., 2000, C. Kalavati, Visakhapatnam, Visakhapatnam district.

Diagnosis : Early development intracellular; epimerite simple, button-shaped surrounded by a hood and connected to protomerite by a short neck; sporadins elongated, 350.0–400.0 μm x 80.0–120.0 μm ; protomerite hyaline, dome shaped; deutomerite cylindrical; sporodins bio-associative, syzyzy caudofrontal; gametocysts spherical, 383.0 –750.0 μm in size, ectocyst thick, gametes isogamous; oocysts barrel-shaped with truncated ends, 7.6 μm x 5.8 μm .

Host : *Poecilocerus pictus*; site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam and Guntur districts).

Remarks : Narasimhamurti and Ganapati (1961) described the sporogony and chromosome cycle of this parasite. Pampapathi Rao (1958) observed the behaviour of the parasite under heterosmotic conditions. Levine (1988) emended this species *Gregarina poecilocerum* as *G. poeciloceri*.

Genus *Anisolobus* Vincent, 1924

1924. *Anisolobus*, Vincent, M., *Parasitology*, 16 : 44-47.

Diagnosis : As in the key.

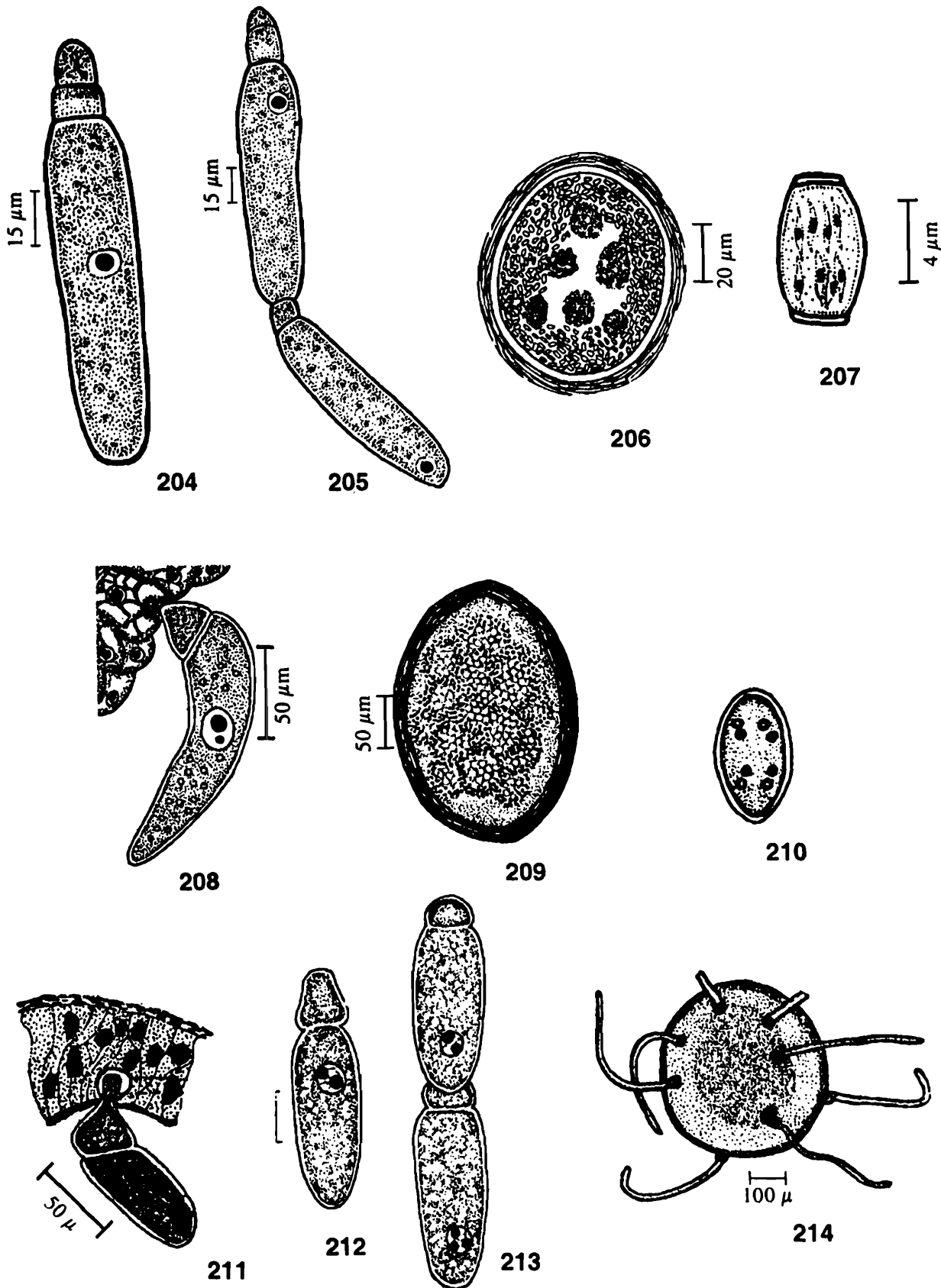
167. *Anisolobus triboli* n. sp
(Figs. 215-218)

1991. *Anisolobus* sp. Prasada Rao, M.Phil Dissertation (unpublished), Andhra University, India.

Type material : Holotype *anisolobus* 1; Paratypes *anisolobus* 2, 3 & 4, deposited in the Protozoology laboratory, Andhra University.

Material examined : Sev. exs., Sep–Dec., 1987, Prasada Rao; Dec., 2002, Kalavati, Visakhapatnam, Visakhapatnam district.

Diagnosis : Development extracellular; epimerite absent; young cephalonts elliptical, obese, 11.0 μm x 2.5 μm in size; protomerite broad, subspherical, hyaline; anterior end of the protomerite modified into a strong sucker-like adhesive organelle with deeply stained elevated rim with 4 incipient lobes; sporadins large, elliptical or obese, broad, subspherical, hyaline,



Figs. 204-214. Gregarine parasites of Andhra Pradesh : 204-207. *Gregarina crescentica*; 208-210. *G. macrotermitis* and 211-214. *G. poecilocerum*.

11.3–70.9 (29.81) μm x 2.5–24.7 (11.2) μm ; LP : TL 1 : 4.6; LD : TL 1 : 1.27; syzygy caudofrontal, primite larger than satellite; gametocyst opaque white, ovoid with a thick ectocyst, 65.0–95.0 μm x 75.0–120.0 μm , gametes isogamous; oocysts oval with rounded corners. 4.8–6.4 μm x 8.0–9.4 μm .

Host : *Tribolium ferruginum* Larvae; site of infection : mid gut.

Distribution : India : Andhra Pradesh, (Visakhapatnam district).

Remarks : Genus *Anisobolus* Vincent, 1924 is characterized by the absence of true epimerite and a broadly hemispherical sucker-like epimerite with variable number of lobes. Only eight species of *Anisobolus*, viz., *A. dacnecola* Vincent, 1924 from *Dacne rufifrons*, *A. bulliardi* Theodorides and Joilivat 1959 from *Autispyris planicollis*, *A. aleocharae*, Geus 1969 from *Aleochara intricata*, *A. gymnopholi* Theodorides *et al.* 1972 from *Gymnopholus marquarti*, *A. desportis* Theodorides and Jolivet, 1981 from *Cratopus frappieri*, *A. theodoridesi* Levine, 1984 (syn. *Anisobolus* sp. Theodorides and Desportes, 1966) from *Cryphaeus gazella* (cited from Levine, 1988), *A. indicus* Haldar, Ray and Bose, 1988 from *Coccinella septempunctata* and *A. rayii* (Roy, 1989) Das *et al.*, 1993 from *Brassica comprestis* have been described so far. Among them, two species *Anisobolus indicus* Haldar, Ray and Bose, 1988 and *Anisobolus rayi* Roy (1989, *J. Protozool.*, **36**(1), p.20) were described from India. Since both the species were described under the same name *Anisobolus indicus*, Das *et al.* (1993) proposed a new name for it as *Anisobolus rayi* comb. nov. according to International Code of Zoological Nomenclature. Theodorides and Jolivet, 1981 differentiated the species *Anisobolus* described till then based on the number of lobes seen in the protomerite. For examples there were 4-10 lobes in *A. bulliardi*, about 15 in *A. gymnopholi* and several in *A. dacnecola* and circular, cushion-like with 8 lobes in *A. desportis*. Lobes were not described in *A. indicus* and *A. rayi*. The present species appears distinct in having a rim-like adhesive organ with 4 lobes. Morphometrically the trophozoite of *A. rayi* is much broader (21-30 μm x 38-64 μm) than the present species (29.81 μm x 11.2 μm). In *Anisobolus indicus* described from a beetle *Coccinella septempunctata* the size of the sporont is 117.5 μm x 37.4 μm and hence not comparable. Besides, this is the first report of the species of *Anisobolus* from *Tribolium ferruginum* collected from Visakhapatnam. In view of the above mentioned reasons it is proposed herein to name the undetermined species described by Prasada Rao (1991) as *Anisobolus triboli* n.sp after the generic name of the host.

Family METAMERIDAE Levine, 1979

1979. *Metameridae* Levine. N.D., *J. Protozool.*, **26**(4) : pp. 532-536.

Diagnosis : As in the key.

Genus *Gopalilella* Ganapati, Kalavati and Sundaram, 1974

1974. *Gopalilella* Ganapati, Kalavati and Sundaram, *Arch. Protistenk.*, **116** : pp. 224-250.

Diagnosis : Trophozoites single, multi-segmented (usually 8, occasionally 11), young cephalonts non-septate with a mucron at the tip, mature trophozoites with 8–11 segments, umbrella-like epimerite with central deeply stained rod, gametes isogamous oval, oocysts biconical, dehiscence simple.

168. *Gopalilella marphysae* Ganapati, Kalavati and Sundaram, 1974
(Figs. 219-233)

1974. *Gopalilella marphysae*. Ganapati, Kalavati and Sundaram, *Arch. Protistenk.*, **116** : pp. 244-250.

Material examined : Sev. exs., July–August 1952, P. S. Sundaram ; August 1973, C. Kalavati, Southern lighter channel, Visakhapatnam harbour, Visakhapatnam, Visakhapatnam district.

Diagnosis : Early trophozoites elongate, non-septate, $70.0\ \mu\text{m} \times 20.0\ \mu\text{m}$; epimerite simple, represented by small dot-like structure; mature trophozoites multi-segmented with 8-11 segments, $840\ \mu\text{m} \times 120\ \mu\text{m}$ in size; epimerite differentiated into a complex inverted umbrella-shaped structure, base of the epimerite flask-shaped, distal end expands into an inverted umbrella with protoplasmic extensions; the deeply stained dot in the early stages getting elongated with blunt, round disc-like organ, nucleus always located in penultimate segment; sporadins solitary, cysts spherical, 200-300 μm , ectocyst 8-10 μm in thickness; gametes isogamous, spherical, 4.0-5.0 μm ; oocysts spherical, 8.0-10 μm in diameter.

Host : *Marphysa gravelyi*; site of infection : gut.

Distribution : India, Andhra Pradesh (Visakhapatnam district).

Remarks : *G. marphysae* is a monotypic species.

Family DIDYMOPHYIDAE Leger, 1892

1892. *Didymophyidae* Leger. L., *Tabl. Zool.*, **3** : pp. 1-182.

Diagnosis : As in the key.

Key to the genera

1. Epimerite cylindro-conical, very degenerate small pointed papillae, gametocyst spherical, oocysts grouped in spherical pockets in gametocysts ***Didymophyes***
2. Epimerite spherical, hyaline with 14-16 ridges at the anterior end, syzygy biassociative, gametocyst spherical, dehiscence by simple rupture, oocysts spindle-shaped
..... ***Leposcelisus***

Genus *Didymophyes* Stein, 1848

1848. *Didymophyes* Stein, *Apch. Anat. Physiol* : pp. 182-223.

Diagnosis : As in the key.

169. *Didymophyes penaei* Kalavati and Aravindan, 1998
(Figs. 224-226)

1998. *Didymophyes penaei* Kalavati and Aravindan *Riv. Parassitol.* **15** (59) : pp. 9-16.

Material examined : Sev. exs., Feb.–April, 1996, N. Aravindan, Visakhapatnam, Visakhapatnam District.

Diagnosis : Cephalonts long, slender, 170.0-200.0 μm x 15.0-25.0 μm ; epimerite simple, small, triangular and papilla-like; protomerite indistinct marked by a break in cytoplasm, no distinct septum; deutomerite elongate; syzyzy linear, generally with 2-3 satellites, primite retaining epimerite, satellite without protomerite; gametocyst spherical, 120-150 μm ; oocysts ellipsoidal, 15.0 μm x 8.0 μm , enclosed in a thin triangular exospore, dehiscence by simple rupture.

Host : *Penaeus monodon*; site of infection : midgut.

Distribution : India, Andhra Pradesh (Visakhapatnam district).

Genus *Liposcelis* Sarkar and Halдар, 1980

1980. *Liposcelis* Sarkar and Halдар., *Riv. Parasitol.*, **54**(2) : pp. 219-224.

Diagnosis : As in the key.

170. *Liposcelis dytiscusi* Kalavati and Prasada Rao
(Figs. 227 & 228)

1995. *Liposcelis dytiscusi*, Kalavati and Prasada Rao, *Uttar Pradesh J. Zool.*, **15**(1) : 64-66.

Material examined : Sev. exs., August–September 1997, D.D.V. Prasada Rao, Visakhapatnam, Visakhapatnam District.

Diagnosis : Early development intracellular; trophozoites spherical, 6.4 μm in diameter; young cephalonts 25.4 μm x 9.0 μm , attached to gut epithelium; cephalonts rotund or obese with a characteristic spherical disc-like depression with 16–20 peripheral ridges; protomerite rectangular or oval; deutomerite hemispherical; sporadins 22.0–59.6 μm x 24.0–81.4 μm , biassociative, syzyzy caudofrontal; gametocysts opaque white, spherical 200–380 μm in size, gametes isogamous; oocysts spindle-shaped with rounded corners.

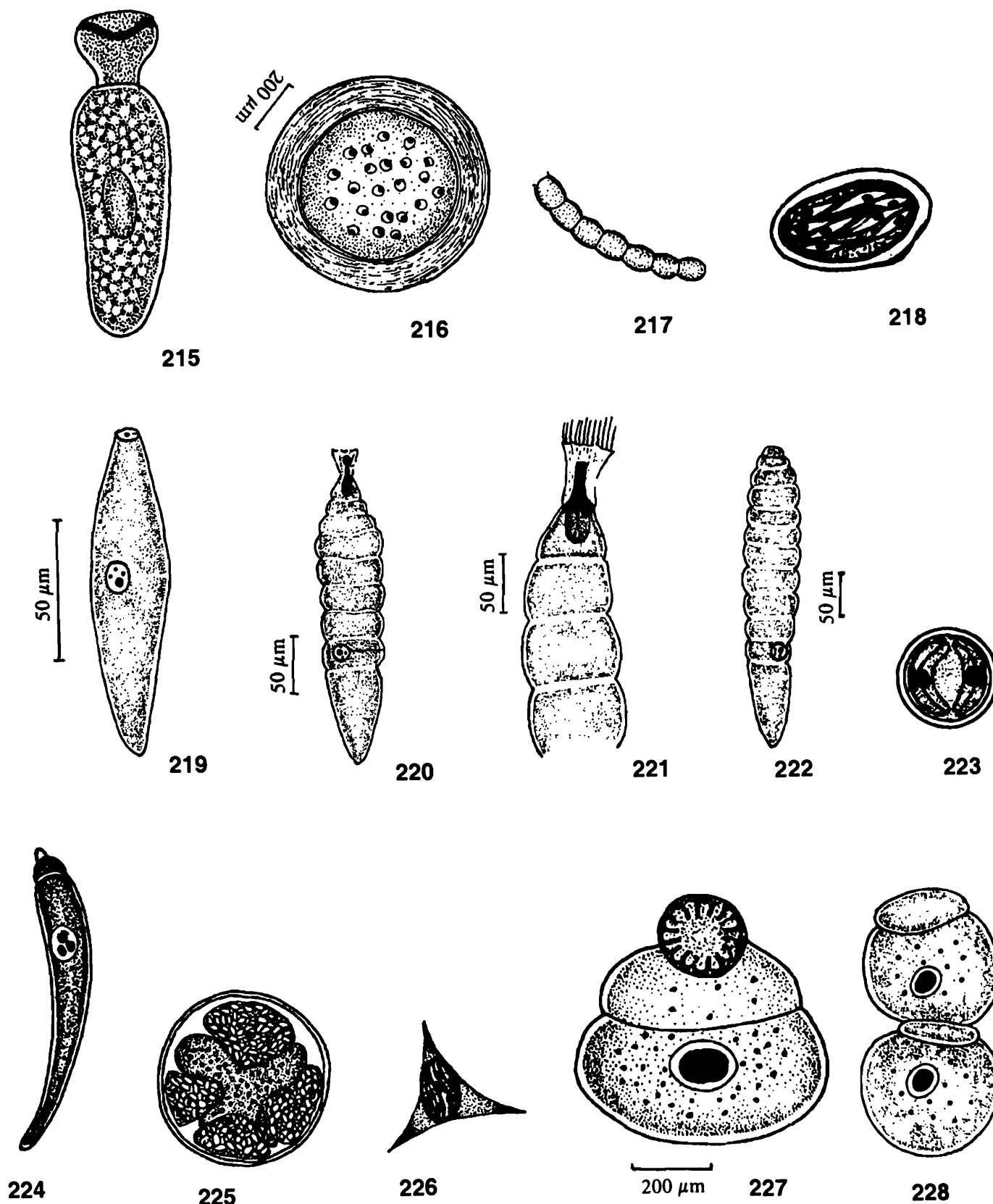
Host : *Dytiscus* sp. (Coleoptera, Insecta); site of infection : mid gut.

Distribution : India : Andhra Pradesh; (Visakhapatnam district).

Family HIRMOCYSTIDAE Grasse, 1953

1953. *Hirmocystidae* Grasse, *Traite de Zoologie*, Vol. I, Fascicule II, Masson et cie, Paris : pp. 550-690.

Diagnosis : As in the key.



Figs. 215-228. Gregarine parasites of Andhra Pradesh : 215-218. Mature sporadin, gametocyst, spores in chain after liberation and spore of *Anisolobus triboli* n. sp.; 219-223. *Gopaliella marphysae*; 224-226. *Didymophyes penaei* and 227-228. *Liposcelisus dytiscusi*.

Genus *Retractocephalus* Halдар and Chakraborty, 1976

1976. *Retractocephalus* Halдар and Chakraborty, *Curr. Sci.*, **45** (18) : pp. 668-669.

Diagnosis : Epimerite globular retractile into protomerite, early development intra-cellular, syzyzy caudofrontal, dehiscence by simple rupture, oocyst barrel-shaped, extruded in chains.

Key to the species

1. Epimerite simple, globular and button-like with a narrow stalk and retracted into a cup-like depression in the protomerite, oocysts barrel-shaped with thin wall. $5.0\ \mu\text{m} \times 8.4\ \mu\text{m}$ in size *R. corcyrae* n.sp.
2. Epimerite simple, globular and button-like with a small depression in the center, spores barrel-shaped with thin wall, $12.8\ \mu\text{m} \times 5.6\ \mu\text{m}$ in size *R. melanopli*
3. Epimerite small, knob-like, retracted into a depression in the rectangular protomerite, deutomerite long, cylindrical or oval *R. waltirensis*

171. *Retractocephalus corcyrae* n.sp.

(Figs. 229 & 230)

1991. *Retractocephalus* sp., Prasada Rao, M.Phil Dissertation (unpublished), Andhra University, India.

Type material : Holotype : Rec. cor 1; Paratype Rec. cor. 2, sev. exs., deposited in the Protozoology laboratory, Andhra University. Type locality : Visakhapatnam, Visakhapatnam District, Dec 1986–May 1987, D.D.V. Prasada Rao; May 2002, Kalavati; Vizianagaram, Vizianagaram District.

Diagnosis : Early stages of the development of the parasite intracellular; trophozoites oval, $8.0\ \mu\text{m} \times 12.0\ \mu\text{m}$, aseptate; young cephalonts attached to the epithelial cells of the midgut, elongate or ellipsoidal, $14.5\text{--}18.6\ \mu\text{m} \times 4.2\text{--}6.2\ \mu\text{m}$; epimerite simple, globular and button-like with a narrow stalk; protomerite subspherical or rectangular; mature cephalonts $15.9\text{--}70.9\ \mu\text{m} \times 28.0\text{--}40.8\ \mu\text{m}$, in mature cephalonts epimerite retracted into a cup-like depression in the protomerite, protomerite sub-spherical; deutomerite oblong, elongated or cylindrical; sporadins large and rotund with thick nonstriated epicyte and promerite sometimes sinks into a depression in the deutomerite; LP : TL 1 : 6.84; syzyzy caudofrontal, biassociative, primite smaller than the satellite; gametocysts spherical, $100.0\text{--}120.0\ \mu\text{m}$ in diameter, gametes isogamous, oval, $5.0\ \mu\text{m} \times 3.2\ \mu\text{m}$; oocysts barrel-shaped with thin wall, $5.0\ \mu\text{m} \times 8.4\ \mu\text{m}$ in size, dehiscence by simple rupture.

Host : *Corcyra cephalanica* (Lepidoptera, Insecta); site of infection : mid-gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Eight species of *Retractocephalus* have so far been described from insect hosts by Halдар and Chakraborty (1976), Halдар *et al.* (1982), Rajakumari and Narsimhamurti

(1984) and Kalavati and Krishnamurthy (1989). These species are reported from orthopteran and coleopteran hosts, while the present species is recorded from a lepidopteran insect. Morphometrically this species is much smaller in size ($15.9 - 70.9 \mu\text{m} \times 28.0 - 40.8 \mu\text{m}$) than all the other described species and is not comparable. It appears distinct in having a globular epimerite with a narrow stalk-like base, rotund sporadins with retractable protomerite. Prasada Rao (1991) described this species and refrained from naming it since he could not observe the gametocysts and oocysts. Since the description is completed now, it is proposed to name the species as *Retractocephalus corcyrae* n.sp. after the generic name of the host.

172. *Retractocephalus melanopli* Kalavati and Krishnamurty, 1989
(Figs. 231-234)

1989. *Retractocephalus melanopli* Kalavati and Krishnamurty., *Acta. Protozool.*, **28** (1) : pp. 35-40.

Material examined : Sev. exs., G. Krishnamurty, May-June 1987, Visakhapatnam, Visakhapatnam District.

Diagnosis : Early stages of the development of the parasite intracellular; young cephalonts attached to the epithelial cells of the midgut; epimerite simple, globular and button-like with a small depression in the centre; $10.0-12.0 \mu\text{m} \times 12.0-24.0 \mu\text{m}$ in size, retractable into a cup-like depression in the protomerite, mature cephalonts $60.5-160 \mu\text{m}$; deutomerite sub-spherical, oblong, elongated or cylindrical; protomerite sub-spherical; sporadins elongate, biassociative; gametocysts spherical, $208.0-310.0 \mu\text{m}$ in diameter, gametes isogamous, oval, $8.0 \mu\text{m} \times 4.0 \mu\text{m}$; oocysts barrel-shaped with thin wall, $12.8 \mu\text{m} \times 5.6 \mu\text{m}$ in size, dehiscence by simple rupture.

Host : *Melanoplus* sp.; site of infection : mid-gut

Distribution : India : Andhra Pradesh (Visakhapatnam district).

173. *Retractocephalus waltirensis* Rajakumari and Narasimhamurti, 1984
(Figs. 235-237)

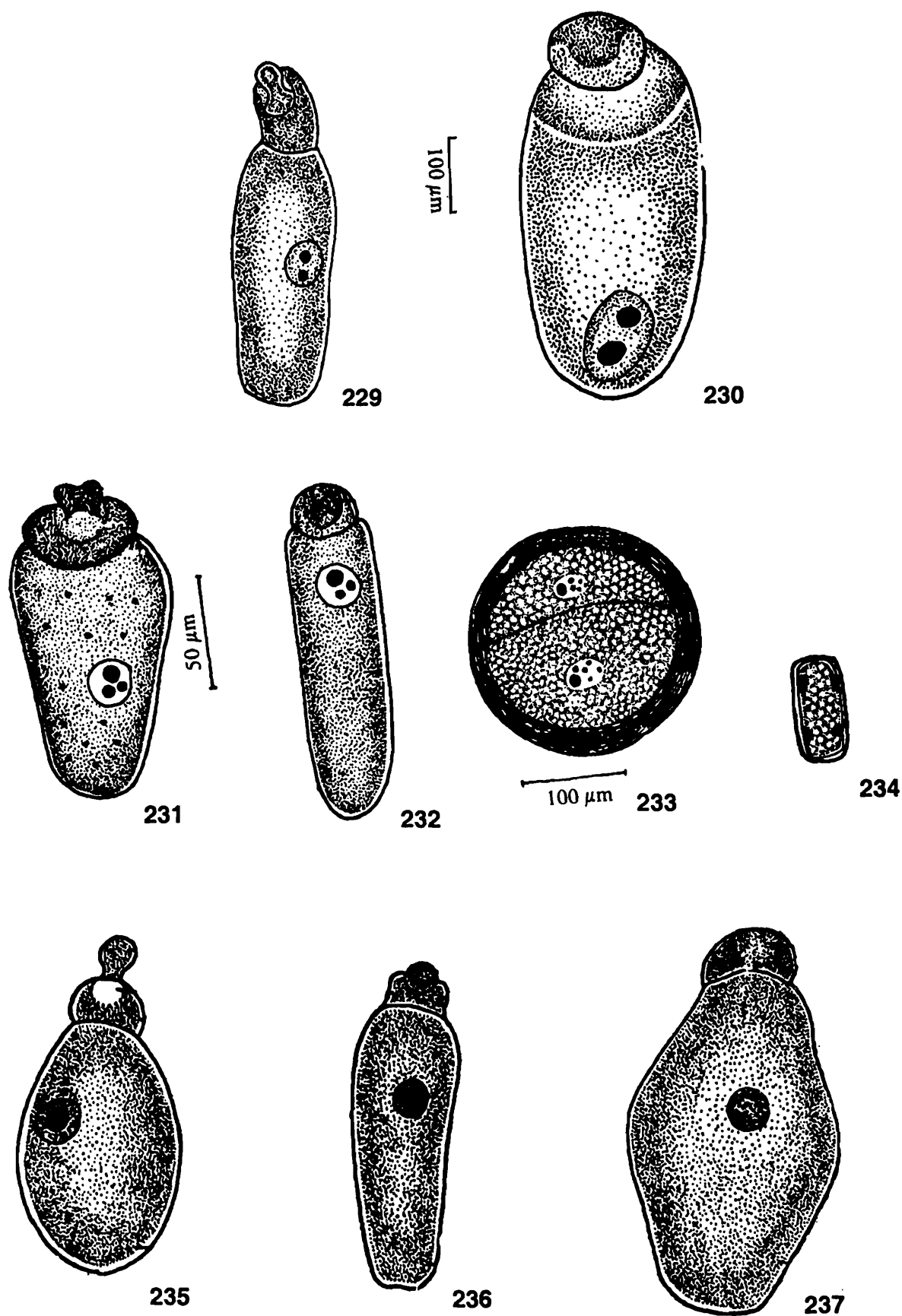
1984. *Retractocephalus waltirensis* Rajakumari and Narasimhamurti, *Indian J. Parasitol.*, **8** (1) : pp. 107-109.

Material examined : Sev. exs., K. Raja Kumari, Mar.-Oct. 1982, Visakhapatnam, Visakhapatnam District.

Diagnosis : Early stages intracellular, spherical, $13.5 \mu\text{m}$ in diameter; young cephalonts $71.0 \mu\text{m} \times 31.0 \mu\text{m}$ in size; epimerite small, knob-like, retractable into a depression in the rectangular protomerite; deutomerite long, cylindrical or oval; sporonts $88.0-137.0 \mu\text{m} \times 53.0-60.0 \mu\text{m}$, bi-associative; gametocysts and oocysts not described.

Host : *Raphidopalpa stevensi*; site of infection : malphigian tubules, haemocoel.

Distribution : India : Andhra Pradesh (Visakhapatnam district).



Figs. 229-237. Gregarine parasites of Andhra Pradesh : 229-230. Mature cephalont and sporadin of *Retractocephalus corcyrae* n. sp.; 231-234. *R. melanopli* and 235-237. *R. waltirensis*.

Superfamily STENOPHORICAE Levine, 1970
(Synonym Solitericae Chakravarty, 1960)

1960. Solitericae Chakravarty, M.M., *Proc. Zool. Soc. Bengal.*, **12** : pp. 71-81.

1979. Stenophoricae, Levine, N.D., *J. Protozoology*, **26** (4) : pp. 532-536.

Diagnosis : Gamonts solitary, early development intra or extracellular, epimerite simple or complex, gametocysts with or without sporoducts.

Key to the families

1. Early development intracellular, syzygy caudofrontal, late, gametes anisogamous, anisogamy accentuated, dehiscence by simple rupture, oocysts ovoid or ellipsoidal
..... STENOPHORIDAE
2. Early development intracellular; epimerite vesicular and retractile with prongs; with deep myocyte composed of 2 axial bundles, the anterior retracting epimerite and contained in protomerite, gametocyst with single sporoduct, oocyst truncate
..... MONODUCTIDAE
3. Epimerite thick horizontal disc with milled border or absent, protomerite atrophied in adults, dehiscence by simple rupture, oocysts ovoid or biconical
..... SPHAEROCYSTIDAE
4. Epimerite complex, digitate without a long neck, nucleus in protomerite, syzygy late, frontal, gametes anisogamous, anisogamy accentuated, gametocysts with single residuum
..... DACTYLOPHORIDAE
5. Epimerite elongated with or without appendages, early development extracellular, syzygy frontal, gametocyst residuum present, oocysts hat-shaped emitted in chains
..... STYLOCEPHALIDAE
6. Epimerite symmetrical with or without appendage, syzygy late frontal, gametocyst without sporoducts, dehiscence by simple rupture, oocysts simple, biconical or cylindroconical or irregular or spiny
..... ACTINOCEPHALIDAE

Family STENOPHORIDAE Leger and Duboscq, 1904

1904. Stenophoridae Leger and Duboscq, *Arch. Protistenk.*, **4** : pp. 335-383.

Diagnosis : As in the key.

Key to the genera

1. Epimerite small, tongue-shaped, bordered by a collar at its base, oocysts covered by a hyaline membrane *Hyalosporina*
2. Epimerite lacking or rudimentary, oocysts ovoid with equatorial line *Stenophora*

Genus *Hyalosporina* Chakraborty, 1935

1935. *Hyalosporina* Chakraborty, *Arch. Protistenkd.*, **86** : pp. 211-218.

Diagnosis : As in the key.

174. *Hyalosporina froilanoi* Karandikar and Rodgi, 1955
(Figs. 238 & 239)

1955. *Hyalosporina froilanoi* Karandikar and Rodgi., *J. Univ. Bombay*, **24B** : pp. 11-37.

Material examined : Sev. exs., Sep–Oct., 1976, N. Sailaja, Sep–Oct 1997, C. Kalavati.

Diagnosis : Gamonts elongated, 250-300 μm x 15-38 μm ; epimerite rounded; protomerite small triangular in shape, second nucleus often seen in protomerite; deutomerite broader anteriorly, tapering posteriorly, nucleus spherical, tethered to pellicle by myonemes; gametocyst spherical 77 –116.5 μm in diameter; oocysts elongately oval.

Host : *Chondromorpha keelarti* (Diplopoda, Arthropoda); site of infection : gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Sailaja (1978) recorded this species for the first time from this state.

Genus *Stenophora* Labbe, 1899

1899. *Stenophora* Labbe., *Sporozoa*, In *das teirreich* **5** : pp. 196.

Diagnosis : Early development intracellular. Oocyst ovoid with prominent equatorial suture.

Key to the species

1. Epimerite small and rudimentary, protomerite broadly oval, produced anteriorly into a short stalk with a shallow depression covered by epicyte, gametocysts spherical, oocyst cylindrical with rounded corners *S. thyrogluti*
2. Epimerite small, knob-like, sporonts solitary, gametocysts spherical, gametes anisogamous, oocysts oval 4.0 x 3.0 μm *S. xenoboli*

175. *Stenophora thyrogluti* Ganapati and Narasimhamurti, 1962
(Figs. 240-243)

1962. *Stenophora thyrogluti* Ganapati and Narasimhamurti *Proc. All India Congress Zoology*, Part 2 : pp. 305-310.

Material examined : Sev exs., C.C. Narasimhamurti, Visakhapatnam, Visakhapatnam district.

Diagnosis : Early development stage intracellular, oval; epimerite small and rudimentary; trophozoite elongate, 1196 μm x 247 μm ; protomerite broadly ovoidal, produced anteriorly into a short stalk with a shallow depression covered over by epicyte, a flask-shaped area at

the anterior end of the protomerite filled with hyaline protoplasm; gametocysts spherical, 260-300 μm , with gelatinous ectocyst; oocysts cylindrical with rounded corners, 10.5 μm x 4.5 μm , a hyaline episporal coat seen in close contact with sporoblast wall.

Host : *Thyroglutus* sp; site of infection : intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

176. *Stenophora xenoboli* Ganapati and Narasimhamurti, 1956
(Figs. 244-246)

1956. *Stenophora xenoboli* Ganapati and Narasimhamurti, *J. Zool. Soc. India*, 8 (2) : pp. 165-170.

Material examined : Sev. exs., C.C. Narasimhamurti, Visakhapatnam, Visakhapatnam District.

Diagnosis : Early development intracellular; trophozoites 37.0-450.0 μm , anterior half of the body broader than posterior; epimerite small, knob-like; sporonts solitary; gametocysts spherical, 200.0-225.0 μm in diameter, gametes anisogamous, microgamete oval with one end drawn out into a conical projection with a short blunt flagellum, macrogametes oval, 3.25 μm x 3.0 μm ; oocysts oval 4.0 μm x 3.0 μm with a hyaline episporal coat.

Host : *Xenobolus* sp.; site of infection : Intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

177. *Stenophora* sp. 1
(Figs. 247-251)

Material examined : Sev. exs., Visakhapatnam, November, 1976, N. Sailaja.

Diagnosis : Early development intracellular; cephalonts 192-160 μm ; epimerite small, deeply stained spine-like; sporadins long, narrow, attenuated, 228 μm x 48 μm ; gametocysts oval or spherical, 200-225 μm in size, gametes isogamous, dehiscence simple rupture; oocysts oval 8.0 μm x 4.1 μm .

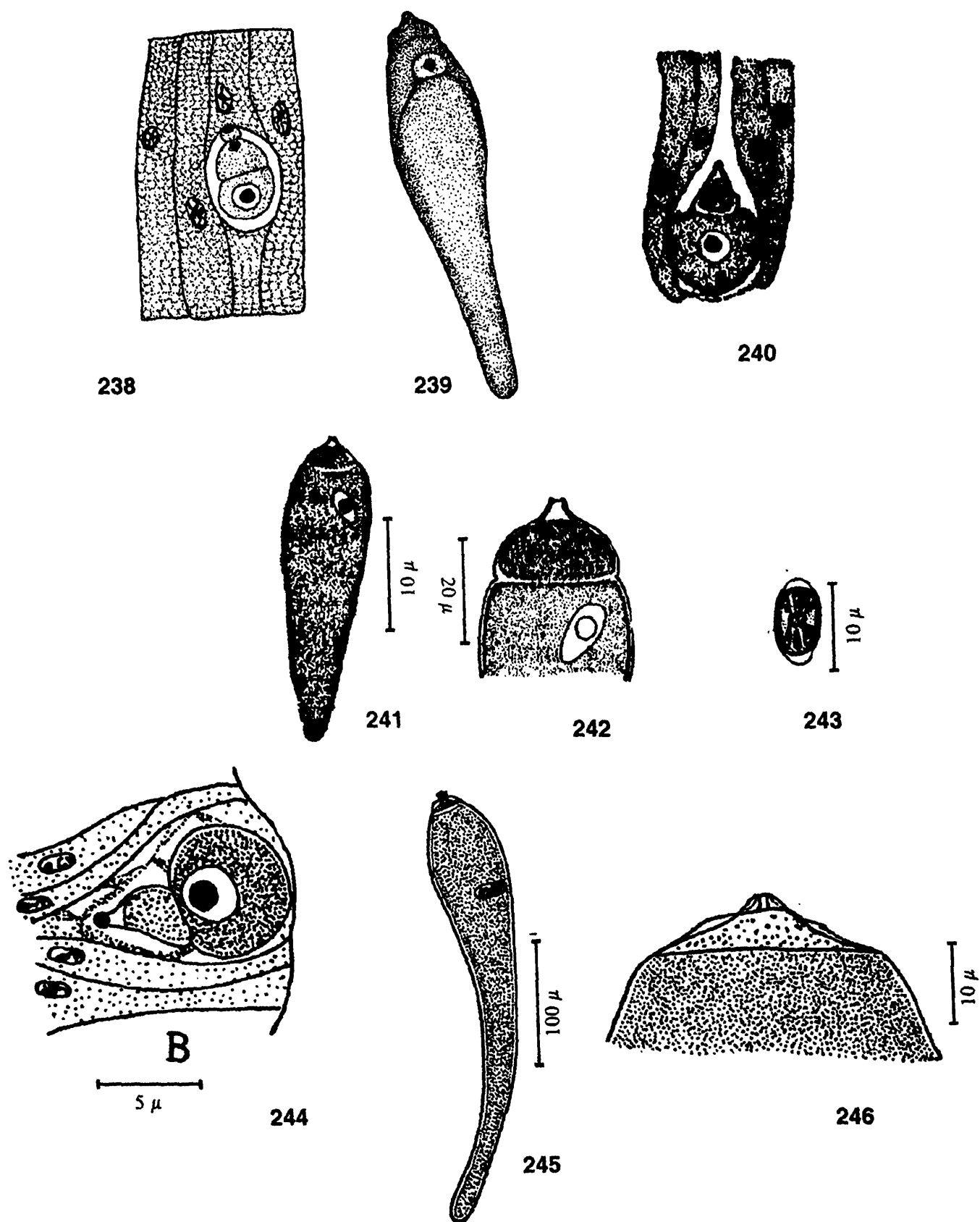
Host : *Strongylosoma contortipes* (Myriapoda); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Sailaja (1978) recorded this species as new to science in the unpublished thesis which is treated herein as unnamed species, being unpublished, as per International Code of Zoological Nomenclature.

178. *Stenophora* sp. 2
(Figs. 252-254)

Material examined : Sev. exs., Visakhapatnam, October, 1977, N. Sailaja.



Figs. 238-246. Gregarine parasites of Andhra Pradesh : 238-239. *Hyalosporina froilani*; 240-243. *Stenophora thyrogluti* and 244-246. *S. xenoboli*.

Diagnosis : Early development intracellular; cephalonts 26-745 μm ; epimerite simple, hyaline, triangular; protomerite with numerous deeply stained chromatin bodies; deutomerite elongated with blunt posterior end; gametocysts spherical 300-425 μm in size, gametes isogamous, dehiscence simple rupture; oocysts cylindrical 8.5 μm x 6.4 μm .

Host : *Strongylosoma contortipes* (Myriapoda); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : As for preceding species.

179. *Stenophora* sp. 3
(Figs. 255-257)

Material examined : Sev. exs., Visakhapatnam, November, 1976, N. Sailaja.

Diagnosis : Early development intracellular; cephalonts 192-160 μm ; epimerite broadly conical, bilobed and nipple-like; sporadins 184 μm x 140 μm , rotund and oval; gametocysts spherical 90-200 μm in size, gametes isogamous, dehiscence simple rupture; oocysts oval 6.5 μm x 5.0 μm .

Host : *Strongylosoma contortipes* (Myriapoda); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : As for preceding species.

Family MONODUCTIDAE Ray and Chakravarty, 1933

1933. *Monoductidae* Ray, H.N. and Chakravarty, M.M., *Arch. Protistenkd.*, **81** : pp. 352-360.

Diagnosis : As in the key.

Genus *Monoductus* Ray and Chakravarty, 1933

1933. *Monoductus* Ray, H.N. and Chakravarty, M.M., *Arch. Protistenkd.*, **81** : pp. 352-360.

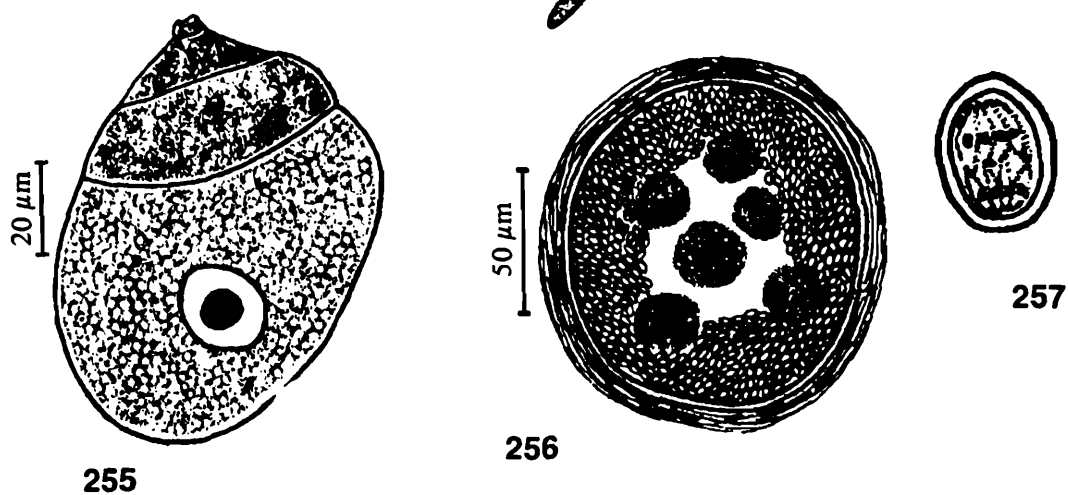
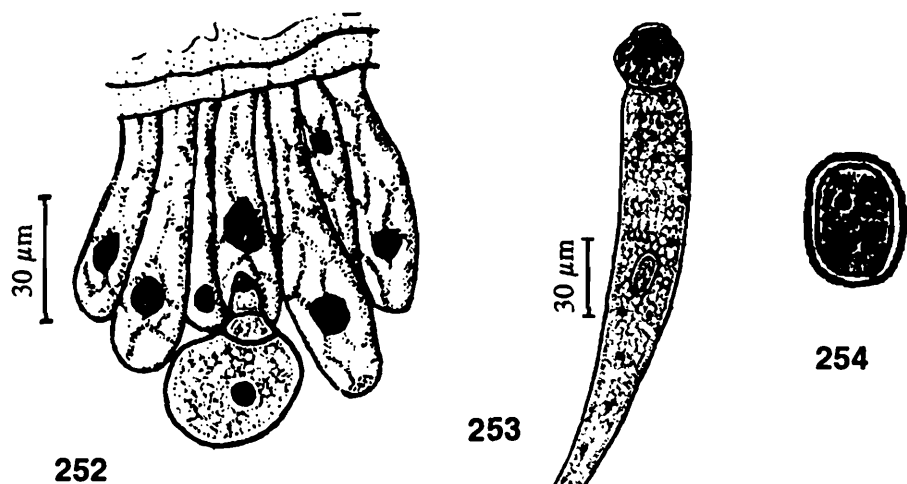
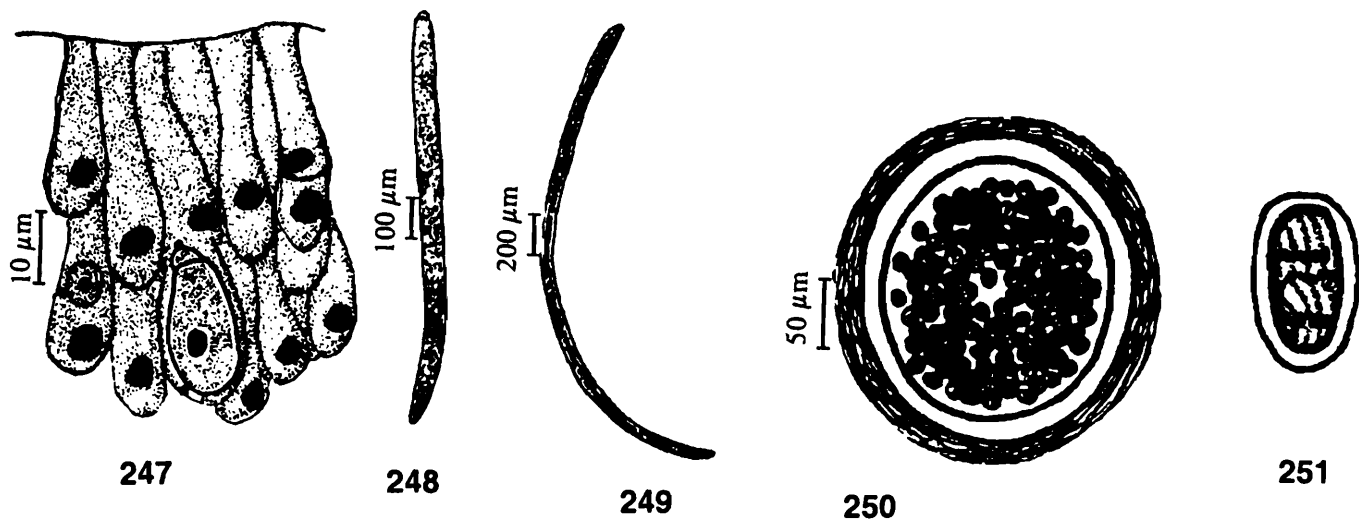
Diagnosis : Syzyzy late, anisogamy present.

180. *Monoductus lunatus* Ray and Chakravarty, 1933
(Figs. 258 & 259)

1933. *Monoductus lunatus* Ray and Chakravarty, *Arch. Protistenkd.*, **81** : pp. 352-360.

Material examined : Sev. exs., April-May 1977, N. Sailaja, Visakhapatnam, Visakhapatnam District.

Diagnosis : Trophozoite elongated, 225-445 μm x 33-49 μm ; epimerite knob-like with 12-16 stiff radiating processes at its neck; protomerite small more or less conical; deutomerite



Figs. 247-257. Gregarine parasites of Andhra Pradesh : 247-251. *Stenophora* sp. 1; 252-254. *Stenophora* sp. 2; 255-257. *Stenophora* sp. 3.

elongated, cylindrical; sporonts solitary or associative; gametocyst spherical; 225.0–230.0 μm in diameter, oocysts compressed, truncated at one pole, single sporoduct releasing spores in long chains

Host : *Strongylosoma contortipes* (Diplopoda, Arthropoda); site of infection : gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Sailaja (1978) recorded this species from this state.

Family SPHAEROCYSTIDAE Chakravarty, 1960

1960. *Sphaeocystidae* Chakravarty, *Proc. zool. Soc., Calcutta*, **12** : pp. 71-81.

Diagnosis : As in the key.

Genus *Sphaerocystis* Leger, 1892

1892. *Sphaerocystis* Leger, *Tabl. Zool.*, **3** : pp. 1-182.

Diagnosis : Epimerite labile, gamonts apparently with single segment, solitary, oocysts ellipsoidal with adherent endospore and epispor.

181. *Sphaerocystis odontotermis* Kalavati and Narasimhamurti, 1979

(Syn. *S. odontotermi* Kalavati and Narasimhamurti, 1979)

(Figs. 260-262)

1979. *Sphaerocystis odontotermi* Kalavati and Narasimhamurti, *Proc. Ind. Acad. Sci.*, **89** (1) : pp. 25-28.

Material examined : Sev. exs., August to December, 1968, C. Kalavati, Visakhapatnam, Visakhapatnam (District); July-August 1978, K. Rajakumari, Tuni, East Godavari (District), and July–August 1976, G. Krishnamurti, Vizianagaram, Vizianagaram (District).

Diagnosis : Cephalonts attached to gut epithelium, 25 μm x 125 μm in size; epimerite dome-shaped, 8.5 μm x 12.5 μm in size; deutomerite elongate; protomerite indistinct; sporonts sub-spherical, solitary; gametocysts spherical, 200.0-220.0 μm in diameter, ectocyst 10.0-20.0 μm thick, gametes isogamous, spherical, 3.2 μm in diameter; oocysts ovocylindrical, 10.0 μm x 6.0 μm , arranged in the form of 7-8 balls inside the cyst, each surrounded by thin membrane, dehiscence by simple rupture.

Host : *Odontotermes* sp.; site of infection : mid and hindguts.

Distribution : India : Andhra Pradesh (Visakhapatnam, Vizianagaram and East Godavari districts).

Family DACTYLOPHORIDAE Leger, 1892

1892. *Dactylophoridae* Leger, *Tabl. Zool.*, **3** : pp. 1-182.

Diagnosis : As in the key.

Key to the genera

1. Protomerite spread out transversely with numerous delicate rhizoids of 2 long horizontal narrow, peripheral portion with many teeth from which long filaments project *Grebneckiella*
2. Epimerite with sucker-like border of ramified lobes, transeverse fibrils conspicuous, gametocyst ellipsoidal, oocyst biconical *Dendrorhynchus*
3. Epimerite cup-shaped with numerous intracellular filaments, gamont with septum between protomerite and deutomerite, gametes anisogamous, oocyst simple *Mecistophora*

Genus *Grebneckiella* Bhatia, 1938

1938. *Grebneckiella* Bhatia, *Fauna of British India*, pp. 1-497.

Diagnosis : As in the key.

182. *Grebneckiella pixellae* Misra, 1942 (Figs. 263 & 264)

1942. *Grebneckiella pixellae* Misra, *Rec. Ind. Mus.*, 44 : pp. 323-337.

Material examined : Sev. exs., May 1954, C.C. Narasimhamurti; August 1989, C. Kalavati Visakhapatnam, Visakhapatnam District.

Diagnosis : Gamonts solitary, 1050-4050 μm long; PL:TL = 1:15 -25; epimerite caduceus with digitiform protruberances and thread-like proximal filaments, long arm with a vesicular nucleus at its distal end, short arm with bifid distal extremity; gametocysts spherical, 208.0-672.0 μm , oocysts cylindrical or long ovoidal, 10.0-13.0 μm x 4.0-5.0 μm , released in oblique chains.

Host : *Scolopendra morsitans* (Myriapoda, Arthropoda); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Ganapati and Narasimhamurti (1955) reported the species from the same host in Visakhapatnam and described the distribution of paraglycogen in different stages of the life cycle.

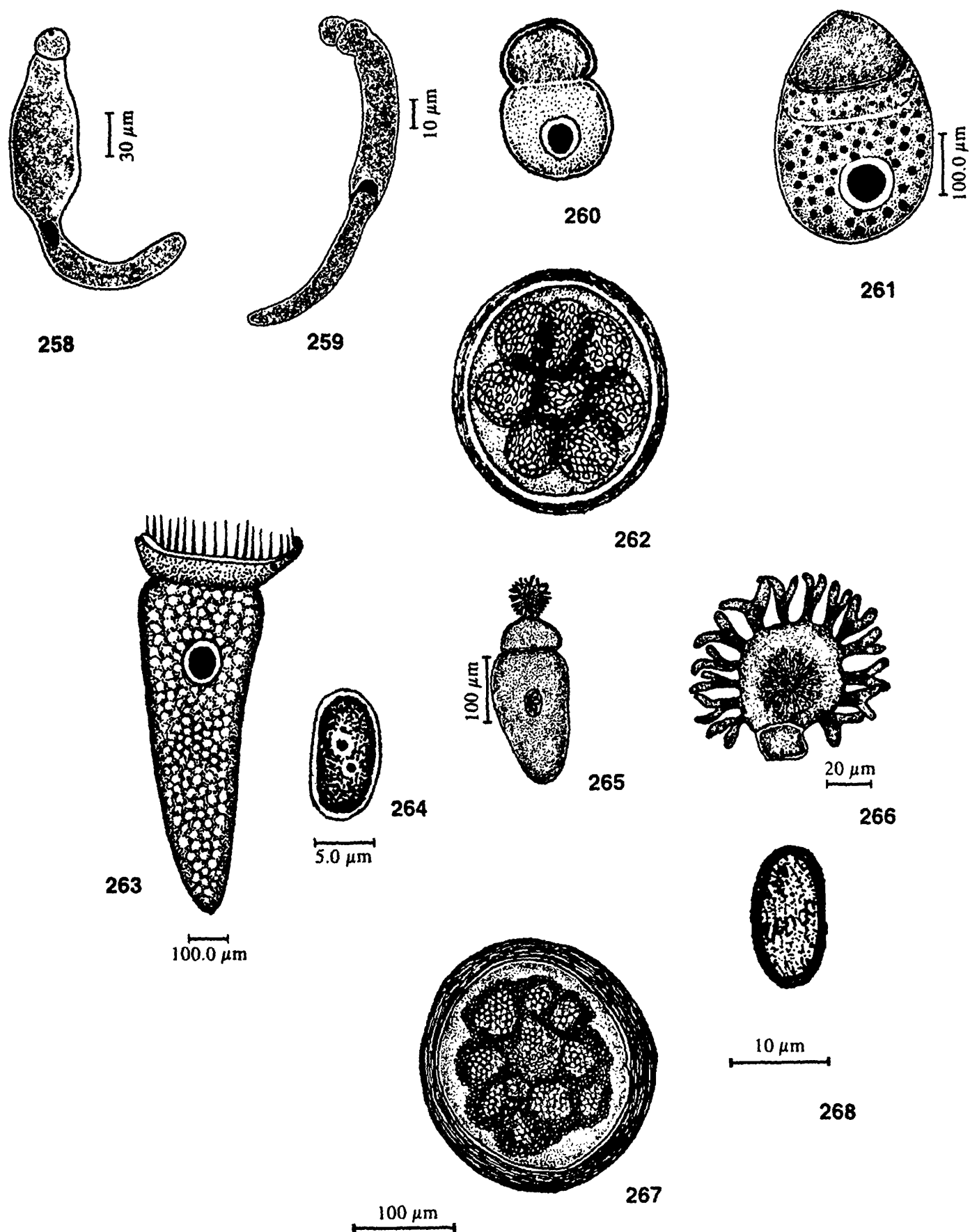
Genus *Dendrorhynchus* Keilin, 1920

1920. *Dendrorhynchus* Keilin, *Parasitology*, 12 : pp. 154-158.

Diagnosis : As in the key.

183. *Dendrorhynchus keilini* Nazeer Ahmed and Narasimhamurti, 1979 (Figs. 265-268)

1979. *Dendrorhynchus keilini* Nazeer Ahmed and Narasimhamurti, *Acta Protozool.*, 18(3) : pp. 441-450.



Figs. 258-268. Gregarine parasites of Andhra Pradesh : 258-259. *Monoductus lunatus*; 260-262. *Sphaerocystis odontotermi*; 263-264. *Grebneckiella pixellae* and 265-268. *Dendrorhynchus keileni*.

Material examined : Sev. exs., S. Nazeer Ahmed, 1975, Sep-November, Visakhapatnam, Visakhapatnam District.

Diagnosis : Trophozoites reaching a maximum size of $400.0\ \mu\text{m} \times 300.0\ \mu\text{m}$; epimerite expanded with a disc-like structure, the margin of which produced into 13-16 bifid papillae; gametocysts spherical, reaching a diameter of $225\ \mu\text{m}$, ectocyst $30\ \mu\text{m}$ thick, gametes isogamous, $7.5\ \mu\text{m} \times 4.5\ \mu\text{m}$ in size; oocyst oval, $7.0\ \mu\text{m} \times 3.0\ \mu\text{m}$ in size, dehiscence simple.

Host : *Ceriagrion coromandelianum* (Fabr); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Genus *Mecistophora* Ganapati and Narasimhamurti, 1960

1960. *Mecistophora* Ganapati and Narasimhamurti, *Arch. Protistenkd.* **104** (4) : pp. 554- 558.

Diagnosis : As in the key.

184. *Mecistophora legeri* Ganapati and Narasimhamurti, 1960 (Figs. 269-271)

1960. *Mecistophora legeri* Ganapati and Narasimhamurti, *Arch. Protistenkd.* **104** (4) : pp. 554-558.

Material examined : Sev. exs., C.C. Narasimhamurti, Visakhapatnam.

Diagnosis : Mature trophozoite $595.0\ \mu\text{m} \times 148.0\ \mu\text{m}$, elongated and cylindrical with a bluntly pointed posterior end; epimerite in the form of a shallow cup-like structure with raised margins that frayed out into numerous filamentous processes; protomerite ovoid, posterior surface concave; sporonts associate in pairs by their sides with protomerites in opposite direction; gametocysts covered by a thick gelatinous ectocyst, $10.0\text{-}12.0\ \mu\text{m}$ in thickness, gametes anisogamous, macrogametes ovoidal, $4.5\ \mu\text{m} \times 3.75\ \mu\text{m}$ in size, microgametes comma-shaped, $3.5\text{-}4.0\ \mu\text{m}$ in length; oocyst cylindrical with rounded ends $6.5\ \mu\text{m} \times 3.5\ \mu\text{m}$ in length, dehiscence by pseudocyst formation.

Host : *Mecistocephalus punctifrons*; site of infection : midgut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : This is a monotypic species.

Family STYLOCEPHALIDAE Ellis, 1912 (Syn : Stylorhynchidae, Scheneider, 1886)

1912. *Stylocephalidae* Ellis, *Zool. Anz.*, **39** : pp. 25-27.

Diagnosis : As in the key.

Key to the genera

1. Epimerite broad at the base swollen as bulb with olive-shaped prolongation, oocysts hat-shaped *Cystocephalus*
2. Epimerite elongated as neck, swollen posteriorly at free end, gametocyst covered with papillae, oocysts hat-like, usually emerging in chains *Stylocephalus*
3. Epimerite very long with sharp or blunt point on a filiform neck, oocyst hat-shaped. *Xiphocephalus*

Genus *Cystocephalus* Schneider, 1886

1866. *Cystocephalus* Schneider, *Tabl. Zool.*, 1 : pp. 90-103.

Diagnosis : As in the key.

185. *Cystocephalus gonocephali* n. sp. (Figs. 272-276)

1983. *Cystocephalus* sp., Rajakumari, M. Phil. Dissertation (unpublished), Andhra University, India.

Type material : Holotype Cys. Gon. 1 and paratypes Cys. Gon. 2, 3 & 4 deposited in Protozoology laboratory, Andhra University.

Material examined : Sev. exs., April 1982, Rajakumari, April 2002, Kalavati Visakhapatnam, Visakhapatnam (District).

Diagnosis : Body elongated, 205-400 μm x 36-34 μm , with greatest width from anterior $\frac{1}{3}$ region; young cephalonts found free in the lumen of the gut; epimerite disproportionately large, swollen, bulb-like in shape with a blunt conical tip based on a collar; protomerite at this stage not clearly demarcated, appearing like a collar between epimerite and deutomerite, no clear septum between proto and deutomerite; in mature cephalonts epimerite broad spatula-like, relatively smaller in size, septum between proto and deutomerites well marked; nucleus oval, 16 μm x 48 μm , with two masses of chromatin; collar distinct; gametocysts oval or spherical, 202-235.0 μm x 152.0-206.0 μm , gametes anisogamous, anisogamy well marked; oocysts hat-shaped, 13.0 μm x 10.3 μm with thickened black ends and released in chains.

Host : *Gonocephalum arenarium* (Coleoptera; Insecta); site of infection : midgut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : So far ten species of the genus *Cystocephalus* are reported from coleopteran insect hosts (Levine, 1988) and in comparison the gamonts in the present species are found smaller than *C. algerianus*, *C. albrechti*, *C. aethiopicus*, *C. gabei* and *C. devdhari* and larger than *C. hollendaei*. Besides these species, *Cystocephalus harpalus* and *C. trapezus* are reported by Nelson (1970) and *C. rhytinotus* by Patil and Amoji (1980). Theodorides (1954) emended *Leidyana leidy* Kamm, 1917 as *Cystocephalus leidy* (Kamm, 1917). The present species

differs from all these species in having a bulb-like large epimerite that reduces in size and appears like a spatula in mature cephalonts. Nucleus is oval, $16\ \mu\text{m} \times 48\ \mu\text{m}$, with two masses of chromatin. Oocysts are relatively large in comparison to *C. gabei*, *C. rhyntinotus* and *C. devdhari* and hat-shaped with black thickened ends. According to Corbel (1971) *C. aethiopicus* and *C. gabei* are synonymous, while the complete life cycle is known only for a few species viz., *C. aethiopicus*, *C. algerianus*, *C. devdhari* and *C. rhyntinotus*. Among these species the spores of new gregarine are larger ($13.0\ \mu\text{m} \times 10.3\ \mu\text{m}$) than the others [*C. algerianus*, $10\ \mu\text{m} \times 10.5\ \mu\text{m}$; *C. aethiopicus* (= *C. gabei*), $8\ \mu\text{m}$; *C. devdhari*, $10\ \mu\text{m} \times 7.5\ \mu\text{m}$; and *C. rhyntinotus*, $11.25\ \mu\text{m} \times 8.75\ \mu\text{m}$]. In view of the above differences in epimerite, oocysts and spores supposedly having stable characters and its occurrence in a new host, *Gonocephalum arenarium*, it is considered new to science for which the name *Cystocephalus gonocephali* n. sp. is proposed after the host. Rajakumari (1983) initially studied this species and identified as *Cystocephalus* sp.

Genus *Stylocephalus* Ellis, 1912

1912. *Stylocephalus*, Ellis, *Zool. Anz.*, **39** : pp. 25-27.

Diagnosis : As in the key.

Key to the species.

1. Epimerite elongated with slightly dialated tip appearing like a raised cup with central papilla-like extension *S. gonocephali*
2. Epimerite with long neck and saucer-shaped structure, cephalont elongated serpent like *S. serpentula*

186. *Stylocephalus gonocephali* Bhushana Rao, 1962 (Figs. 277-279)

1962. *Stylocephalus gonocephali* Bhushana Rao, *Proc. All India Congress Zool.*, Pt. 2. : pp. 265-269.

Material examined : Sev. exs., N. Sailaja, September–December, 1976, Visakhapatnam, Visakhapatnam District.

Diagnosis : Gamonts solitary; epimerite elongated with slightly dialated tip appearing like a raised cup with central papilla-like extension; gamonts elongated and cylindrical, $1300\ \mu\text{m} \times 110\ \mu\text{m}$ in size; gametocysts spherical, $340.0\ \mu\text{m}$ in diameter, gametes anisogamous; oocysts hat-shaped and released in chains.

Host : *Gonocephalum brachyelytra* and *G. arenarium* (Coleoptera, Insecta); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Sailaja (1978) described the chromosome cycle of this species.

187. *Stylocephalus serpentula* Devdhar and Amoji, 1977
(Figs. 280 & 281)

1977. *Stylocephalus serpentula* Devdhar and Amoji, *Arch. Protistenkd*, **119** : pp. 75-85.

Material examined : Sev, exs., N. Sailaja, December 1977, Visakhapatnam, Visakhapatnam District.

Diagnosis : Cephalonts elongated, serpent-like; LP : TL = 1 : 37; epimerite long with a narrow neck 3–3½ times longer than protomerite, distal end saucer-shaped expanded; protomerite dome-shaped; gametocyst spherical, 230–285 µm; oocysts hat-shaped 9.8 µm x 7.0 µm.

Host : *Gonocephalum hoffmannseggi* and *G. arenarium*; site of infection : mid gut.

Distribution : India : Andhra Pradesh, (Visakhapatnam district), Karnataka (Gulbarga).

Remarks : Sailaja (1978) recorded this species from *G. arenarium* from this state. Corbel (1971) transpositioned this species *S. serpentula* to the genus *Xiphocephalus* as *X. serpentula*. A review of the diagnostic characteristics reveals that the epimerite of the present species is elongated with a narrow neck and has an expanded, broad, saucer-like distal end. In the original description of *S. serpentula*, Devdhar and Amoji (1977) described epimerite as broad, lancet-shaped at the tip of a neck. Both these descriptions justify assigning this species to the genus *Stylocephalus* which has a "mucron elongated into a narrow neck swollen posteriorly at the free end" (Levine, 1988) rather than the genus *Xiphocephalus* which is characterized by "mucron very long with sharp or blunt point on a filiform neck" (Levine, 1988). It is, therefore, contended to retain the original status of this species in the genus *Stylocephalus* as *S. serpentula* until the type material is studied or family level revision is made to the family Stylocephalidae.

188. *Stylocephalus* sp.
(Figs. 282-287)

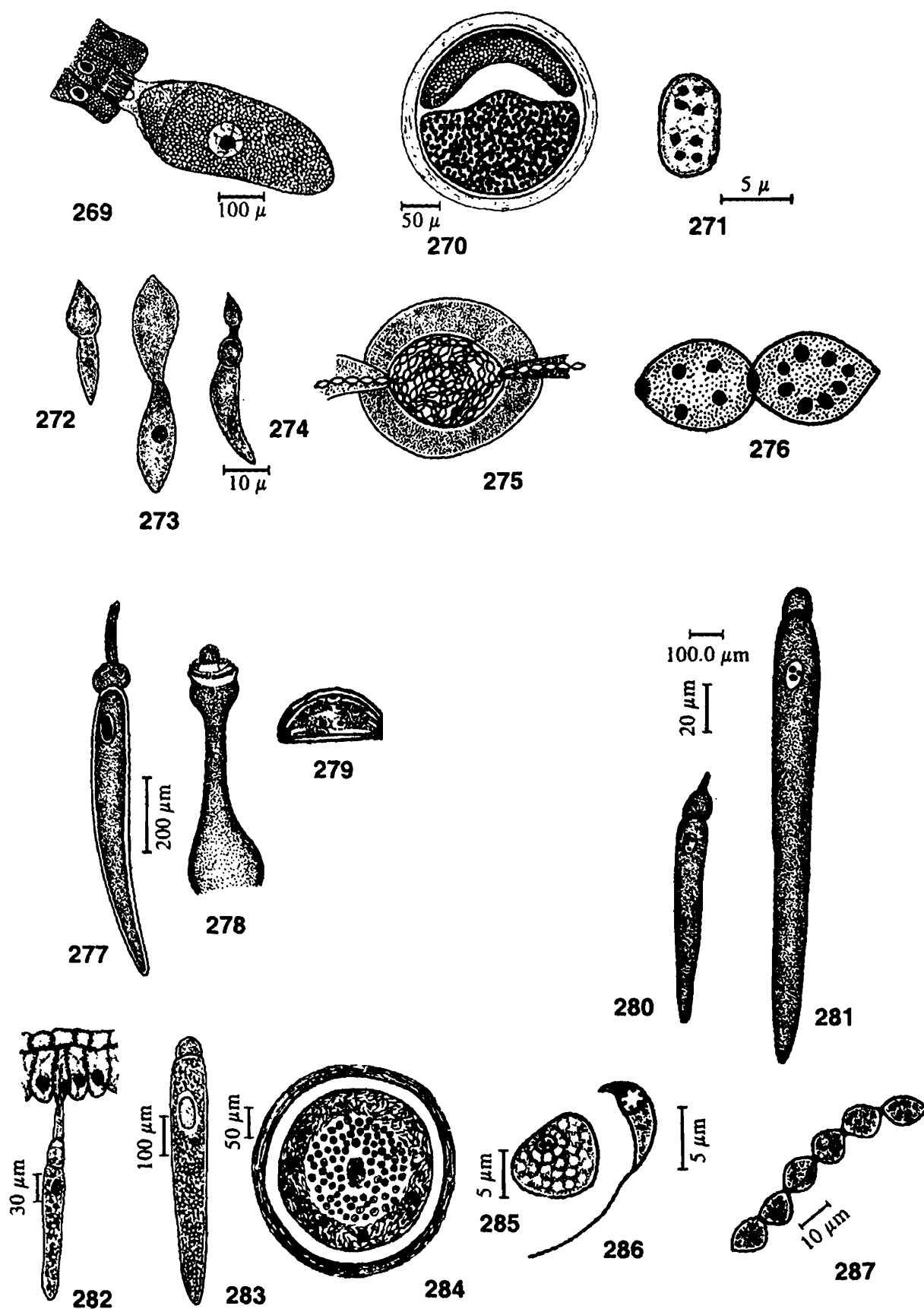
Material examined : Sev, exs., Visakhapatnam, March-April, 1976, N. Sailaja.

Diagnosis : Cephalonts 88-624 µm x 20-56 µm; epimerite with a pointed distal and broad bulbous proximal ends; sporadins 280-592 µm x 40-80 µm; gametocysts spherical 200-300 µm; gametes anisogamous; oocysts oval, 11.2 µm x 8.8 µm, expelled in chains.

Host : *Gonocephalum arenarium* (Coleoptera : Insecta); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Sailaja (1978) recorded this species as new to science in the unpublished thesis which is treated herein as unnamed species, being unpublished, as per International Code of Zoological Nomenclature.



Figs. 269-287. Gregarine parasites of Andhra Pradesh : 269-271. *Mecistophora legeri*; 272-276. Three different stages of cephalonts, gametocysts and oocysts in chain of *Cystocephalus gonocephali* n.sp.; 277-279. *Stylocephalus gonocephali*; 280-281. *S. serpentula* and 282-287. *Stylocephalus* sp.

Genus *Xiphocephalus* Corbel, 1971

1971. *Xiphicephalus* Corbel., *Naturalist Can.*, **98** : pp. 1-39.

Diagnosis : As in the key.

189. *Xiphocephalus rhytinotus* n. sp.
(Figs. 288-290)

1991. *Xiphicephalus* sp., Prasada Rao. M. Phil Dissertation (unpublished), Andhra University, India.

Type slides : Holotype Xi. rh 1; paratypes Xi. rh 2, 3 & 4, deposited in Protozoology laboratory, Andhra University.

Material examined : Sev. exs., November 1986–Feb 1987, D.D.V. Prasada Rao; Feb. 2003, Kalavati, Visakhapatnam, Visakhapatnam District.

Diagnosis : Sporadins solitary, thin, elongated and worm-like, posterior region with a spine-like ectoplasmic thickening; young cephalonts oval, $2.0\ \mu\text{m} \times 8.0\ \mu\text{m}$, free in the lumen of the gut; epimerite lancet-shaped with short neck in young cephalont and in mature form epimerite lancet-shaped, very long, $14.5\text{--}23.3\ \mu\text{m}$, with sharp point on a filiform neck; protomerite dome-like; deutomerite oval or elongated, $41.8\text{--}132.5\ \mu\text{m} \times 5.5\text{--}20\ \mu\text{m}$; LD : TL = 1 : 1.15, LP : TL = 1 : 24.4; sporonts long and thin with epicytic striations; gametocysts spherical, $200\text{--}250.0\ \mu\text{m}$ in diameter, cyst wall papillated, gametes anisogamous; oocysts barrel-shaped with peripheral thickenings and expelled in chains.

Host : *Rhytinota* sp. (Coleoptera, Insecta); site of infection : midgut and haemocoel.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : The present species does not resemble any of the eight species of *Xiphicephalus* viz., *X. africanus* (Syn. *Stylocephalus africanus*), *X. gladiator*, *X. gonocephali*, *X. karnatakaensis* (Syn. *Stylocephalus* (X.) *karnatakaensis*), *X. latipes*, *X. phalesiae* (Syn. *Stylocephalus phaleriae*) *X. reitteri* (Syn. *X. reitterae*) and *X. serpentula* (Syn. *Stylocephalus* (X.) *serpentula*) described so far from insects (Levine, 1988) and is not comparable with them in size and some other morphological characters as tabulated in the comparative chart on the next page. Further, the lancet-shaped epimerite with a sharp point on a filiform neck and the barrel-shaped sporocyst appeared unique for this species. Beside, it is the first record of *Xiphicephalus* from *Rhytinota* sp. Prasada Rao (1991) who observed the species earlier refrained from naming the species since he did not find the stages of gametogony and sporogony. Therefore, name of the species *Xiphocephalus rhytinotus* n. sp. is proposed after the host.

Comparative chart of *Xiphocephalus* species (figures indicate measurement in μm)

Species (Host)	Morphometric features of <i>Xiphocephalus</i> species			
	Epimerite	Sporadins	Gametocysts	Sporocysts
<i>Xiphocephalus ellisi</i> (Host : <i>Eleodes spacus</i>)	Elongated, xiphoid, ensiform.	Elongated 737.39-1,756.0	Oval, 285-480 x 240-470	Lithocystic or seed-shaped 9.73 x 8.45 x 1.98
<i>Xiphocephalus gladiator</i> (Host : <i>Helenophorus collaris</i>)	Xiphoid to lanceolate, very long, on a distinct filiform neck	Serpent-shaped, 300-720	Unknown	Unknown
<i>Xiphocephalus gonocephali</i> (Host : <i>Gonocephalus depressum</i>)	Cone-shaped in young; lancet-shaped with a round collar in mature forms.	Serpent-shaped 2800, LP : TL = 1 : 56, WP : WD = 1 : 2	Spherical, 250-850 in diameter, cyst wall papillated	Hat-shaped with articulated points, 10 x 9
<i>Xiphocephalus karnatakensis</i> (Host : <i>Gonocephalum hoffmannseggii</i>)	Lancet-shaped with long neck 100-120	Elongated, 925-1332; WP : WD = 1 : 1.7	Spherical, 310-408 in diameter, cyst wall papillated	Hat-shaped 12 x 9 brownish black in colour
<i>Xiphocephalus latipes</i> (Host : <i>Sceleron latipes</i>)	Lancet-shaped with long neck, 100	Elongated, 750, LP : TL = 1 : 18 WP : WD = 1 : 1.2	Spherical, 300, cyst wall papillated	Hat-shaped, 9.0 x 8.5
<i>Xiphocephalus reitterae</i> (Host : <i>Scleron reitteri</i>)	tubular with pointed apex,	Elongated, 545-650	Spherical, 390, cyst wall papillated	Hat-shaped 10.25 x 10.0
<i>Xiphocephalus serpentula</i> (Hosts : <i>Gonocephalum hoffmannseggii</i>)	Lancet-shaped with long neck, 135	Serpent-shaped 1800-2584, LP; TL = 1: 37 WP : WD = 1 : 1.5	Oval, 238-285	Hat-shaped, 9.8 x 7.0
<i>Xiphocephalus rhytinotus</i> n. sp. (Host : <i>Rhytinota</i> sp.)	Lancet-shaped with long, filiform, 14.5-23.3	Elongated, with a spine-like ectoplasmic thickening; LP : TL = 1 : 24.4 LD : TL = 1 : 1.5	Spherical, 200-250, cyst wall papillated	Barrel-shaped with peripheral thickening

Note : The species *Xiphocephalus serpentula* (Syn. *Stylocephalus serpentula*) is included for comparison as it is transpositioned to the genus *Xiphocephalus* by Corbel (1971), even though the original specific status is retained in this communication for reasons stated under remarks of this species (please vide supra in page 199).

Family ACTINOCEPHALIDAE Leger, 1892

1892. *Actinocephalidae* Leger. *Tabl. Zool.*, **3** : pp. 1-182.

Diagnosis : As in the key.

Subfamily ACTINOCEPHALINAE Leger, 1899

1899. *Actinocephalinae* Leger., *C.R. Society biology*, Paris, **52** : pp. 567-577.

Diagnosis : Oocysts without spines or thickenings at the poles.

Key to the genera

1. Epimerite with short neck having 8-10 simple digitiform processes at apex, neck persisting more or less in gamonts, dehiscence of gametocyst by formation of a hole, oocysts biconical or lemon-shaped *Actinocephalus*
2. Epimerite large flattened, fluted disc, oocysts biconical or ovoid, released in lateral chains *Anthorhynchus*
3. Epimerite in the form a disc with small stalk and 14 indentations arranged in 2 whorls of 7 each *Acanthogregarina*
4. Epimerite highly complex, bowl-like having a bulb-like round base, narrow elongated neck and truncated apex beset with 4 short slender symmetrical filaments or spines, spherical gametocysts, ellipsoidal oocysts released in lateral chains *Harendraia*
5. Epimerite a short motile digitiform process that becoming a flattened structure later, oocysts biconical, swollen *Steinina*

Genus *Actinocephalus* Stein, 1848

1848. *Actinocephalus* Stein, *Apch. Anat. Physio.*, pp. 182-223.

Diagnosis : As in the key.

190. *Actinocephalus bradinopygi* Narasimhamurti and Nazeer Ahmed, 1980
(Figs. 291-294)

1980. *Actinocephalus bradinopygi* Narasimhamurti and Nazeer Ahmed, *Acta Protozool.*, **19** (1) : pp. 61-66.

Diagnosis : Cephalonts large, reaching a maximum size of 825.0 μm x 168.0 μm ; epimerite complex, broad at base and is drawn out into a long tubular neck, tip of the neck expanded into a shallow cup, margin of which produced into 9-11 petaloid lobes, when contracted it appeared bulb-like; deutomerite long, 540.0 μm x 125.0 μm in size, with

conspicuous epicyteal striations; sporonts solitary, 1300.0 μm x 225.0 μm ; gametocysts spherical, 800.0 μm in diameter, ectocyst 150.0 μm thick, gametes isogamous, spherical, 10.0 μm in diameter; oocysts oval, 17.0 μm x 5.0 μm .

Host : *Bradinopyga geminata* (Rambur); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Genus ***Anthorhynchus*** Labbe, 1887
(Syn. *Anthocephalus* Scheneider, 1887)

1899. *Anthorhynchus* Labbe, *Sporozoa in Das Tierreich*, 5 : 196 pp.

Diagnosis : As in the key.

191. ***Anthorhynchus hanumanthi*** Kalavati and Narasimhamurti, 1978
(Figs. 295-297)

1978. *Anthorhynchus hanumanthi* Kalavati and Narasimhamurti, *Proc. Ind. Acad. Sci.*, 87 (12) : pp. 397-404.

Material examined : Sev. exs., C. Kalavati, August, 1976, S. Kota and Visakhapatnam, Visakhapatnam district.

Diagnosis : Trophozoites elongate, 150.0-250.0 μm x 60.0-80.0 μm ; epimerite large, flattened, fluted disc with transparent edges; protomerite small and deutomerite long; sporadins solitary, 300.0-600.0 μm ; gametocysts oval, 350.0-500.0 μm x 600.0-800.0 μm ; spores biconical with polar thickenings, 10.0-12.0 μm x 5.0-5.6 μm in size.

Host : *Odontotermes* sp.; site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

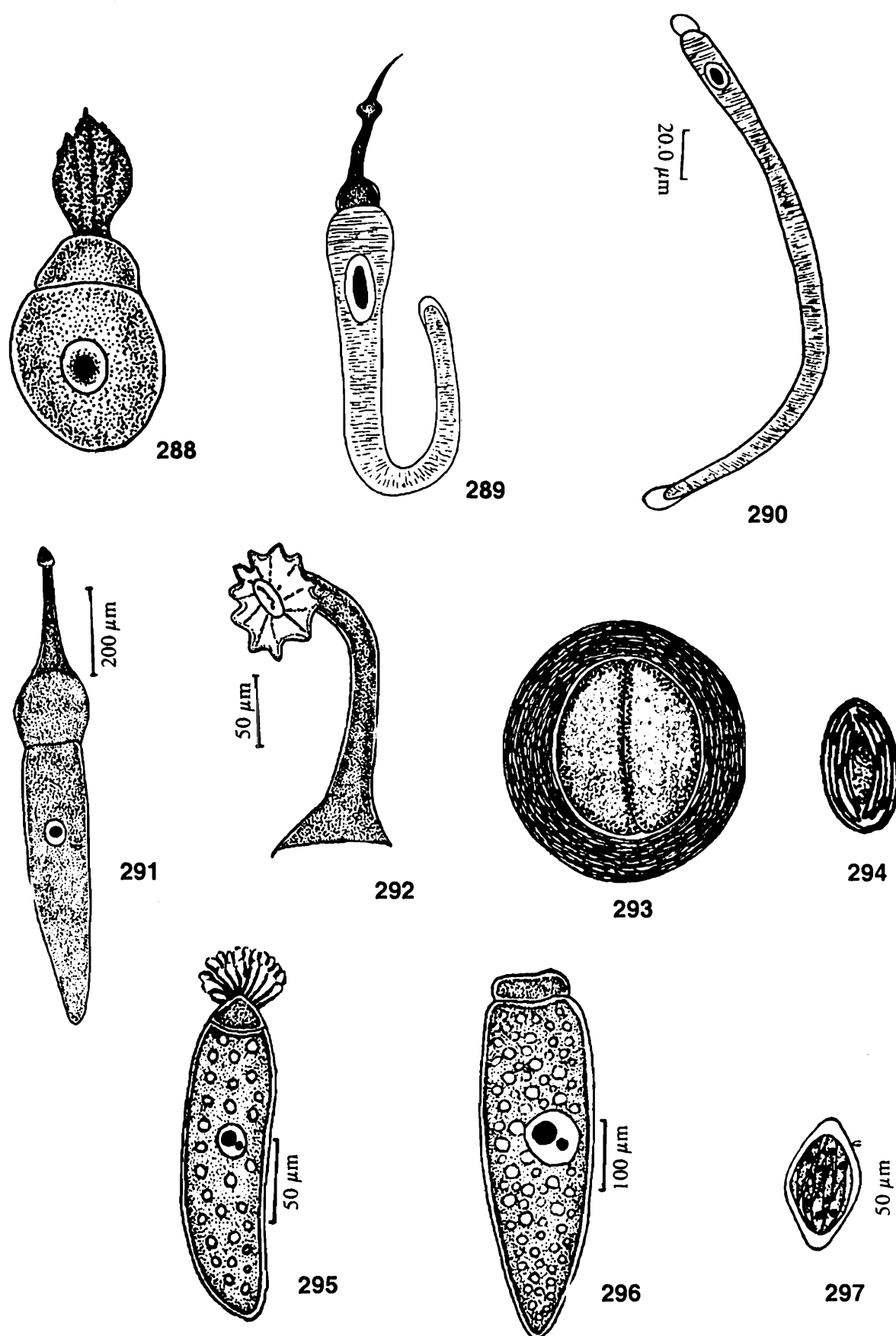
Genus ***Acanthogregarina*** Kalavati,
Narasimhamurti and Vidyullatha Devi, 1988

1988. *Acanthogregarina* Kalavati, Narasimhamurti and Vidyullatha Devi, *Vest. Ces. Spolec. Zool.*, 52 : pp. 245-249.

Diagnosis : As in the key.

192. ***Acanthogregarina hoshidei*** Kalavati, Narasimhamurti and
Vidyullatha Devi, 1988
(Figs. 298-302)

1988. *Acanthogregarina hoshidei* Kalavati, Narasimhamurti and Vidyullatha Devi, *Vest. Ces. Spolec. Zool.*, 52 : pp. 245-249.



Figs. 288-297. Gregarine parasites of Andhra Pradesh : 288-290. Sporadin, young cephalont and sporont of *Xiphocephalus rhytinotus* n.sp.; 291-294. *Actinocephalus bradinopygi* and 295-297. *Anthorhynchus hanumanthi*.

Material examined : Sev. exs., N. Vidyullatha Devi, March-August, 1981, Visakhapatnam, Visakhapatnam district.

Diagnosis : Early development was intraepithelial; epimerite complex in the form of a disc with a small stalk and 14 peripheral indentations arranged in 2 whorls of 7 each; cephalonts $150\text{--}298\text{ }\mu\text{m} \times 70\text{--}120\text{ }\mu\text{m}$; protomerite typically dome-shaped; sporonts $169\text{--}323\text{ }\mu\text{m} \times 45\text{--}169\text{ }\mu\text{m}$ in size, bioassociative, association caudo-frontal; gametocysts spherical, transparent, gametes isogamous, $4.0\text{ }\mu\text{m}$ in diameter, dehiscence by rupture at specific areas; spore ducts absent; oocysts cylindrical with thickened poles, $24\text{ }\mu\text{m} \times 16.0\text{ }\mu\text{m}$.

Host : *Leiogryllus* sp.; site of infection : gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Genus Harendraia Sarkar, 1984

1984. *Harendraia* Sarkar, Arch. Protistenkd., 128 : pp. 273-281.

Diagnosis : As in the key.

193. *Harendraia murtii* n. sp.

(Figs. 303 & 304)

(Syn. *Harendraia* sp. Prasada Rao, 1991)

1991. *Harendraia* sp., Prasada Rao, M. Phil Dissertation (unpublished), Andhra University, India.

Type slides : Holotype Har. 1; Paratype Har 2&3, Protozoology laboratory, Andhra University.

Material examined : Sev. exs., January 1987, Prasada Rao, Visakhapatnam, Visakhapatnam district.

Diagnosis : Gamonts solitary; trophozoites $100\text{--}120\text{ }\mu\text{m} \times 20\text{--}28.6\text{ }\mu\text{m}$ in size; epimerite highly complex, bowl-like having a bulb-like round base, narrow elongated neck and truncated apex beset with 8–10 fine, short, slender symmetrical filaments arranged in 2 groups on either side; protomerite dome-shaped, a distinct short hyaline neck between epimerite and protomerite; deutomerite long cylindrical with a tapering posterior end; sporadins elongated. $180.0\text{--}200.0\text{ }\mu\text{m} \times 28.0\text{--}36.0\text{ }\mu\text{m}$; gametocysts oval, $120\text{--}150\text{ }\mu\text{m} \times 90\text{--}110\text{ }\mu\text{m}$; oocyst ellipsoidal, $9.0\text{ }\mu\text{m} \times 5.6\text{ }\mu\text{m}$ in size.

Host : *Gallerucida bicolor* (Coleoptera, Insecta); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : This is the second species under the genus *Harendraia*. It differs from the only described species *H. intricata* Sarkar, 1984 in the size of the trophozoites ($100\text{--}120\text{ }\mu\text{m} \times 20\text{--}28.6\text{ }\mu\text{m}$) and sporadins ($180.0\text{--}200.0\text{ }\mu\text{m} \times 28.0\text{--}36.0\text{ }\mu\text{m}$) being much smaller than

H. intricata (trophozoites 87.3–246.3 μm x 20.0–83.5; sporadins, 31.2–334.0 μm x 12.5–104.4 μm) and larger (120–50 μm x 90–110 μm) than *H. intricata* in the size of the gametocyst (90–108 μm). Besides, the epimerite had 8–10 filaments arranged in 2 groups and appears distinct. It is therefore considered different and new to science for which the name *Harendraia murtii* n. sp. is suggested in honour of Late Professor C.C. Narasimhamurti, Protozoologist from Andhra University.

Genus *Steinina* Leger and Duboscq, 1904

1904. *Steinina* Leger and Duboscq, *Arch. Protistenk.*, **4** : pp. 335-393.

Diagnosis : As in the key.

Key to the species

1. Epimerite small, knob-like at the tip of neck in the early stages, variable, flattened with wavy margins in mature forms *S. coptotermis*
2. Epimerite small, digitiform always embedded in an extension of epicyte *S. rodgii*

194. *Steinina coptotermis* Kalavati and Narasimhamurti, 1978

(Syn. *S. coptotermi* Kalavati and Narasimhamurti, 1978)

(Figs. 305-307)

1978. *Steinina coptotermi* Kalavati and Narasimhamurti, *Proc. Ind. Acad. Sci.*, **87** (12) : pp. 397-404.

Material examined : Sev. exs., C. Kalavati, November 1970, A.U. campus, Visakhapatnam, Visakhapatnam district.

Diagnosis : Cephalonts 150 μm x 70 μm ; epimerite small, knob-like at the tip of neck in the early stages, variable, flattened with wavy margins in mature forms; sporadins solitary, 350-450 μm x 50-150 μm ; deutomerite long; gametocysts spherical, 600-800 μm in diameter, ectocyst thin and gelatinous, gametes anisogamous, macrogametes spherical and microgametes elongate; oocysts hat-shaped, 8.0 μm x 3.2 μm in size.

Host : *Coptotermes heimi*; site of infection : mid gut.

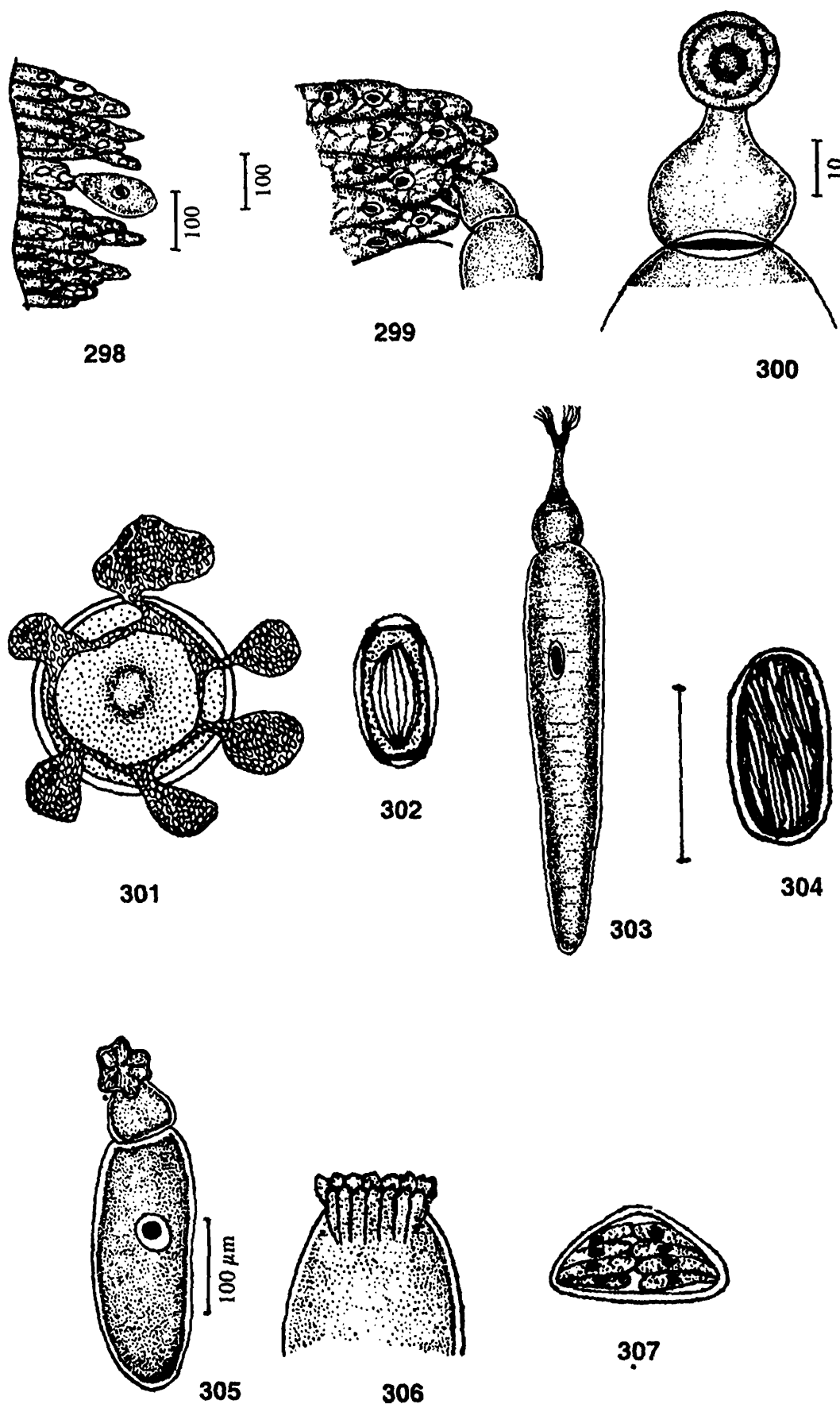
Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Kalavati and Narasimhamurthi (1978) described this species as *Steinina coptotermi*. Levine (1988) emended it as *Steinina coptotermis* following the Code of Zoological Nomenclature.

195. *Steinina rodgii* Patil and Amoji, 1986

(Figs. 308-312)

1986. *Steinina rodgii* Patil and Amoji, *Acta. Protozool.*, **25** (2) : pp. 213-218.



Figs. 298-307. Gregarine parasites of Andhra Pradesh : 298-303. *Acanthogregarina hoshidei*; 303-304. Trophozoite and oocyst of *Harendraia murtii* n. sp. and 305-307. *Steinina coptotermi*.

Material examined : Sev. exs., C. Kalavati, May-June, 1999, Visakhapatnam, Visakhapatnam district.

Diagnosis : Cephalonts 150 μm -x 70 μm ; epimerite small, digitiform always embedded in an extension of epicyte; protomerite hemispherical, LP : TL = 1 : 3.0 –3.8 WP : WD = 1 : 1.2; sporadions solitary; deutomerite long; gametocysts spherical, 130.0 μm –150.0 μm in diameter, gametes anisogamous; oocysts biconical, dehiscence by simple rupture.

Host : *Heliocorpis* sp. (Coleoptera, Insecta); site of infection : mid gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district); Karnataka (Gulbarga).

Remarks : Patil and Amoji (1986) originally described this species from *Scleron retteri*. *Heliocorpis* sp. is a new host record.

Subfamily ACANTHOSPORINAE Leger, 1892

1892. *Acanthosporinae* Leger, *Tabl. Zool.*, 3 : pp. 1-182.

Diagnosis : Oocysts with spines or thickenings at poles sometimes at equator and along edges.

Genus *Ancyrophora* Leger, 1892

1892. *Ancyrophora* Leger, *Tabl. Zool.*, 3 : pp. 1-182.

Diagnosis : Epimerite as a head having flexible or rigid appendages forming hooks that may curve backwards, oocysts biconical with polar knobs and equatorial spines.

196. *Ancyrophora ceriagrioni* Nazeer Ahmed and Narasimhamurti, 1979 (Figs. 313-316)

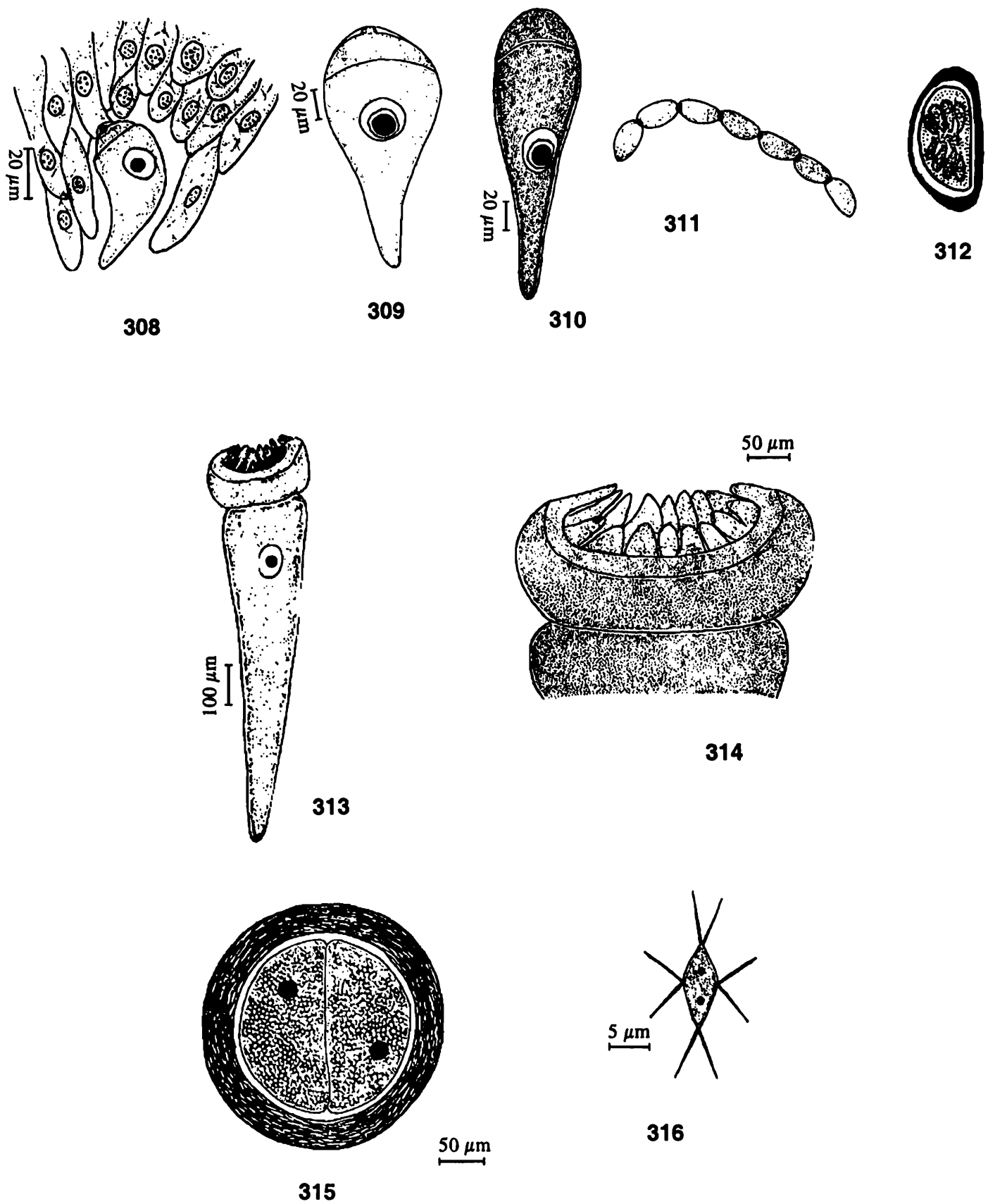
1979. *Ancyrophora ceriagrini* Nazeer Ahmed and Narasimhamurti, *Acta Protozool.*, 18 (3) : pp. 441-450.

Material examined : Sev. exs., S. Nazeer Ahmed, August–October 1976, stream in Visakhapatnam and Kondakarla Lake, Anakapalle, Visakhapatnam district.

Diagnosis : Cephalonts elongate, cylindrical, measuring 900.0 μm x 200.0 μm ; epimeric complex in the form of a shallow cup, the margin of which produced into 17-22 digitiform process folding inwards when contracted; sporonts solitary; gametocysts spherical, 225-350 μm in diameter, ectocyst thick, dehiscence simple; oocysts biconical, 5.4-6.5 μm x 5.0-5.4 μm in size, with 4 polar spines, two at each pole and 4 equatorial spines two on each side.

Host : *Ceriagrion coromadelianum* (Fabr.); site of infection : mid gut.

Distribution : India : Andhra Pradesh, stream in Visakhapatnam and Kondakarla Lake, Anakapalle, Visakhapatnam district.



Figs. 308-316. Gregarine parasites of Andhra Pradesh : 308-312. *Steinina rodgii* and 313-316. *Ancyrophora ceriagrini*.

Remarks : While describing a new genus and a new species of gregarine, *Tetrameridionospora karnataki* from damelfly, *Agriocnemis* sp. Kori and Amoji (1985) transpositioned the present species, *Ancyrophora ceriagrioni* to the genus *Tetrameridionospora* Kori and Amoji 1985; which is characterised by oocysts with rows of meridional spines, as also listed by Levine (1988). However, this species *A. ceriagrioni* is retained herein until the type species, *T. karnataki* / type material is studied / reviewed.

Subclass COCCIDIA
Order EUCOCCIDA
Suborder ADELINA
Family ADELEIDAE

Diagnosis : Oocyst producing sporoblasts, each of which developing into a spore with two or four sporozoites; occurring typically in the gut epithelium of invertebrates.

Key to the genera

- 1(6) Oocysts with more than three sporocysts
- 2(3) Oocysts ovoid, with one side flattened; possessing 15-20 spherical sporocysts *Ganapatiella*
- 3(2) Oocysts spherical, subspherical, ellipsoidal or ovoid; possessing 3-20 or 6-48 sporocysts 4
- 4(5) Oocysts thin-walled with numerous flattened spores, each with two sporozoites *Adelea*
- 5(4) Oocysts thick-walled, spores spherical, comparatively small in number, occurring in the gut or coelom of arthropods and oligochaetes *Adelina*
- 6(1) Oocysts with three sporocysts, each with four or six (or more) sporozoites, occurring in insects *Chagasella*

Genus *Adelea* Schneider, 1875

1875. *Adelea* Schneider, *Arch. Zool. Exp.*, 4 : p. 493.

Diagnosis : Oocysts ellipsoidal or ovoid, thin-walled with 6-48 flattened sporocysts, each with two sporozoites; in chilopods and molluscs.

197. *Adelea hylospora* Narasimhamurti, 1960
(Figs. 317-321)

1960. *Adelea hyalospora* Narasimhamurti, *J. zool. Soc. India*, 12(1) : pp. 59-68.

Diagnosis : Schizonts of two kinds, both producing merozoites, developing into male and female gametocyte respectively; one type of schizonts producing 18-20 elongate and vermiform merozoites of $10.5-12\ \mu\text{m} \times 2.0\ \mu\text{m}$ in dimension, having nucleus with central karyosome, developing into macrogametocyte measuring $16\ \mu\text{m} \times 13.5\ \mu\text{m}$; 2nd type of schizonts lacking central karyosome in its nucleus, producing 14-16 merozoites, measuring $11-12\ \mu\text{m} \times 1.5-2.0\ \mu\text{m}$; female gametocyte ovoidal, $7\ \mu\text{m} \times 5\ \mu\text{m}$, in early stage, growing rapidly reaching a size of $30\ \mu\text{m} \times 14\ \mu\text{m}$, mature macrogametocyte ovoidal, $34\ \mu\text{m} \times 24\ \mu\text{m}$; male gametocyte elongated and vermiform, $10\ \mu\text{m} \times 25\ \mu\text{m}$, when fully grown microgametocyte either rounded or oval, $9\ \mu\text{m} \times 4\ \mu\text{m}$; unsegmented oocysts in faeces; oocysts bean-shaped, $36\ \mu\text{m} \times 21\ \mu\text{m}$, double walled, polysporocystid, germinating in 4 days at room temperature into 36-42 (exceptionally 48) sporoblasts; sporoblasts oval, disc-like, $7.5\ \mu\text{m} \times 5.25\ \mu\text{m}$, with outer hyaline epispor, lying in close contact with sporoblast wall; sporulation completed in about 8-10 days under laboratory conditions, each sporoblast developing into two sporozoites; sporozoites sausage-shaped, $11\ \mu\text{m} \times 2.5\ \mu\text{m}$, with hyaline cytoplasm.

Host : Centipede, *Rhysida longipes* site of infection: gut content.

Distribution : India: Andhra Pradesh (Waltair, Visapatnam district).

Genus *Adelina* Hesse, 1911

1911. *Adelina* Hesse, *Arch. Zool. Exp.*, **47**, p. ?

Diagnosis : Oocysts spherical or subspherical with thick wall, containing 3-20 spherical or ellipsoidal sporocysts, each with two sporozoites; in the gut or coelom of arthropods and oligochaetes.

Key to the species

1(2) Oocysts ovoid, $20-22\ \mu\text{m} \times 18-20\ \mu\text{m}$ in dimensions; octosporous *A. rayi*

2(1) Oocysts variable in size depending on the number of sporocysts (3-17) *A. dimidiata*

198. *Adelina dimidiata* (Schneider, 1885)

1885. *Klossia dimidiata* Schneider, *Tablettes zoologiques*. Poitiers, I.

1913. *Adelina dimidiata* (Schneider): Schellack, *Arb. K. Gesundheitsamte*, **45** : p. 260.

Diagnosis : Oocyst variable in size depending on the number (3-17) of sporocysts, giving rise to a number of sporoblasts by a budding process, leaving a large residual body; sporoblasts secreting spherical sporocysts ($15\ \mu\text{m}$ in diameter) containing two sporozoites without formation of a residual body; sporulation time about seven days; asexual reproduction by schizogony; schizonts producing 4-30 merozoites of varying in length from $3-21\ \mu\text{m} \times 1.8-2.5\ \mu\text{m}$; macrogametocyte with a finger-like process and with nucleus retaining its karyosome throughout; microgametocyte also producing finger-like process.

Host : Centipede, *Rhysida longipes*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Narasimhamurti (1960) reported this species on subsequent examination from the same host in which he recorded *Adelea hyalospora* from this state. However, this species is known to occur in the gut of *Scolopendra cingulata* and other myriapods (Wenyon, 1926).

199. *Adelina rayi* Narasimhamurti, 1977
(Figs. 322-325)

1977. *Adelina rayi* Narasimhamurti, *Proc. Indian Acad. Sci.*, **86B** : pp. 239-244, figs. 1-13.

Diagnosis : Oocyst ovoid, 20.0-22.0 μm x 18.0-20.0 μm , octosporous, dizoic with no oocyst residuum; two types of schizogony; macroschizonts developing with 80-100 macrozoites; microschizonts developing in the middle of the epithelium below the level of the host cell nuclei and producing 16 merozoites.

Host : Centipede, *Rhysida longipes*; site of infection: gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Genus *Chagasella* Machado, 1911

1911. *Chagasella* Machado, *Mem. Inst. Oswaldo Cruz.*, **3** : p. 108.

Diagnosis : Oocyst with three sporocysts, each with four or six or more sporozoites; in intestine of insects.

200. *Chagasella ganapatii* Narasimhamurti and Kalavati, 1968
(Figs. 326-328)

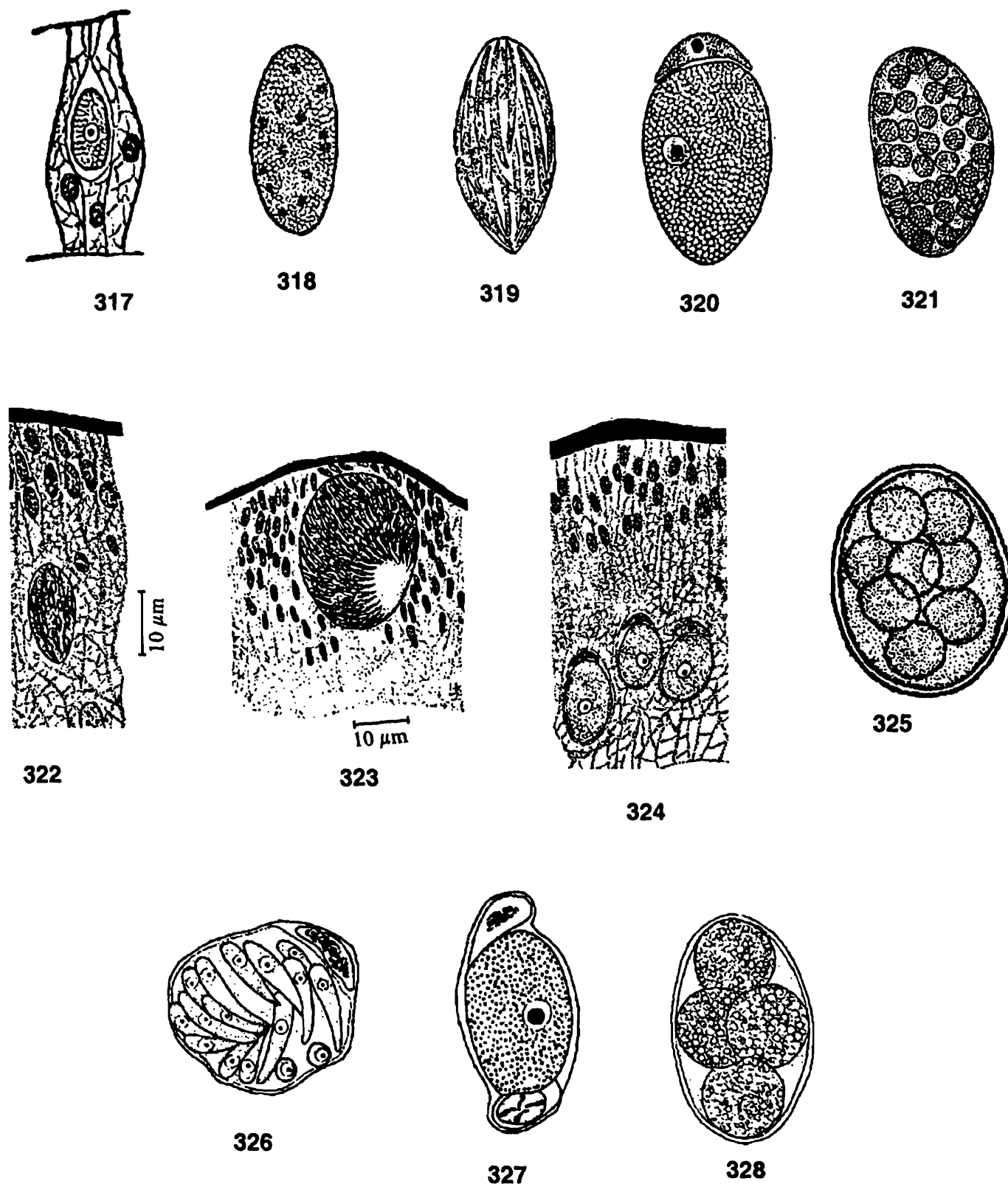
1968. *Chagasella ganapatii* Narasimhamurti and Kalavati, *Arch. Protistenk.*, **110** : p.426.

Material examined : Sev exs. Andhra University campus, Waltair, Visakhapatnam.

Diagnosis : Oocysts bean-shaped, thick-walled, measuring 22-25 μm x 10-13 μm ; usually with three and occasionally with four sporoblasts, each containing four sporozoites; sporoblasts rounded or oval, measuring 8.0-8.5 μm x 7.0-7.5 μm ; oocyst and sporocyst residuum absent; sporozoites measuring 9.5 μm x 2.5 μm ; schizonts of two types, large (13 μm x 11 μm) and small (8 μm x 7 μm), with 14 and 6 nuclei respectively; large schizonts, 16.5 μm x 14.0 μm , producing 16 elongated merozoites; female gametocyte round or oval of 5-3.5 μm in size; male gametocyte smaller of 3.0-2.5 μm in size; in the fully grown association stage male and female gametocytes measuring 9 μm x 3.5 μm and 18 x 4 μm respectively.

Host : Termite, *Odontotermes obesus* Rambur; site of infection: gut

Distribution : India : Andhra Pradesh (Visakhapatnam district).



Figs. 317-328. Coccidian parasites of Andhra Pradesh : 317-321. *Adelea hyalospora*, intraepithelial stage, schizont, merozoites, gametocytes, oocyst; 322-325. *Adelina rayi*, micromerozoites, macromerozoites, gametocytes, oocyst and 326-328. *Chagasella ganapatii*, merozoites, gametocytes, oocyst.

Genus *Ganapatiella* Kalavati, 1977

1977. *Ganapatiella* Kalavati, *Arch. Protistenk.*, **119** : pp. 217-223.

Diagnosis : Gamonts associated from an early stage, developing close association; microgamonts producing 8 comma-shaped microgametes; oocysts ovoid, with one side flattened, forming 15-20 sporoblasts, each of which becoming a spherical sporocyst containing 2 elongate sporozoites.

201. *Ganapatiella odontotermitis* Kalavati, 1977

(Syn. *Ganapatiella odontotermiti*)

(Figs. 329-332)

1977. *Ganapatiella odontotermiti* Kalavati, *Arch. Protistenk.*, **119** : pp. 217-

Materials examined : Sev. exs., C. Kalavati, Visakhapatnam

Diagnosis : Gametocytes associated from an early state, developing in close association, microgametocytes 9 μm , oval or pear-shaped, producing 8 “comma” shaped microgametes; oocysts oval with one side flattened, measuring 38.0-45.0 μm , with a thin tough transparent outer membrane; oocysts developing 15-20 sporoblasts, each containing 2 sporozoites; oocysts and sporocyst residuum present; female gametocyte measuring 27.0-34.2 μm x 18.0-21.0 μm ; sporulation time 21 days; sporozoite elongated 4.8 μm x 1.2 μm ; schizont 18.0 μm x 7.2 μm , with 24 nuclei; merozoites pear-shaped 3.5 μm x 2.5 μm .

Host : Termite, *Odontotermes obesus*; site of infection: adipose tissue.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Family HAEMOGREGARINIDAE

Diagnosis : Oocyst producing sporoblasts, each of which developing into a spore with two or four sporozoites; occurring in two hosts, circulatory system of vertebrates and digestive system of invertebrates.

Key to the genera

- 1(2) Oocysts with 8 or more naked sporozoites, infection of vertebrate host by bite of invertebrate, schizogony in erythrocytes of vertebrates *Haemogregarina*
- 2(1) Oocysts enormous with many sporocysts, each with 4-16 or more sporozoites, infection of vertebrate host by ingestion of invertebrate host, schizogony occurring in cells of liver, spleen and other organs of vertebrate *Hepatozoon*

Genus *Haemogregarina* Danilewsky, 1885

1885. *Haemogregarina* Danilewsky, *Arch. Mikr. Anat.*, **24** : pp. 588-598.

Diagnosis : Oocysts small, with 8 or more naked sporozoites without sporocysts formed from a single germinal centre; infection of vertebrate host by the bite of an invertebrate; schizogony occurring in erythrocytes of vertebrates; merogony ordinarily in internal organs of cold blooded vertebrate; sporogony in invertebrates; no sporokinetes.

Remarks : Members of this genus are parasites of aquatic vertebrates, including fishes, reptiles, and possibly amphians. Thus far, only leeches have been identified as intermediate hosts and vectors. Life cycles and vectors of the great majority of haemogregarine species are unknown. So in most cases their assignment to one or another of the four genera viz. *Haemogregarina*, *Karyolysus*, *Hepatozoon* and *Cyrrillia* belonging to the family Haemogregarinidae can not be considered more than tentative (Levine, 1982). As a practical matter, unless they are piroplasmids, malaria parasites, or related forms, most blood cell parasites of vertebrates are almost automatically called *Haemogregarina*.

Key to the species

- 1(2) Gametocytes relatively small, 11.5 μm x 4.5 μm , parasitic in turtles *H. ganapatii*
- 2(1) Gametocytes relatively large, parasitic in squamate reptiles 3
- 3(4) Gametocytes 14-15 μm x 4-5 μm in size, parasitic in snake *H. mirabilis*
- 4(3) Gametocytes 14.5 μm x 5.0 μm , parasitic in lizards *H. waltirensis*

202. *Haemogregarina ganapatii* Saratchandra, 1981 (Figs. 333 & 334)

1981. *Haemogregarina ganapatii* Saratchandra, *Proc. Indian Acad. Sci. Anim. Sci.*, **90** : pp. 365-371.

Diagnosis : Smallest trophozoite in the erythrocyte pear-shaped, 7 μm x 3 μm , with thin cell membrane and a few vacuoles in the cytoplasm; parasite measuring 8 μm x 3.8 μm showed first nuclear division, two nucleate schizont measuring 9.5 μm x 5.5 μm , largest erythrocytic schizont 11.5 μm x 6.5 μm containing 7 nuclei; schizogonic stages also occurring in lungs and liver; largest schizont measuring 11.0 μm x 9.5 μm in lungs and that of liver measuring 7.0 μm x 6.5 μm , both containing 24 nuclei; smallest gametocyte 6 μm x 3 μm , similar to trophozoite excepting that the cytoplasm non-vacuolated and nucleus much diffused, occupying $\frac{2}{3}$ of the cytoplasm; larger form 10.5 μm x 4 μm ; fully grown form sausage-shaped, 11.5 μm x 4.5 μm , with finely vacuolated cytoplasm; capsule absent.

Host : *Lissemys punctata granosa* (Sheopff); site of infection: blood, liver and lungs.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

203. *Haemogregarina mirabilis* Castellani and Willey, 1904

1904. *Haemogregarina mirabilis* Castellani and Willey, *Spolia Zeylanica*, **2** : p. 86.

Diagnosis : Gametocytes sausage-shaped, 14-15 μm x 4-5 μm ; cytoplasm non-vacuolated; nucleus 4.5-7.5 μm x 3.5-4.5 μm , with closely connected chromatin clumps enclosed in a thin nuclear membrane; macrogametocyte 12 μm in length, gregarine-like, elongated, slightly crescentic or reniform in shape, thick and bent; cytoplasm staining uniformly blue, leaving no clear pole; nucleus reddish blue, near the anterior pole; hypertrophy of host corpuscles; early schizonts 5-8 μm x 4-6 μm , containing 10-40 nuclei.

Host : Rat snakes, *Ptyas mucosus*; site of infection : blood.

Distribution : India : Andhra Pradesh (Gudivada, Krishna district).

Remarks : Saratchandra (1979, 1981) recorded this species from the above cited host from this state.

204. *Haemogrerina waltirensis* Saratchandra, 1981
(Figs. 335 & 336)

1981. *Haemogregarina waltirensis* Saratchandra, *Proc. Indian Acad. Sci. Anim. Sci.*, **90** : pp. 365-371.

Diagnosis : Smallest gametocytes sausage-shaped, 8.0 μm x 4.0 μm ; cytoplasm vacuolated with pink-stained granules aggregated at one or both poles; nucleus 2.5 μm x 1.6 μm ; later stages of parasite cigar-shaped with broader end containing vacuolated cytoplasm and the other narrower end with non-vacuolated cytoplasm; largest form 14.5 μm x 5.0 μm , sausage-shaped, with nucleus 4.8 μm x 4.5 μm ; capsule absent; schizogony in liver, lungs and bone marrow; largest schizont 14.0 μm x 11.0 μm in liver.

Host : Lizard, *Calotes versicolor* (Daudin); site of infection: blood, liver, lungs and bone marrow..

Distribution : India: Andhra Pradesh (Waltair, Visakhapatnam district).

Genus *Hepatozoon* Miller, 1908

1908. *Hepatozoon* Miller, U.S. Treasury Department Hygienic Laboratory, *Bull.* No. 46.

Diagnosis : Large oocysts containing many sporocysts, each with 4-16 or more sporozoites; infection of vertebrate host by ingestion of invertebrate host; vertebrate hosts amphibians, reptiles, birds and mammals; invertebrate hosts mites, ticks, insects and leeches; gamonts in erythrocytes or leucocytes; merogony in vertebrate internal organs; sporogony in invertebrate host; no sporokinetes.

205. *Hepatozoon canis* (James, 1905)

1905. *Leucocytozoon canis* James, *Brit. Med. J.* **1** : 1361.

1926. *Hepatozoon canis* : Wenyon, *Protozoology*, p. 1091.

Diagnosis : Large oocysts about 100 μm in longest diameter, containing 30-50 sporocysts of 15-16 μm in length; each sporocyst with about 16 sporozoites and a residual body; sporozoites 14-15 μm in length; schizonts occurring in spleen, liver, and bone marrow; small merozoites in leucocytes.

Host : Dog, *Canis familiaris*; site of infection; blood spleen etc.

Distribution : India : Andhra Pradesh.

Elsewhere : Malaya, Indochina, Singapore, Central Africa, North Africa, Middle East Italy.

Remarks : Rao *et al.* (1986) reported this species from this state. It may cause serious disease and affected dogs may die in 4 to 8 weeks (Levine, 1967).

Suborder EIMERINA

Family SELENOCOCCIDIIDAE

Diagnosis : Meronts develop as vermicules in host intestinal lumen; meronts with myonemes and a row of nuclei; gametic differentiation on the borderline between Coccidida and Gregarinida.

Genus *Selenococcidium* Leger and Duboscq, 1910

1910. *Selenococcidium* Leger and Duboscq, *Arch. Zool. Exp. Gen.*, 5 : p. 187.

Diagnosis : With the characters of the family, parasitic in lobsters; nucleus of vermiform trophozoites producing eight nuclei.

206. *Selenococcidium indicus* Aravindan, Kalavati and Sheeja, 2002

2002. *Solenococcidium indicus* Aravindan, Kalavati and Sheeja, *J. Expt. Zool. India*, 5(1) : pp. 17-24.

Materials examined : Sev. exs., C. Kalavati, Kakinda Bay, East Godavari.

Diagnosis : Motile, vermiform trophozoites with 6-8 nuclei, measuring 60-70 μm x 5-8 μm , occurring in the lumen of the gut; schizonts 35.0-42.8 μm x 30-38 μm in size, with varying number of nuclei, inhabiting in epithelial cells; merozoites eight, slender, long, 50-60 μm x 3.8-5.4 μm in size; macrogametocytes large, oval, 35.8 x 42.6 μm , with cytoplasm filled with numerous vesicles and a distinct, vesicular nucleus containing central endosome; microgametocytes oval, 20 μm x 24.6 μm , with several dot-like irregularly distributed nuclei.

Host : Prawn, *Penaeus indicus*; site of infection: gut.

Distribution : India : Andhra Pradesh (Kakinada Bay, East Godavari district).

Remarks : The generic name of this parasite appeared in the original paper as *Solenococcidium* instead of *Selenococcidium*.

Family AGGREGATIDAE

Diagnosis : Anisogamy resulting in production of zygotes which transforming into many spores, each with two to thirty sporozoites; in schizogony cytomeres first appeared and then merozoites; alternation of generations and of marine annelid, mollusc and crustacean hosts.

Genus *Aggregata* Frenzel, 1885

1885. *Aggregata* Frenzel, *Arch. Mikr. Anat.*, **24** : p. 545.

Diagnosis : Oocysts large, with many sporocysts, each with 3-28 sporozoites; heteroxenous, with merogony in decapod crustacean and gamogony in a cephalopod host.

207. *Aggregata kudoï* Narasimhamurti, 1979
(Figs. 337-339)

1979. *Aggregata kudoï* Narasimhamurti, *Angew. Parasitol.*, **20** : pp. 154-158.

Diagnosis : Oocysts large, measuring 0.5-1.0 μm in diameter, with a thin wall; number of sporoblasts very large, each sporoblast measuring 9.4-10.8 μm in diameter; sporocysts giving rise to 6 sporozoites; a few abnormal sporocysts measuring 13.2-14.5 μm and producing 12 sporozoites occasionally; female gametocytes 12.0 μm x 6.0 μm having coarsely alveolated cytoplasm, largest female parasite measuring 260 x 180 μm and oval in shape; largest male gametocytes 120 μm x 80 μm , varying greatly in size; microgamete long, 30-40 μm in length, and filamentous, having two flagella and an elongated nucleus.

Host : Cephalopod, *Sepia elliptica*; site of infection: proximal gut epithelium.

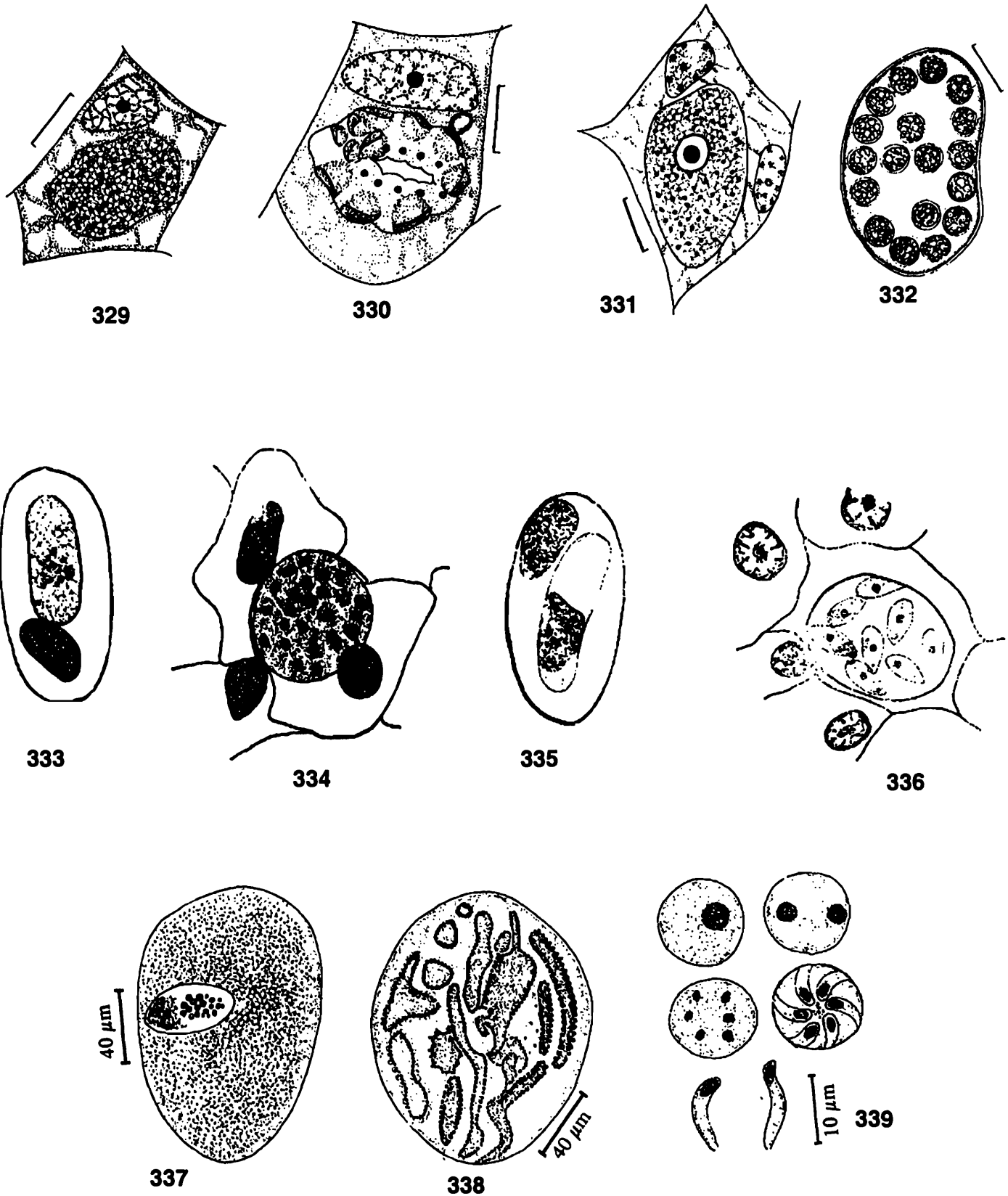
Distribution : India : Andhra Pradesh (Offshore fishery station, Visakhapatnam district).

Family EIMERIIDAE

Diagnosis : Monoxenous; schizogony and gametogony within host cells, and sporogony ordinarily occurring outside the host's body; oocysts and schizonts lack attachment organ; oocysts containing 0, 1, 2, 4, or many sporocysts, each containing one or more sporozoites.

Key to the genera

- 1(2) Monosporoblastic, tetrazoic oocysts *Mantonella*
- 2(1) Disporoblastic, dizoic or tetrazoic oocysts 3
- 3(4) Two sporocysts, each with two sporozoites *Eimeria*
- 4(3) Two sporocysts, each with four sporozoites *Isospora*



Figs. 329-339. Coccidian parasites of Andhra Pradesh : 329-332. *Ganapatiella odontotermi* (Schizont, merozoites; gametocytes, oocyst); 333-334. *Haemogregarina ganapatii* (gametocyte in R.B.C, merozoites in lung); 335-336. *H. waltirensis* (gametocyte in R.B.C, merozoites in liver) and 337-339. *Aggregata kudoi* (macrogametocyte, microgametocyte, stages of sporogony).

Genus *Eimeria* Schneider, 1875

1875. *Eimeria* Schneider, *Arch. Zool. Exp. Gen.*, 4 : p. 473.

Diagnosis : Each oocyst with 4 sporocysts, each sporocyst with two sporozoites; merogony intracellular; parasitic in vertebrates and only in a few invertebrates.

Key to the species of *Eimeria* of centipedes

Oocysts spherical, 30-32 μm in diameter; sporoblasts 14 μm x 10 μm
.....*E. mecistophori*

Key to the species of *Eimeria* of reptiles

Oocysts spherical or oval, 16.5-20.5 μm x 14.5-18.5 μm ; sporocysts ovoid, 9-11 μm
x 7.5-8.5 μm *E. knowlesi*

Key to the species of *Eimeria* of birds

- 1(2) Oocyst wall striated, micropyle present*E. tenella*
- 2(1) Oocyst wall smooth
- 3(8) Oocyst double-walled
- 4(5) Oocystic residuum present *E. columbae*
- 5(4) Oocystic residuum absent
- 6(7) Oocyst nearly spherical or ovoid, micropyle prominent, sporocystic residuum present
.....*E. anatis*
- 7(6) Oocyst broad ovoid, micropyle absent *E. necatrix*
- 8(3) Oocyst single walled, micropyle and oocystic residuum absent, sporocystic residuum
present *E. brunetti*

Key to the species of *Eimeria* of mammals

- 1(12) Oocyst double layered
- 2(7) Micropyle present
- 3(6) Micropyle with micropylar cap
- 4(5) Oocyst elongate ellipsoidal, oocyst wall transparent, micropyle with a crescent-shaped
micropylar cap*E. arloingi*
- 5(4) Oocyst elongate ovoid, sometimes ellipsoid, oocyst wall with a smooth pinkish outer
layer, micropylar cap mound-shaped*E. tirupatiensis*

- 6(3) Micropyle without micropylar cap, oocyst broadly ovoid, smooth walled, polar granule, oocystic residuum absent *E. bovis*
- 7(2) Micropyle absent
- 8(9) Oocyst spherical to ovoidal, sporozoite 9 μm x 3 μm with a refractile granule *E. zuernii*
- 9(8) Oocyst ovoid to ellipsoidal or ellipsoidal to ovoidal, sporozoite without any refractile granule
- 10(11) Sporocyst ellipsoidal or ovoid, 14-18 μm x 6-8 μm , sporozoite elongated with two clear globules *E. deblickei*
- 11(10) Sporocyst ovoid, 4-11 μm x 4-6 μm , sporozoite with one end slender and pointed and the other end thick and rounded *E. ninakohlyakimovae*
- 12(1) Oocyst not double layered
- 13(14) Oocyst spherical to ovoid, 19-23 μm x 17-22 μm , micropyle with a micropylar cap present *E. crandalis*
- 14(13) Oocyst ovoid, 25-35 μm x 18-24 μm , micropyle at the narrower end without any cap *E. faurei*

A. *Eimeria* of centipedes

208. *Eimeria mecistophori* Narasimhamurti, 1976 (Figs. 340-344)

1976. *Eimeria mecistophori* Narasimhamurti, *Proc. Indian Acad. Sci. (B)*, **48**(4) : pp. 141-147, figs. 1-20.

Diagnosis : Oocysts perfectly spherical, 30.0-32.0 μm , containing 4 sporoblasts measuring 14.0 μm x 10.0 μm in diameter, each containing 2 sporozoites measuring 10.0-12.0 μm x 2.25-3.0 μm ; merozoites large, elongated or oval, females larger than males; macrogametocytes rounded measuring 30.0-32.0 μm in diameter, cytoplasm alveolated with a large quantity of reserved food materials; microgametocytes oval or rounded, 26.0-28.0 μm in diameter, giving rise to a large number of biflagellate, comma-shaped microgametes.

Host : Centipede, *Mecistophora punctifrons* Newp.; site of infection: gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

B. *Eimeria* of reptiles

209. *Eimeria knowlesi* Bhatia, 1936 (Figs. 345-349)

1936. *Eimeria knowlesi* Bhatia, *Curr. Sci.*, **5** : p.177.

Diagnosis : Oocysts spherical or oval, double-layered, without any micropyle and residuum, 16.5-20.5 (18.5) μm x 14.5-18.5 (16.5) μm ; sporocysts ovoid, 9.00-11.00 (10.0) μm x 7.5-8.5 (7.9) μm ; sporocystic residual mass in between the sporozoites; sporozoite elongated, 7.2 μm in length.

Host : House Lizard, *Hemidactylus flaviviridis* (Ruppell) and *Hemidactylus prashadi*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Saratchandra and Narasimhamurti (1981) studied the life cycle of this species occurring in the small intestine of a different host, *Hemidactylus prashadi* from Visakhapatnam, Andhra Pradesh. The oocysts observed by them were oval and much larger (28.6-30.8 μm x 28.4-29.7 μm) than those of *E. knowlesi* described by Bhatia (1936) from *Hemidactylus flaviviridis*.

C. *Eimeria* of birds

210. *Eimeria anatis* Scholtyseck, 1955

1955. *Eimeria anatis* Scholtyseck, *Arch. Protistenk.*, **100** : p. 431.

1987. *Eimeria anatis*: Mandal: *Fauna of India: Protozoa: Sporozoa: Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 297.

Material examined : Sev. exs., Nalgonda, 29.i.03, R. Nandi.

Diagnosis : Oocyst nearly spherical or ovoid with a truncated end and a smooth double contoured wall of 1 μm thick, measuring 15-19 (16.9) μm x 11-15 (14.3) μm , outer layer colourless and thick, inner layer straw coloured; with a prominent micropyle, measuring 4 μm wide, oocystic residuum absent, with one or two polar granules; sporocyst ovoid with one pointed end, measuring 8-10 μm in length and 5-6.6 μm in width, stieda body absent, sporocystic residuum present; sporozoite elongated-pyiform, measuring 6-7 μm in length and 2.7 μm in width with one narrower end and the other end broadly rounded, with two refractile globules.

Host : Domestic duck, *Anas platyrhynchos*; site of infection : intestine.

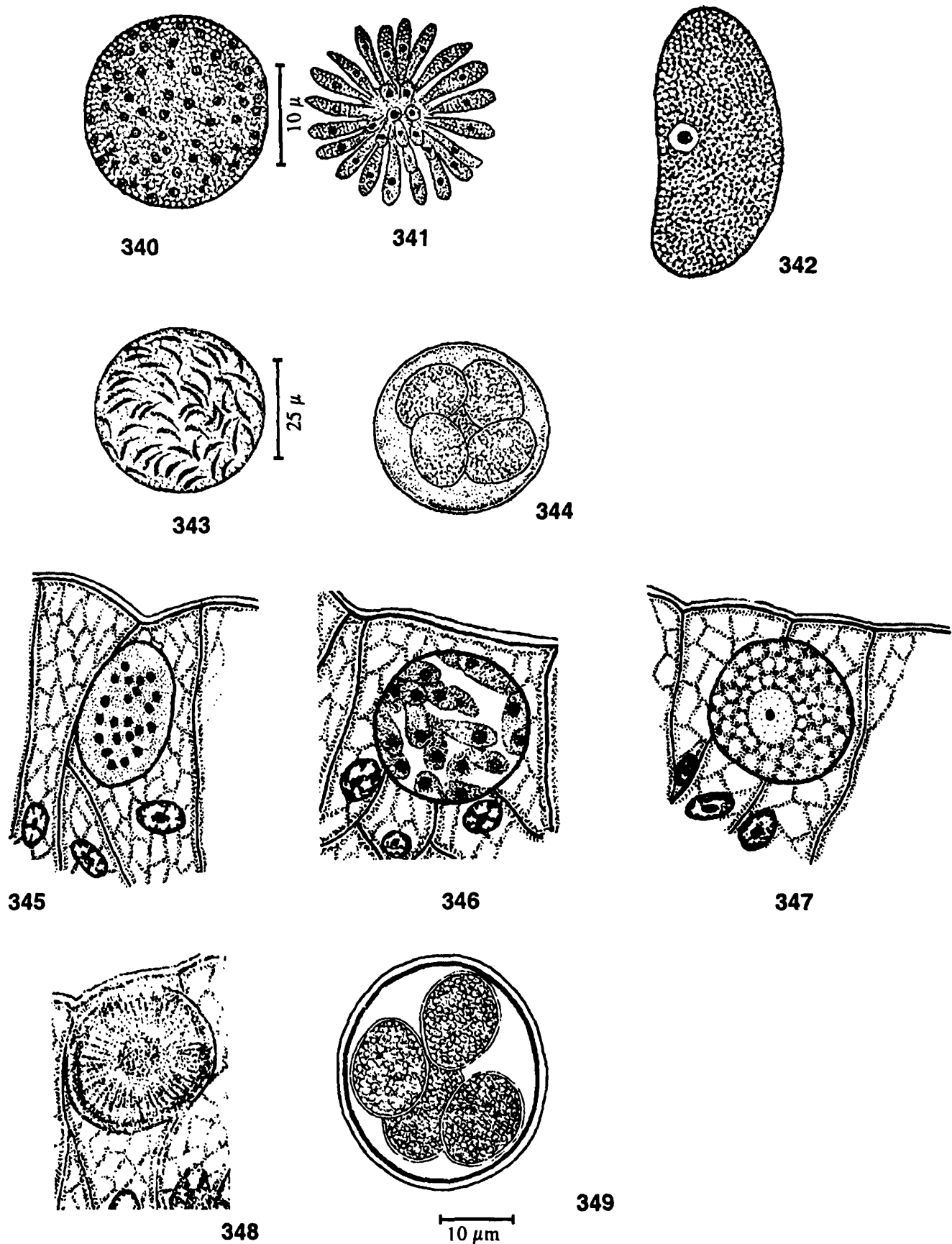
Distribution : India : Andhra Pradesh (Nalgonda district).

211. *Eimeria brunetti* Levine, 1942

1941. *Eimeria brunetti* Levine, *Cornell vet.*, **32** : p. 430.

1987. *Eimeria brunetti* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 172.

Material examined : Sev. exs., Mulug, Warangal district, 8.ii.03, R. Nandi.



Figs. 340-349. Coccidian parasites of Andhra Pradesh : 340-344. *Eimeria mecistophori* (schizont, merozoites, macrogametocyte, microgametocyte, oocyst and 345-349. *E. knowloesi* (schizont, merozoites, macrogametocyte, microgametocyte, oocyst).

Diagnosis : Oocyst oval, smooth, thin-walled, measuring 20.7-30.3 (26.8) μm x 18.1-24.2 (21.7) μm ; with polar granule; micropyle and oocystic residuum absent; sporocyst elongate ovoid, 11-16 μm x 5-10 μm , with a stieda body, sporocystic residuum present.

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

Distribution : India : Andhra Pradesh (Warangal district), Uttar Pradesh, Madhya Pradesh.

Remarks : This species is pathogenic, but its effects depend upon the degree of infection. This species is also reported to occur in and around Hyderabad city along with *E. necatrix* and *E. tenella* in poultry birds.

212. *Eimeria columbae* Mitra and Das gupta, 1937

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

1987. *Eimeria columbae*: Mandal: *Fauna of India: Protozoa: Sporozoa: Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 176.

Material examined : Sev. exs., Shantinagar, Hyderabad district, 10.ii.03, R. Nandi.

Diagnosis : Oocyst subspherical, double walled, outer wall thinner and membranous, 14.5-17.5 (16.5) μm x 13.5-15.5 (14.5) μm , shape index 1.14; micropyle absent, oocystic residuum present; sporocyst ellipsoidal without any knob, 6.5-8.5(7.3) μm x 3.5-5.8(4.6) μm , shape index 1.6, sporocystic residuum present as scattered mass; sporozoites curved with one end pointed and the other end rounded; schizont 4.1 μm in diameter; macrogamete 6.1 μm in diameter.

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

Distribution : India : Andhra Pradesh (Hyderabad district). *E. columbae* in pigeons is common in occurrence in and around Hyderabad city (pers. com.).

213. *Eimeria necatrix* Johnson, 1930

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

1987. *Eimeria necatrix* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 203.

Material examined : Sev. exs., Suriapet, Nalgonda district, 28.i.03, R. Nandi; sev. exs., Huzurnagar, Nalgonda district, 30.i.03, R. Nandi.

Diagnosis : Oocyst broad ovoid in shape, one end less pointed, measuring 15.3-23.3 (20.5) μm x 13.6-20.2 (16.8) μm ; shape index 1.0-1.6 (1.26); oocyst wall smooth and double contoured; micropyle and oocystic residuum absent; sporocysts elongated, each measuring 10 μm in length and 6 μm in width; a polar body present.

Host : Domestic Fowl, *Gallus domesticus*; site of infection: intestine.

Distribution : India : Andhra Pradesh (Nalgonda district).

214. *Eimeria tenella* (Railliet and Lucet, 1891)

1891. *Eimeria avium* auct., *Coccidium tenellum* Railliet and Lucet, *Bull. Soc. Zool. Fr.*, **16** : p. 246.

1987. *Eimeria tenella*: Mandal: *Fauna of India: Protozoa: Sporozoa: Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 213.

Material examined : Sev. exs., Khammam, Khammam district, 31.i.03, R. Nandi.

Diagnosis : Oocyst broad-ovoid, 19.2-26 μm x 16-22 μm , oocystic wall striated, micropyle present; sporocyst measuring 11 μm x 7 μm , stieda body present; sporozoites elongated banana-shaped, 5-8 μm in length; mature schizont 42.5 μm x 37.5 μm , merozoite 6.5 μm in length.

Host : Domestic Fowl, *Gallus domesticus*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Khammam district), Uttar Pradesh, Madhya Pradesh, Tamil Nadu, West Bengal.

Elsewhere : Cosmopolitan.

Remarks : This is the most pathogenic of the chicken coccidia and is responsible for heavy losses in poultry farms. Padmavathi and Muralidharan (1987) and Padmavathi *et al.* (1988) made experimental studies regarding clinico-pathological and some histochemical features as well as immunological responses due to *E. tenella* from the College of Veterinary Sciences, Hyderabad.

D. *Eimeria* of mammals215. *Eimeria arloingi* (Marotel, 1905)
(Fig. 350)

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

1987. *Eimeria arloingi* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 229.

Material examined : Sev. exs., Nalgonda, 29.i.03, R. Nandi; sev. exs. Kottagudem, Khammam district, 3.ii.03, R. Nandi; sev. exs., Warangal, 5.ii.03, R. Nandi; sev. exs., Hyderabad, 12.ii.03, R. Nandi.

Diagnosis : Oocyst elongate ellipsoidal, asymmetrical or slightly ovoid, 17-42 (27) μm x 13-27 (18) μm , oocyst wall transparent, double layered, micropyle with a crescent-shaped micropylar cap present, a polar granule present, oocyst residuum absent; sporocyst elongate ovoid, 11-17 μm x 6-10 μm , stieda body absent or vestigial, sporocyst residuum present; sporozoite elongated.

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

Distribution : India : Andhra Pradesh (Nalgonda, Warangal, Khammam and Hyderabad districts), Haryana, Uttar Pradesh, Maharashtra, Bihar.

Elsewhere : Cosmopolitan.

Remarks : This species is slightly pathogenic.

216. *Eimeria bovis* (Zublin, 1908)
(Fig. 351)

1908. *Coccidium bovis* Zublin (in partim), *Schweizer. Arch. Treihelk.*, **50** : p.123.

1987. *Eimeria bovis* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 239.

Material examined : Sev. exs., Nalgonda, 29.i.03, R. Nandi; sev. exs., Madhira, Khammam district, 1.ii.03, R. Nandi; sev. exs., Mulug, Warangal, 5.ii.03, R. Nandi; sev. exs., Hyderabad, 10.ii.03, R. Nandi.

Diagnosis : Oocyst broadly ovoid, smooth walled, double layered, with a narrower micropylar end, measuring 23-33 (28) μm x 15-26 (21) μm in dimension; micropylar cap, polar granule and oocystic residuum absent; sporocyst elongate ovoid, 15-17 μm x 6-7 μm , stieda body and sporocystic residuum present; sporozoite elongated, banana-shaped, measuring 13 μm x 3 μm , with two refractile granules.

Host : Buffalo, *Bubalus bubalis* Linn.; site of infection: intestine.

Distribution : India : Andhra Pradesh (Nalgonda, Khammam, Warangal and Hyderabad districts), Haryana, Uttar Pradesh, Maharashtra, Bihar.

Elsewhere : Cosmopolitan.

217. *Eimeria crandallis* Honess, 1942
(Fig. 352)

1942. *Eimeria crandallis* Honess, *Univ. Wyo. Agric. Expt. Sta.*, **249**, p. 3.

1987. *Eimeria crandallis* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 258.

Material examined : Sev. exs., Huzurnagar, Nalgonda, 30.i.03, R. Nandi; sev. exs. Madhira, Khammam district, 1.ii.03, R. Nandi; sev. exs., Hyderabad, 12.ii.03, R. Nandi.

Diagnosis : Oocyst spherical to broadly ellipsoidal to ovoid, 17-23 (21.9) μm x 17-22 (19.4) μm , a micropyle and micropylar cap present, oocyst residuum absent; sporocyst ovoid, 8-11 μm x 5-8 μm , with no stieda body, sporocyst residuum usually present; sporozoite with one or two clear globules.

Host : Domestic sheep, *Ovis aries*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Nalgonda, Khammam and Hyderabad districts), Kashmir, Haryana, Uttar Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu, Bihar, Orissa, West Bengal.

Elsewhere : Syria, Turkey, Poland, U.K., U.S.A.

Remarks : Besides *Eimeria crandallis* and *E. faurei* encountered in sheep in the present investigation, there are a few more species of *Eimeria* viz., *E. ahasta*, *E. arloingi*, *E. intricata*, *E. ninakohlyakimovae* and *E. parva* recorded in sheep from this state. The ovine coccidiosis causes thickening and oedema of the small intestine (pers. comm.) These species are observed by veterinary parasitologists but not communicated.

218. *Eimeria deblicieki* Douwes, 1921

1921. *Eimeria deblicieki* Douwes, *Bijdrage tot de kennis van enkele darmprotozoen der huisdieren in het bijzonder bij schaap en varken*, Diss., Utrecht, p. 62.

1987. *Eimeria deblicieki*: Mandal: *Fauna of India: Protozoa: Sporozoa: Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 264.

Material examined : Sev. exs., Nalgonda, 29.i.03, R. Nandi; sev. exs. Kottagudem, Khammam district, 3.ii.03, R. Nandi; sev. exs., Warangal, 5.ii.03, R. Nandi; sev. exs., Hyderabad, 12.ii.03, R. Nandi.

Diagnosis : Oocyst ovoid to ellipsoidal or spherical, smooth walled, double layered, 13-29 μm x 13-19 μm ; micropyle, polar granule and oocystic residuum absent; sporocyst ellipsoidal or ovoid, 14-18 μm x 6-8 μm , stieda body and sporocystic residuum present; sporozoite elongated with two clear globules.

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

Distribution : India : Andhra Pradesh (Nalgonda, Khammam, Warangal and Hyderabad districts), Haryana, Madhya Pradesh and Uttar Pradesh.

Remarks : this species is slightly pathogenic, but it may cause diarrhoea and even death of young pigs.

219. *Eimeria faurei* (Moussu and Marotel, 1902) (Fig. 353)

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

1987. *Eimeria faurei*: Mandal: *Fauna of India: Protozoa: Sporozoa: Eucoccidiida: Eimeriidae*, Zoological Survey of India, Calcutta, p. 269.

Material examined : Sev. exs., Khammam, 31.i.03, R. Nandi;

Diagnosis : Oocyst ovoid, 25-35 (28.9) μm x 18-24 (21.0) μm , conspicuous micropyle at the narrower end with no cap, oocyst residuum absent, polar granule present; sporocyst

ellipsoidal, 15-17 μm x 8-10 μm , sporocyst residuum scattered, stieda body absent; sporozoite elongated.

Host : Domestic sheep, *Ovis aries*; site of infection: intestine.

Distribution: India: Andhra Pradesh (Khammam district), Punjab, Haryana Maharashtra, Madhya Pradesh, Uttar Pradesh, Orissa, West Bengal.

Remarks : This species is only mildly pathogenic.

220. *Eimeria ninakohlyakimovae* Yakimoff and Rastegaieff, 1930
(Fig. 354)

1930. *Eimeria ninakohlyakimovae* Yakimoff and Rastegaieff, *Arch. Protistenk.*, **70** : p. 185.

1987. *Eimeria ninakohlyakimovae* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 297.

Material examined : Sev. exs., Khammam, 31.i.03, R. Nandi; sev. exs., Hyderabad, 12.ii.03, R. Nandi.

Diagnosis : Oocyst ellipsoidal, spherical or ovoid, 16-27 (23.1) μm x 13-22 (18.3) μm ; oocyst wall thick, transparent and double layered; micropyle, micropylar cap, polar granule and oocyst residuum absent; sporocyst ovoid, 4-11 μm x 4-6 μm , with sporocyst residuum; sporozoite 4-5 μm x 2 μm , with one end slender and pointed and the other end thick and rounded; lying head to tail in the sporocyst.

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

Distribution : India: Andhra Pradesh (Khammam and Hyderabad districts); Punjab, Haryana, Madhya Pradesh, Uttar Pradesh, Orissa, West Bengal.

Elsewhere : Kazakhstan, Tunisia, Germany, United States.

Remarks: This is one of the most pathogenic species of coccidium in sheep.

221. *Eimeria tirupatiensis* Sivanarayan and Venkataratnam, 1969

1969. *Eimeria tirupatiensis* Sivanarayan and Venkataratnam, *Indian vet J.*, **46** : p. 447.

1987. *Eimeria tirupatiensis* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 69.

Diagnosis : Oocyst usually elongated ovoid, sometimes ellipsoid measuring 37-44 (40.1) μm x 25-31 (28.5) μm ; oocyst wall bilayered, with a smooth pinkish outer layer of about 1 μm thick and a brownish inner layer about 0.9 μm ; micropylar cap mound-shaped, 1.5-4 (2.2) μm high and 8.5-11 (9.4) μm wide; oocyst possessing one to three polar granules, but no residuum; ellipsoid or ovoid sporocyst, 11-16 (14.1) μm x 9-11 (9.6) μm , with a stieda body; sporozoites measuring 11-16 (13.7) μm x 4.5-7 (5) μm with a granular sporocystic residuum present between the sporozoites.

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

Distribution : India : Andhra Pradesh (Tirupati, Chittoor district).

222. *Eimeria zuernii* (Rivolta, 1878)
(Fig. 355)

1878. *Cryptosporidium zurnii* Rivolta, *Geor. Anat. Fisiol. Patol. Anim.*, Pisa, 4 : p.220.

1987. *Eimeria zuernii* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 338.

Material examined : Sev. exs., Suriapet, Nalgonda, 28.i.03, R. Nandi; sev. exs., Kottagudem, Khammam district, 3.ii.03, R. Nandi; sev. exs., Warangal, 5.ii.03, R. Nandi; sev. exs., Hyderabad, 10.ii.03, R. Nandi.

Diagnosis : Oocyst spherical, subspherical, bluntly ellipsoidal or ovoidal, smooth walled, double layered, 14-22 (17) μm x 13-19 (16) μm ; micropyle, micropylar cap, polar granule and oocystic residuum absent; sporocyst elongate ovoid, 8.0-10.5 μm x 5.0-7.0 μm , stieda body and sporocystic residuum present; sporozoite 9 μm x 3 μm , with a refractile granule.

Host : Cattle, *Bos indicus*; site of infection : intestine.

Distribution : India: Andhra Pradesh (Nalgonda, Khammam, Warangal and Hyderabad districts), Orissa, Uttar Pradesh, Haryana.

Elsewhere : cosmopolitan.

Genus *Isospora* Schneider, 1881

1881. *Isospora* Schneider, *Arch. Zool. Exp. Gen.*, 9 : p. 389.

Diagnosis : Oocysts with two sporocysts, each sporocyst with four sporozoites; usually parasitic in vertebrates.

Key to the species of *Isospora* of birds

- 1(2) Oocyst spherical or subspherical, sporocyst ovoid to pyriform with a button-shaped plug at narrower end, sporozoite bean-shaped *I. lacazei*
- 2(1) Oocyst spherical to broadly ovoidal, sporocyst oval with a small plug-like stieda body situated at the narrower end, sporozoite slender, slightly curved with refractile granules on either side of nucleus *I. rajuli*

Key to the species of *Isospora* of mammals

- 1(2) Oocyst spherical or ellipsoidal, of two sizes, larger ones 18-20 μm x 14-16 μm , smaller ones 10-14 μm x 7-9 μm , sporocyst ellipsoidal, 7.5-9.0 μm x 5-7 μm *I. bigemina*

- 2(1) Oocyst ovoid, large, 32-53 μm x 26-43 μm , sporocyst ellipsoid, 20-27 μm x 18-21 μm
 *I. felis*

A. *Isospora* of birds

223. *Isospora lacazei* (Labbe, 1893)

1893. *Diplospora lacazei* Labbe, *C. r. heb. Seanc. Acad. Sci.*, Paris, **117** : p.407.
 1893. *Isospora lacazei* Labbe, *C. r. heb. Seanc. Acad. Sci.*, Paris, **117** : p.407.
 1987. *Isospora lacazei* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 69.

Diagnosis : Oocyst spherical or subspherical, double walled, 24-32 (26.8) μm x 20-30 (27.4) μm , micropyle and oocystic residuum absent; sporocyst ovoid to pyriform with a button-shaped plug at the narrow anterior end, 14-22 (17.2) μm x 10-11 (10.3) μm , sporocyst residuum present; sporozoite bean-shaped, 8.5 μm x 2.3 μm in size.

Host : Sparrow, *Passer domesticus*; site of infection : intestine.

Distribution : India : Andhra Pradesh, West Bengal : cosmopolitan in distribution.

Remarks : Satyanarayancharulu *et al.* (1971) reported this species as *Isospora lacazei* var. *indicus* in a sparrow. The new variety 'indicus' is not accepted as valid due to worldwide distribution of the species (Mandal, 1987).

224. *Isospora rajuli* Satyanarayanacharulu, Subba Rao and Christopher, 1969

1969. *Isospora rajuli* Satyanarayanacharulu, Subba Rao and Christopher, *Indian J. Microbiol.*, **9** : pp. 121-122.
 1987. *Isospora rajuli* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 82.

Diagnosis : Oocysts spherical to broadly ovoidal, 19.2-34.4 (26.24) μm x 17.4-26.6 (21.84) μm , with both ends rounded; oocyst wall smooth, double-layered and colourless; micropyle inconspicuous or absent; oocystic residuum absent; sporocyst oval, 14.8-20.2 (17.4) μm x 11.2-13.4 (12.2) μm , with a small plug-like stieda body situated at the narrower end; sporocystic residuum present; sporozoites slender, slightly curved, measuring 10-14 (12.2) μm in length and 3-5 (4.2) μm in width, with a compact centrally located nucleus and refractile globules on either side of the nucleus.

Host : Mynah, *Acridotheres tristis tristis* (Linn.); site of infection : intestine.

Distribution : India : Andhra Pradesh (Tirupati, Chittoor district).

Remarks : Satyanaranacharullu, Subba Rao and Christopher (1969) reported this species from the abovesited host from this state.

B. *Isospora* of mammals**225. *Isospora bigemina* (Stiles, 1891)**

1891. *Coccidium bigeminum* Stiles (partim), *Bull. Soc. Zool., Fr.*, **16** : p.163.

1987. *Isospora bigemina* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 95.

Diagnosis : Oocyst spherical or ellipsoidal, thin walled, single layered, colourless, of two sizes : larger ones 18-20 μm x 14-16 μm , and the smaller, more common ones 10-14 μm x 7-9 μm , micropyle, oocyst polar granule and oocyst residuum absent; sporocyst ellipsoidal, 7.5-9.0 μm x 5-7 μm , without a stieda body, sporocyst residuum present.

Host : White Alsatian pup; site of infection: intestine (faeces).

Distribution : India : Andhra Pradesh (Kakinada, East Godavari district), Tamil Nadu, Uttar Pradesh.

Remarks : Rao (1968) recorded this species as a case report from the District Veterinary Clinical Laboratory, Kakinada, Andhra Pradesh. This species is markedly pathogenic for both cats and dogs (Levine, 1967).

226. *Isospora felis* (Wenyon, 1923)
(Fig. 356)

1904. *Diplospora bigemina* Wasielewsky (partim), *Stuien und Mikrophotogramme zur Kenntnis der pathogennen Protozoen*, Leipzig.

1923. *Isospora felis* Wenyon, *Ann. Trop. Med. Parasit.*, **17** : p. 231.

1987. *Isospora felis* : Mandal : *Fauna of India : Protozoa : Sporozoa : Eucoccidiida : Eimeriidae*, Zoological Survey of India, Calcutta, p. 82.

Diagnosis : Oocyst ovoid, measuring 32-53 (43) μm x 26-43 (33) μm in dimension, smooth walled, colourless, without a micropyle, polar granule and oocyst residuum; sporocyst ellipsoidal, 20-27 μm x 18-21 μm , sporocyst residuum present; sporozoite 10-15 μm long.

Host : White Alsatian pup; site of infection: intestine (faeces).

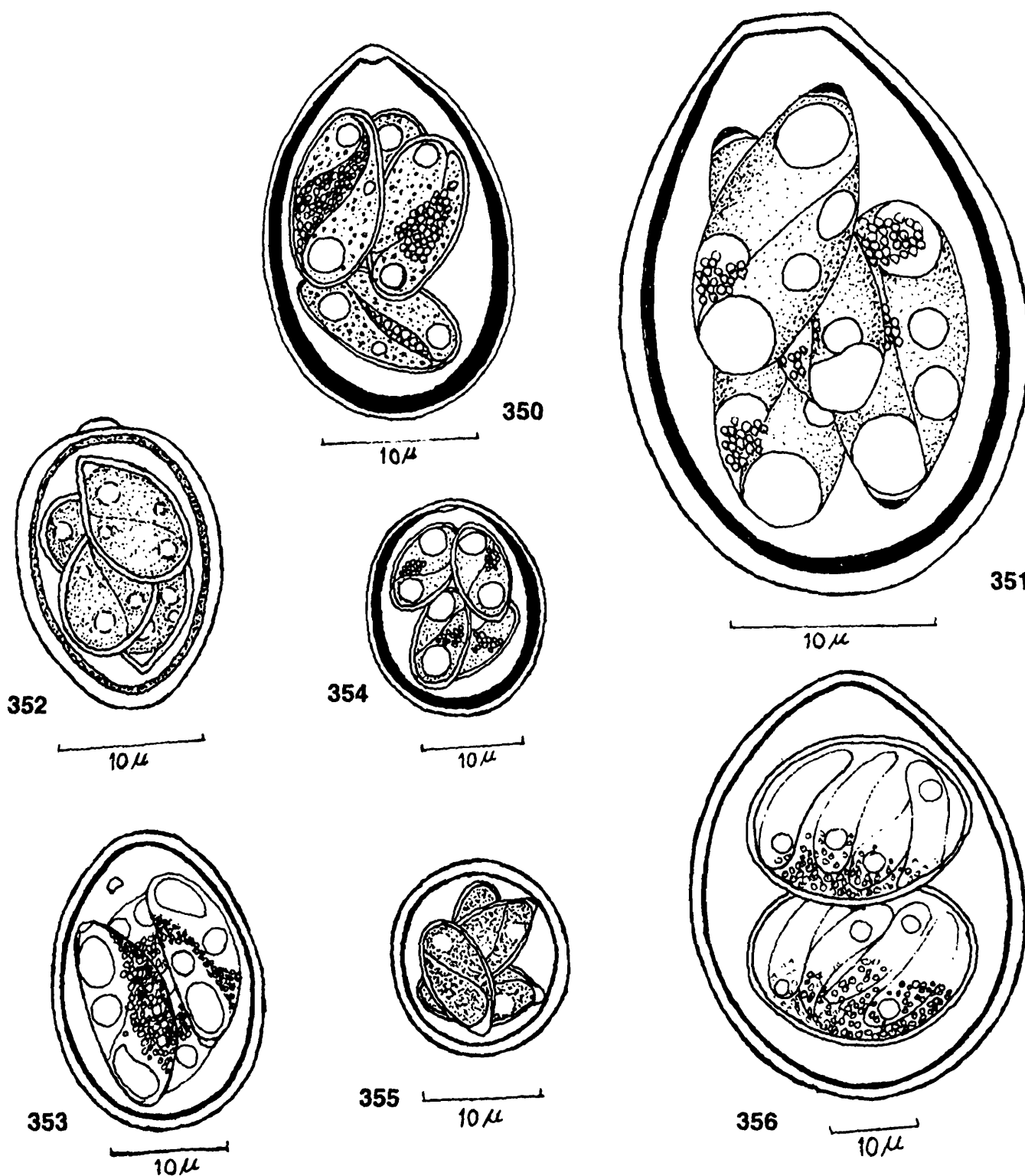
Distribution : India : Andhra Pradesh (Kakinada, East Godavari district).

Remarks : Rao (1968) recorded this species as a case report from District Veterinary Clinical Laboratory, Kakinada, Andhra Pradesh. This species is slightly to moderately pathogenic, dependig on the host species, age, degree of infection, etc. It is less serious in cats than dogs (Levine, 1967).

Genus *Montonella* Vincent, 1936

1936. *Montonella* Vincent, *C. R. Soc. Biol.*, **122** : pp. 260-262.

Diagnosis : Oocysts with one sporocyst, each containing four sporozoites.



Figs. 350-356. Coccidian parasites of Andhra Pradesh : 350. *Eimeria arloingi*; 351. *E. bovis*; 352. *E. crandallis*; 353. *E. faurei*; 354. *E. ninakohlyakimovae*; 355. *E. zuernii* and 356. *Isospora felis*.

227. *Montonella macrobrachii* Aravindan, Kalavati and Sheeja, 2002

Material examined : Sev. exs. on slides from Gambheeragedda estuary, Andhra Pradesh.

Diagnosis : Schizonts oval, 8-13 μm ; merozoites large, spindle-shaped, 10-14 in number; merozoites small, oval, 4 in number; microgametocyte oval, 10-15 x 3.5-7.5 μm ; oocysts elliptical, 20-25 μm x 10-18 μm , thin-walled; sporocyst single, sporocystic residuum large and conspicuous; sporozoites elongate, banna-shaped, 15 μm x 4 μm , with blunt anterior end and tapered posterior end.

Host : *Macrobrachium rosenbergii*; site of infection: intestine and pyloric stomach.

Distribution : India : Andhra Pradesh (Gambheeragedda estuary, Visakhapatnam district).

Suborder HAEMOSPORINA

Family PLASMODIIDAE

Diagnosis : Pigmented gametocytes in mature erythrocytes; asexual cycles in blood cells and tissues of vertebrate host; sexual phase in mosquito.

Genus *Plasmodium* Marchiafava and Celli, 1885

Diagnosis : Asexual stages (trophozoites, schizonts, etc.) and gametocytes, round or elongated, forming haemozoin pigment; exoerythrocytic schizogony in various internal organs; sexual reproduction in Culicidae.

Remarks : In all 23 species' including 6 undetermined species of the genus *Plasmodium* have been recorded so far from Andhra Pradesh. Out of these one unnamed species is reported from reptilian host and several unidentified species from avian hosts. So far, 10 named species are known from birds as well as four named species from non-human primates and 3 species from man. Host-wise key to the species of *Plasmodium* is given below for identification purpose.

Key to the species of *Plasmodium* from birds

1(15) Elongate gametocytes

2(4) Schizogony in primitive blood forming cells present

3(2) Stenoxenous parasite with elongatum type of exoerythrocytic schizogony and insusceptible to canaries, turkeys, ducks, pigeons and chicks *P. huffi*

4(3) Schizogony in primitive blood forming cells absent

5(12) Large erythrocytic schizonts with plentiful cytoplasm

6(7) Mature schizont in the form of a beautiful rosette *P. formosanum*

- 7(6) Mature schizont not in the form of a rosette
- 8 (9) Mature schizont has linear arrangement of merozoites *P. fallax*
- 9(8) Mature schizont has no linear arrangement of merozoites
- 10(11) Mature schizont has a fan-shaped arrangement of 6-18 merozoites *P. pinottii*
- 11(10) Mature schizont containing 8 merozoites peripherally arranged *P. garnhami*
- 12(5) Small erythrocytic schizonts with scanty cytoplasm
- 13(14) Gametocyte adhering to host cell nucleus and has no crinkled inner border
..... *P. nucleophilum*
- 14(13) Gametocyte with inner border much crinkled, lying alongside the host cell nucleus
..... *P. vaughani*
- 15(1) Round gametocytes
- 16(17) Schizogonic cycle 24 hours, with characteristic vacuoles in all stages
..... *P. matuitinum*
- 17(16) Schizogonic cycle 30-36 hours, without such characteristic vacuoles *P. relictum*

Key to the species of *Plasmodium* from non-human primates

- 1(4) Blood cycle in 72 hours
- 2(3) Amoeboidicity marked in young stages, merozoites 12-14 in number, pigment rather inconspicuous, stippling like Schuffner's but smaller dots *P. shortii*
- 3(2) Amoeboidicity slight, merozoites 8-16 in number, pigment fine, stippling heavier than Ziemann's *P. inui*
- 4(1) Blood cycle 48 hours
- 5(6) Marked amoeboidicity, moderate enlargement of infected RBC and presence of Schuffner's stippling, 15-16 merozoites and dark brown pigment *P. cynomolgi*
- 6(5) Moderate amoeboidicity, distortion of infected RBC and presence of flush and faint stippling, 16 merozoites and pigment as large unstable lumps *P. fragile*

Key to the species of *Plasmodium* from man

- 1(2) Full grown schizonts rounded, nearly filling erythrocytes, 6-12 merozoites, typically arranged in circle, schizogony in 72 hours *P. malariae*
- 2(1) Full grown schizonts irregular in form, filling half to two-third the erythrocyte and irregularly arranged, schizogony in about 48 hours 3

- 3(4) Gametocytes crescent-shaped, infected erythrocytes normal or atrophied
 *P. falciparum*
- 4(3) Gametocytes rounded or oval, infected erythrocytes hypertrophied *P. vivax*

A. *Plasmodium* in reptiles

228. *Plasmodium* sp.

Diagnosis : Schizogonic stages and the gametocytes in the red blood corpuscles of the circulating blood; development not synchronous; schizonts measuring $5.5\ \mu\text{m} \times 4.0\ \mu\text{m}$, containing 4 nuclei arranged along the periphery in a single row, pigment dark brown, scattered or clumped up at the pole opposite to the nuclei; largest microgametocyte measuring $10.5\ \mu\text{m} \times 9.5\ \mu\text{m}$; macrogametocyte $14.0\ \mu\text{m} \times 8.0\ \mu\text{m}$ in maximum size, containing a large vacuole and a few small vacuoles; host cell hypertrophied with the displacement of host cell nucleus; multiple invasions present; exo-erythrocytic stages in the lungs, liver and brain; largest schizont in the brain measuring $7.0\ \mu\text{m}$ in diameter and contained 35 nuclei or reached maximum size of $10.0\ \mu\text{m} \times 6\ \mu\text{m}$ and contained 30 nuclei; schizogony stages in the lung rare and reaching a maximum size of $7.0\ \mu\text{m} \times 5.0\ \mu\text{m}$ containing 7 nuclei.

Host : *Hemidactylus prashadi*; site of infection: blood, lungs, liver and brain.

Distribution : India : Andhra Pradesh (locality not mentioned).

Remarks : Narasimhamurti and Saratchandra (1980) recorded this unnamed species presumably from Andhra Pradesh.

B. *Plasmodium* in birds

229. *Plasmodium fallax* Schwetz, 1930

1930. *Plasmodium fallax* Schwetz, *Archs. Inst. Pasteur d' Alger.*, 8 : pp. 289-296.

Diagnosis : Youngest forms small solid bodies, often oval, rarely ring form with large nucleus and amoeboid cytoplasm; trophozoite with one or two circular vacuoles, sometimes extruding filiform pseudopodia, becoming elongate, nucleus stretching out before dividing, pigment localized in a small patch consisting of little yellowish-brown granules; schizont producing 12-18 merozoites, erythrocyte remaining unchanged without any displacement of the nucleus; gametocyte elongate with one extremity hooked round the host cell nucleus; macrogametocyte much vacuolated with 12-14 scattered, much larger pigment granules.

Host : Baya, *Ploceus philippinus*; site of infection: blood, liver and bone marrow.

Distribution : India : Andhra Pradesh.

Elsewhere : Eastern Congo, Southern Sudan.

Remarks : The natural hosts of *P. fallax* are *Syrnium nuchale* in eastern Congo and *Numida meleagris* in the Sudan. It can be adapted to chicks and pigeons, and after five blood passages the birds die of the disease. Bhaskar Rao and Bhaskar Rao (1980) recorded this species in baya from Andhra Pradesh.

230. *Plasmodium formosam* Manwell, 1962

1962. *Plasmodium formosam* Manwell, *J. Protozool.*, **9** : pp. 401-403.

Diagnosis : Youngest forms small rings with large nucleus, becoming amoeboid with growth, pigment usually dark, abundant and conspicuous, forming early; schizont small, round, occupying only a small portion of the corpuscle, scarcely displacing the host cell nucleus, producing 6-16 merozoites, usually 8-10, arranged in a neat rosette or occasionally as a fan; gametocytes elongate and very broad, much larger than the asexual forms, not encircling the nucleus but displacing to some extent the host cell nucleus; macrogametocyte appearing large spherical vacuole with round, coarse, 15-25 pigment granules.

Host : House Crow, *Corvus splendens*; site of infection : blood and liver.

Distribution : India : Andhra Pradesh.

Elsewhere : Formosa.

Remarks : This species commonly inhabits the Formosan hill partridge, *Arboriphila crudigularis* but it was noticed in the crow in Andhra Pradesh, India by Bhaskar Rao and Bhaskar Rao (1980).

231. *Plasmodium garnhami* Guindy, Hoogstral and Mohamed, 1965

1965. *Plasmodium garnhami* Guindy, Hoogstral and Mohamed, *Trans. R. Soc. Trop. Med. Hyg.*, **59**, pp. 280-284.

Diagnosis : Youngest forms small rings, occupying any part of the corpuscle but usually growing at one end displacing the nucleus towards the other end and not exhibiting the 'stranded' appearance, so characteristic of *P. polare*; trophozoite and young schizont vacuolated, producing 2 and then 4 large nuclei, yellowish-black pigment relatively small in amount, clumped into a single small mass; mature schizont predominantly round or ovoid, containing 8 merozoites, sometimes peripherally arranged; gametocytes plump elongate bodies, producing a well-marked lateral displacement of the host cell nucleus; macrogametocyte sausage-shaped body with vacuolated cytoplasm and a central compact nucleus, either spherical or a band across the width of the parasite, pigment scattered, often only about 6 round granules.

Host : Rain Quail, *Coturnix coromandelica*; site of infection: blood and liver.

Distribution : India : Andhra Pradesh.

Elsewhere : Egypt.

Remarks : According to Garnham (1966) *P. garnhami* appears to be confined to the Egyptian form of the European subspecies of hoopoe, *Upua epops major* and infections may be restricted to the vicinity of Cairo. Canaries and young chicks proved to be insusceptible to infection. Bhaskar Rao and Bhaskar Rao (1980) recorded this species in Rain Quail from Andhra Pradesh, which needs further study.

232. *Plasmodium huffi* Muniz, Soares and Batista, 1951

1951. *Plasmodium huffi* Muniz, Soares and Batista, *Revta. bras. Malar. Doenc. Trop.*, **3** : pp. 339-356.

Diagnosis : Youngest trophozoites usually irregular sometimes ring-like in shape, frequently multiple invasion in acute cases; schizonts round or elongate, sometimes invading host cell nucleus displacing it laterally, 6-8 merozoites in early stages and later, the number increased to 30 or more; gametocytes large irregularly elongate bodies, lying beside the nucleus, occupying most of the erythrocyte without appreciably curving around the poles of the nucleus but usually pushing the host cell nucleus to one side; pigment granules quite heavy and conspicuous.

Host : Baya, *Ploceus philippinus*; site of infection: blood, liver and bone marrow.

Distribution : India : Andhra Pradesh.

Elsewhere : Brazil.

Remarks : Bhaskar Rao and Bhaskar Rao (1980) recorded this species in baya *Ploceus philippinus* from Andhra Pradesh. According to Garnham (1966) this species appears to be strictly restricted to the toucan, *Rhamphastos toco* and no other species of bird has proved to be capable of harbouring the infection as it is a typically stenoxenous parasite.

233. *Plasmodium matuitinum* (Huff, 1937)

1937. *Plasmodium relictum* : Huff, *J. Parasitol.*, **23** : pp. 400-404.

1960. *Plasmodium matuitina* Huff: Corradetti, Neri and Scanga: *Parassit.*, **2**, pp. 333-343.

1966. *Plasmodium matuitinum* : Garnham, *Malaria Parasites and other Haemosporidia*, Black Scientific Publication, Oxford, p. 570.

Diagnosis : Youngest parasites not in ring form but solid oval bodies about 1 μm in diameter; trophozoites with small vacuoles, displaced host cell nucleus and pigment clumping into several dark brown masses; schizont spherical, with unusually large nucleus producing 10-30 (average 18) merozoites; gametocytes round or oval with displaced host cell nucleus; macrogametocytes about 8 μm in diameter with a nucleus consisting of a deeply staining karyosome and a lighter areolar zone and with approximately 14 round black grains of pigment granules.

Host : House Crow, *Corvus splendens* and House Sparrow, *Passer domesticus*; site of infection : blood, liver and bone marrow.

Distribution : India : Andhra Pradesh.

Elsewhere : Europe, United States, Mexico.

Remarks : It is a cosmopolitan species and occurs in a wide range of smaller birds. Bhaskar Rao and Bhaskar Rao (1980) recorded this species in House Crow and House Sparrow from Andhra Pradesh.

234. *Plasmodium nucleophilum* Manwell, 1935

1935. *Plasmodium nucleophilum* Manwell, *Am. J. trop. Med.*, **15** : pp. 365-380.

Diagnosis : Parasite in the early stages lying at one pole of the erythrocyte or localized anywhere, becoming elongate and attracted to the nucleus with growth and appearance of one or two pigment granules in the cytoplasm; immature schizont with non-conspicuous and non-refractile pigment characteristically clinging to the side of the nucleus; mature schizont spherical or irregular in form, comparatively small in size, uncommon in the peripheral blood, with clumped pigment granules, producing 4-9 (average 6) merozoites, sometimes up to 12 merozoites in Brazilian strains; gametocytes elongate bodies, closely attached to the side of the nucleus but not showing any tendency to curve round its extremities, having pigment granules grouped together at one pole of the parasite.

Host : House Crow, *Corvus splendens* and House Sparrow, *Passer domesticus*; site of infection: blood, liver and bone marrow.

Distribution : India : Andhra Pradesh.

Elsewhere : Cosmopolitan in distribution.

Remarks : It occurs in a wide variety of smaller avian species. Bhaskar Rao and Bhaskar Rao (1980) recorded this species in House Crow and House Sparrow from Andhra Pradesh.

235. *Plasmodium pinotti* Muniz and Soares, 1954

1954. *Plasmodium pinotti* Muniz and Soares, *Revta. bras. Malari. Doenc. Trop.*, **6** : pp. 611-617.

Diagnosis : Younger trophozoite small fusiform object in adult pigeons (*Columba livia domestica*), which, with growth, throwing out little spiky pseudopodia; schizont 6-8 μ m in size with large nuclei and clumped pigment in early stage, finally producing 6-18 merozoites in a fan-like arrangement, at the base of which lying the coarse black pigment; gametocytes elongate, only curving at the extremities, without encircling or slightly encircling the host cell nucleus in the toucan (*Rhamphastos toco*); macrogametocytes having compact nucleus and about 12 pigment granules of smaller grains.

Host : Jungle Bush Quail, *Perdica asiatica*; site of infection : blood and liver.

Distribution : India : Andhra Pradesh.

Elsewhere : Brazil.

Remarks : It is an oligoxenous parasite of the Brazilian toucan, *Rhamphastos toco*. The infection usually pursues a mild course but it is fatal in pigeons and chicks. Bhaskar Rao and Bhaskar Rao (1980) recorded this species in Jungle Bush Quail from Andhra Pradesh.

236. *Plasmodium relictum* (Grassi and Felletti, 1891)
(Figs. 357-366)

1891. *Haemaeoba relict*a Grassi and Feletti, *Bull. mens. Acad. gioania Sci. nat. Catania*, **16** : p. 16.

1966. *Plasmodium relictum* (Grassi and Feletti) : Garnham : *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 522.

Diagnosis : Youngest parasite oval in shape remaining solid without changing into a 'ring'; early trophozoite slightly amoeboid, developing a small vacuole and a grain of black pigment quite early; schizont spherical or even retaining its oval shape alongside the host cell nucleus which becoming more and more displaced and finally expelled from the red blood cell, pigment grains clumped into one or two foci, parasite nucleus undergoing divisions to produce 8-32 merozoites; gametocytes round or oval, with relatively fine dot-like pigment granules, mature forms markedly displaced or expelled the host cell nucleus.

Host : House Crow, *Corvus splendens* and Black-headed Munia, *Lonchura malacca*; site of infection: blood, liver and bone marrow.

Distribution : India : Andhra Pradesh; outside India: cosmopolitan species occurring throughout the globe.

Remarks : It is a cosmopolitan parasite and occurs in a wide range of hosts. Bhaskar Rao and Bhaskar Rao (1980) recorded this species along with *Plasmodium splendense*, a synonym of *P. relictum*, in House Crow and noticed *P. relictum lutzi* in Black-headed Munia from Andhra Pradesh.

237. *Plasmodium vauhani* Novy and MacNeal, 1904

1904. *Plasmodium vauhani* Novy and MacNeal, *Am. Med.*, **8** : pp. 932-934.

Diagnosis : Early trophozoites very small, amoeboid, with finely drawn out pseudopodia, no typical ring forms, soon a pigment granule arising at the periphery and later, two or even three granules; schizont irregular with 4-8 merozoites, lying in any part of the erythrocyte without displacing the host cell nucleus in most cases; gametocytes elongate bodies even from an early stage, having an irregular outline and much crinkled inner border, and with a much vacuolated cytoplasm, lying alongside the nucleus of the host cell, and often stretching from one end to the other without curving round the nucleus to any appreciable extent, pigment granules varying from strain to strain.

Host : Common Sand Grouse, *Pterocles exustus* and Spotted Dove, *Streptopelia chinensis*; site of infection : blood, liver, bone marrow and brain.

Distribution : India : Andhra Pradesh.

Elsewhere : A cosmopolitan species occurring in Europe, Africa, South America, Panama, Malaya, Sri Lanka.

Remarks : It is a cosmopolitan parasite and occurs in a large number of hosts. Bhaskar Rao and Bhaskar Rao (1980) recorded this species in Common Sand Grouse and Spotted Dove from Andhra Pradesh.

238. *Plasmodium venkataramiahii* Bhaskar Rao, Devi and Bhaskar Rao, 1977

1977. *Plasmodium venkataramiahii* Bhaskar Rao, Devi and Bhaskar Rao, *Int. Congr. Protozool.*, 5 : p. 194.

Diagnosis : Not available.

Host : *Corvus splendens*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : This species is a *nomen nudum*.

239. *Plasmodium* sp.

Host : *Passer domesticus*; site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Qadri (1973) recorded this unnamed species in House Sparrow of Hyderabad, Andhra Pradesh.

240. *Plasmodium* sp.

Host : Common Sand Piper, *Tringa hypoleucos*; site of infection: blood.

Distribution : India : Andhra Pradesh.

Remarks : Bhaskar Rao and Bhaskar Rao (1980) recorded this unnamed species in Common Sand Piper from Andhra Pradesh.

241. *Plasmodium* sp.

Host : Spotted Owlet, *Athene brama*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Bhaskar Rao and Bhaskar Rao (1980) recorded this unnamed species in Spotted Owlet from Andhra Pradesh.

242. *Plasmodium* sp.

Host : Black Drongo, *Dicrurus adsimilis*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Bhaskar Rao and Bhaskar Rao (1980) recorded this unnamed species in Black Drongo from Andhra Pradesh.

243. *Plasmodium* sp.

Host : *Cisticola juncidis*; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Qadri (1962) recorded this unnamed species from Andhra Pradesh.

C. *Plasmodium* in non-human primates244. *Plasmodium cynomolgi* Mayer, 1907

1907. *Plasmodium cynomolgi* Mayer, *Medsche. Klin.*, 3 : pp. 579-580.

1966. *Plasmodium cynomolgi* Mayer : Garnham : *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 175.

Diagnosis : Erythrocytic cycle 48 hours with considerable synchronicity and frequent multiple invasion of the corpuscle; ring forms with a large vacuole and a spherical nucleus practically lying in the circumference of the ring, eventually occupying two-thirds of the erythrocyte with the appearance of Schuffner's dots, much amoeboidicity obvious, slight enlargement of infected cell, production of coarse pseudopodia and quite dark granules of pigment; trophozoite now losing its vacuole with noticeable increment in size of the nucleus; immature schizonts nearly filling the corpuscle with the distortion, severe lesions from the stippling and slight enlargement of the host cell; schizont with pigment agglomerated into several clumps and Schuffner's dots intensified into a dark red rim around the schizont, producing 4-24 usually about 15-16 merozoites; gametocytes round causing greater enlargement and abundant stippling of the erythrocyte.

Host : Bonnet monkey, *Macaca radiata*; site of infection : blood.

Distribution : India : Andhra Pradesh (Hyderabad district), Tamil Nadu and Kerala.

Elsewhere : Malaya, Bangladesh and Cambodia (Garnham, 1966)

Remarks : Anantaraman (1980) reported this species in Bonnet Monkey from Hyderabad. Man is slightly susceptible to *P. cynomolgi*. The human *P. vivax* malaria seems to possess closest affinity to *P. cynomolgi* in the blood phase of the two parasites. The asexual cycle, however, provides slight differences, such as: the erythrocyte is less subject to enlargement in infections with *P. cynomolgi* than *P. vivax* and the simian parasite is less amoeboid (Garnham, 1966).

245. *Plasmodium fragile* Dissanaïke, Nelson and Garnham, 1965

1965. *Plasmodium fragile* Dissanaïke, Nelson and Garnham, *Ceylon J. med. Sci.*, 14 : pp. 1-9.

1966. *Plasmodium fragile* Dissanaïke, Nelson and Garnham: Garnham: *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 349.

Diagnosis : Erythrocytic cycle 48 hours; youngest forms hair-like rings, an accessory dot present in addition to the main nucleus, with growth tenuiform processes sometimes seen; enlarging ring characterized by the accumulation of heavy and numerous spherical, golden black pigment granules scattered throughout the cytoplasm; stippling of infected erythrocyte at first a pinkish flush or pallor, then a faint, but regular stippling, often erythrocyte becoming distorted or shrunk but not enlarged; schizonts usually filling the erythrocyte, lying on one side and budding off 16 merozoites from the residual mass, pigment at first bulky and unstable in composition, fragmented into dust-like particles or disappeared completely or sometimes accumulating on the edge in a black lump or in large golden-black masses; macrogametocyte spherical or oval with eccentrically placed nucleus and pigment sometimes in a curious form, becoming disintegrated with age.

Host : Bonnet monkey, *Macaca radiata*; site of infection : blood.

Distribution : India : Andhra Pradesh (Hyderabad district) and Tamil Nadu.

Elsewhere : Sri Lanka.

Remarks : Anantaraman (1980) reported this species in Bonnet Monkey from Hyderabad.

246. *Plasmodium inui* Halberstadter and von Prowazek, 1907

1907. *Plasmodium inui* Halberstadter and von Prowazek, *Ar. Gesundheitsamt. Berlin*, **26** : pp. 37-43.

1967. *Plasmodium inui* Halberstadter and von Prowazek : Garnham : *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 285.

Diagnosis : Earliest ring stage with exceptionally large spherical nucleus and a vacuole, and with a small cap of cytoplasm; trophozoite feebly amoeboid and projecting an irregular lobose process outwards, becoming quite large later and occupying about half of the corpuscle, and at this stage very fine pigment granules appeared; schizonts practically filling the erythrocyte at 4-8 nucleated stage, when fully mature after 72 hours' development it usually ruptured in the early afternoon producing 8-16 merozoites; macrogametocytes 8 μ m in diameter, filling the erythrocyte, while in microgametocyte a small portion of the corpuscle left visible; infected erythrocyte, only slightly enlarged, pale and stippled, with granulation more evident, constant and heavier than the Ziemann's dots of *P. malariae*.

Host : Bonnet monkey, *Macaca radiata*; site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district).

Elsewhere : Malayan peninsula and surrounding countries.

Remarks : Anantaraman (1980) reported this species in Bonnet Monkey from Hyderabad. *P. inui* is the most widely distributed species in monkeys of the old world. For host records and distribution Garnham (1966) may be consulted.

247. *Plasmodium shortti* Bray, 1963
(Figs. 367-377)

1963. *Plasmodium shortti* Bray, *Ergebn. Mikrobiol. Immun Forsch. exp. Ther.*, **36** : pp. 168-213.
1966. *Plasmodium shortti* Bray : Garnham : *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 300.

Diagnosis : Youngest parasite without vacuole, consisting largely of nucleus with a small portion of cytoplasm, and measuring slightly over 1 μm , later a small vacuole developed, become highly amoeboid with long filamentous extrusions and fine, very light brown pigment granules, difficult to see until their final clumping in the mature schizont, producing 12-14 merozoites at midday, not entirely filling the corpuscle; infected erythrocyte undergone slight hypertrophic changes causing a fine stippling consisting of numerous, even-sized and regularly placed tiny discrete dots, like Schuffner's but in smaller dots; periodicity of asexual schizogony 72 hours in the blood; younger gametocytes characterized by a peculiar thickening at the periphery, partly due to accumulation of pigment granules; mature gametocytes spherical, larger than the erythrocyte which finally disappearing or invisible.

Host : Bonnet monkey, *Macaca radiata*; site of infection : blood.

Distribution : India : Andhra Pradesh (Hyderabad district); elsewhere : Sri Lanka, but its distribution outside India is doubtful (Garnham, 1966).

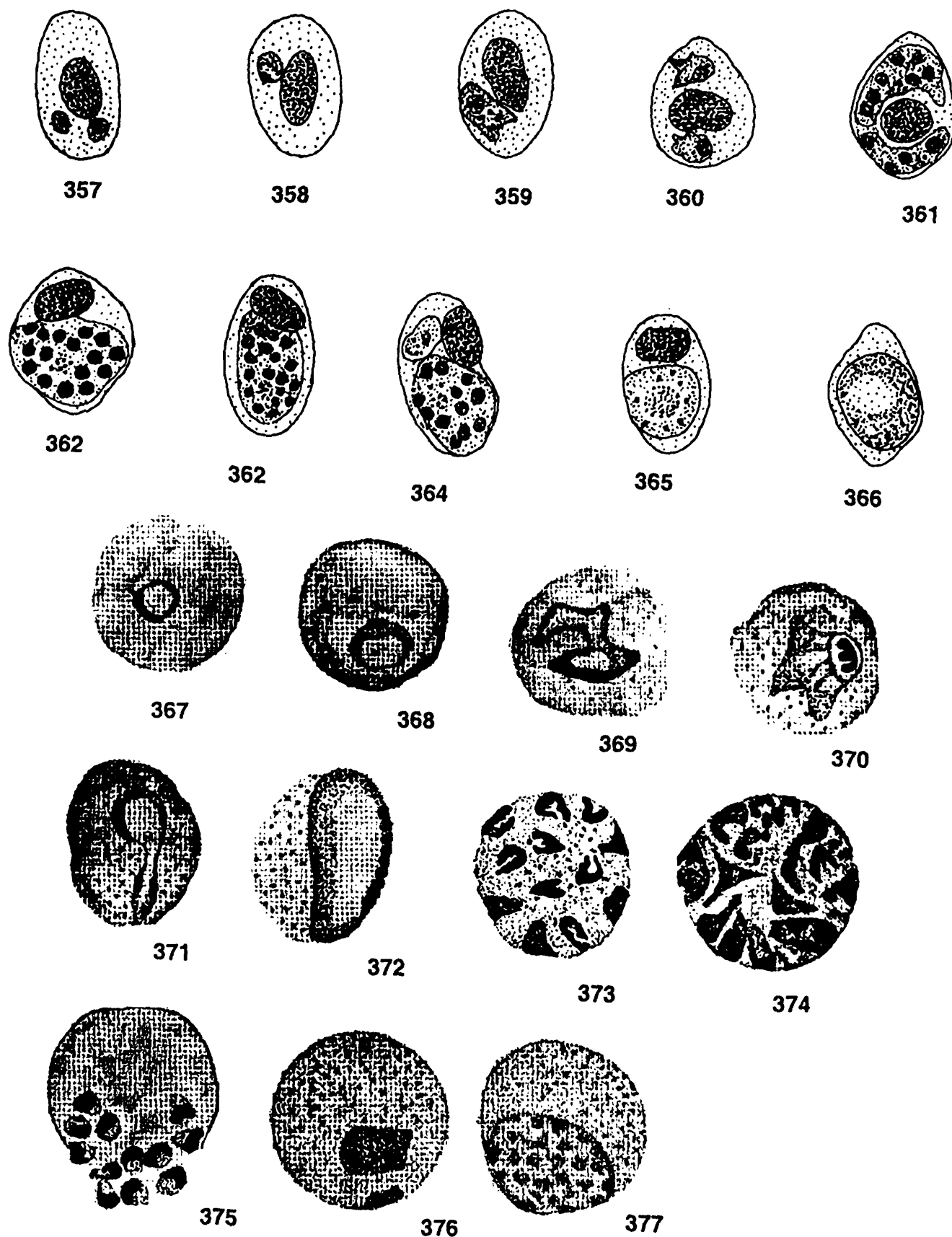
Remarks : Anantaraman (1980) reported this species in Bonnet Monkey from Hyderabad. Shortt, Rao, Qadri and Abraham (1961) provisionally named this parasite of *Macaca radiata* trapped in the adjacent forests of Osmania, Hyderabad as *Plasmodium osmaniae*. This name became a *nomen nudum* as per Article 15 of the International Code of Zoological Nomenclature, which states that after 1960 a 'conditional' name is invalid and accordingly Bray (1963) gave the organism the replacement name of *P. shortti*, and redescribed the blood stages.

D. *Plasmodium* in man

248. *Plasmodium falciparum* (Welch, 1897)
(Figs. 378-382)

1897. *Haematozoon falciparum* Welch, *Syst. Pract. Med.*, **1** : p. 17.
1964. *Plasmodium falciparum* (Grassi and Feletti): Garnham: *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 357.

Diagnosis : Relatively small ring forms with double dots of chromatin, some apparently on edge (accolé forms); usually with crescentic gametocytes, macrogametocyte 12-14 μm long; trophozoite compact, rarely seen in peripheral blood; schizont irregular in form, 5 μm in diameter, 8-32 merozoites, irregularly arranged filling half to two-third the erythrocyte, with early clumping of coarse dark pigments, rarely occur in peripheral circulation; host



Figs. 357-377. Haemosporidian parasites of Andhra Pradesh : 357-366. *Plasmodium relictum* (different stages in RBC) and 367-377. *P. shorti* (different stages in RBC).

erythrocyte not hypertrophied, but accompanied by reddish clefts known as Maurer's clefts; erythrocytic schizogony at 48 hours interval; paroxysms of chills and fever occurring every other day.

Host : *Homo sapiens*; site of infection : blood.

Distribution : India : Andhra Pradesh (possibly all districts) and in almost all over India (Knowles, Senior White and Das Gupta, 1930; Bhatia, 1938). This species is mainly distributed in tropics and subtropics (Garnham, 1966).

Remarks : This species causes malignant tertian malaria and is known as the greatest killer of human race over most parts of Africa and elsewhere in the tropics (Garnham, 1966).

249. *Plasmodium malariae* (Grassi and Feletti, 1892)
(Figs. 383-387)

1892. *Haemamoeba malariae* Grassi and Feletti, *Atti. Acad. Zioenia Sci. nat. Catania*, Memoir, 5 : pp. 1-80.

1966. *Plasmodium malariae* (Grassi and Feletti): Garnham: *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 257.

Diagnosis : 'Ring' form about one-third diameter of erythrocyte, one in each red cells; trophozoite compact, often band-like, schizont rounded, 7 μ m in diameter, nearly filling the erythrocyte, 6-12 merozoites, typically arranged in circle; schizogony in 72 hours; gametocyte round or ovoid, 9 μ m in diameter, with brown-black pigments; host erythrocyte not enlarged, very faint stippling (Ziemann's) after prolonged staining only paroxysms occurring every 3 days.

Host : *Homo sapiens*; site of infection : blood.

Distribution : India : Andhra Pradesh (possibly all districts) and all over India (Bhatia, 1938); worldwide occurring in tropical, subtropical and warmer temperate regions (Garnham, 1966).

Remarks : This species causes quartan malaria in man. It is not very pathogenic, but chronic infection may lead to a lethal kidney condition.

250. *Plasmodium vivax* (Grassi and Feletti, 1890)
(Figs. 388-392)

1890. *Haemoeba vivax* Grassi and Feletti, *Arch. ital. Biol.*, 13, p. 297.

1966. *Plasmodium relictum* (Grassi and Feletti): Garnham : *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 116.

Diagnosis : Relatively large ring forms about one-third diameter of erythrocyte, round or oval, usually one in each red cells, a round chromatin dot in thin part of ring; trophozoite

amoeboid; schizont irregular, filling half to two-third the erythrocyte; schizogony usually at interval of 48 hours, 12-24 merozoites in irregular grape-like cluster, with small brown pigment granules usually collected in a single mass; gametocyte large, round or ovoid, 10 μm in diameter; host erythrocyte enlarged, stippled with red dots known as Schuffner's dots; all erythrocytic stages occurring in peripheral blood, multiple infection in R.B.C. not uncommon; paroxysms at every other day as in falciparum malaria.

Host : *Homo sapiens*; site of infection: blood.

Distribution : India : Andhra Pradesh (all districts) and all over India. This species is worldwide in distribution, occurring mainly in tropics, subtropics and warmer temperate regions (Knowles *et al.*, 1930; Garnham, 1966).

Remarks : This species causes benign tertian malaria in man and is the commonest and the most widely distributed species.

Family HAEMOPROTEIDAE

Diagnosis : Pigmented gametocytes in erythrocytes of the circulating blood, asexual cycle in tissue cells of the vertebrate host; sexual phase in insects other than mosquitos.

Genus *Haemoproteus* Kruse, 1890

1890. *Haemoproteus* Kruse, Mitt. Virchows Archiv., 121 : pp. 359-372.

Diagnosis : Pigmented gametocytes in erythrocytes, usually halter-shaped, partly encircling the host cell nucleus; schizogony in the internal organs, lung, liver, kidney capillary endothelium *etc.*; sporogony in Hippoboscidae and Ceratopogonidae; oocysts either large with more than 500 short sporozoites or small with less than 50 relatively large sporozoites; usually in birds and also in other vertebrates.

Key to the species of *Haemoproteus* in reptiles

Macrogametocyte bladder-like or bean-shaped, but rarely halteridial, 15 μm long; with scattered pigments in fine lines *H. simondi*

Key to the species of *Haemoproteus* in birds

- 1(16) Parasites normally circumnuclear or halteridial
 - 2(3) Parasites circumnuclear, with outline entire and 16-34 pigment granules, occurring in the avian family Picidae *H. velans*
 - 3(2) Parasites not circumnuclear, but halteridial
 - 4(7) Halteridial parasites, with marked displacement of host cell nucleus

- 5(6) Pigment granules 10-15 in number, parasites occupying about 70% of the host cell-parasite complex *H. orizivora*
- 6(5) Pigment granules 6-9 in number, parasites occupying about 50% of the host cell-parasite complex *H. pastoris*
- 7(4) Halteridial parasites, without marked displacement of host cell nucleus
- 8(13) Parasites with outline entire
- 9(10) Halteridial or broadly sausage-shaped parasites, occupying more than 80% of the host cell-parasite complex *H. borgesii*
- 10(9) Parasites not broadly sausage-shaped, occupying less than 80% of the host cell-parasite complex
- 11(12) Parasites occupying 65-70% of the host cell parasite complex, averaging 13 pigment granules per parasite. *H. passeris*
- 12(11) Parasites occupying about 60% of the host cell parasite complex, about 30 pigment granules per parasite, parasitic in the avian family Columbidae *H. columbae*
- 13(8) Parasites with amoeboid or entire outline
- 14(15) Immature parasite amoeboid, mature entire, about 8 pigment granules per parasite, parasitic in the avian family Coraciidae *H. coraciae*
- 15(14) Parasites usually entire, sometimes amoeboid, averaging 14 pigment granules per parasite, parasitic in the avian family Meropidae *H. meropis*
- 16(1) Parasites microhalteridial, bilobed *H. fringillae*

A. *Haemoproteus* in reptiles

251. *Haemoproteus simondi* (Castellani and Willey, 1904)

- 1904. *Haemocystidium simondi* Castellani and Willey, *Spolia Zeylanica*, 2 : pp. 78-92.
- 1966. *Haemocystidium simondi* Castellani and Willey: Garnham: *Malaria Parasites and other Haemosporidia*, Blackwell Scientific Publications, Oxford, p. 952.
- 1988. *Haemoproteus (Haemocystidium) simondi* Castellani and Willey: Levine: *The Protozoan Phylum Apicomplexa*, Vol. II, p. 30.

Diagnosis : Smallest gametocytes amoeboid, less than 2 μm in size, with no vacuole and pigment; macrogametocyte conspicuous, bladder-like or bean-shaped, but rarely halteridial, 15 μm long, slightly larger and more oval than that of the microgametocyte, cytoplasm with scattered pigments in fine lines and a large oval vacuole; nucleus of macrogametocyte oval or elongated, consisting of a pale halo on the periphery and a round karyosome; hypertrophy of corpuscle; exoerythrocytic schizogony in liver or in the reticulo-endothelial cells of the lungs.

Host : Indian gecko, *Hemidactylus* sp., probably *Hemidactylus brooki*; site of infection: blood, liver.

Distribution : India : Andhra Pradesh (Hyderabad district), Goa, Tamil Nadu (Shortt, 1962; de Mello, 1934).

Elsewhere : Sri Lanka (Castellani and Willey, 1904; Robertson, 1908; Dobell, 1910) and Australia (Mackerras, 1961).

Remarks : Shortt (1962) studied this haemoproteid parasites previously in Madras (now Chennai) and also as unnamed haemoproteid species from this state. Garnham (1966) had examined this material and stated it as a saurian haemoproteid, namely, *Haemocystidium simondi* Castellani and Willey, 1904. Levine (1988) indicated the subgeneric status.

B. *Haemoproteus* in birds

252. *Haemoproteus borgesii* Tendeiro, 1947

1947. *Haemoproteus borgesii* Tendeiro, *Rev. Med. Vet.* (Lisbon), **42** : pp. 285-350.

1978. *Haemoproteus borgesii* Tendeiro: Greiner, Mandal and Nandi: *J. Parasitol.*, **63**, pp. 651-656.

Materials examined : Sev. exs., Adilabad, Feb. 1978, N. C. Nandi.

Diagnosis : Macrogametocyte broadly sausage-shaped to slightly halteridial; margin entire, not amoeboid; parasite lateral to erythrocyte nucleus, measuring $13.2\ \mu\text{m} \times 4.0\ \mu\text{m}$ and $51.5\ \mu\text{m}^2$ in area, occupying more than 80% of the host cell-parasite complex; pigment granules discrete, yellow-brown, scattered, and averaging 12 granules per parasite; volutin granules present; parasite nucleus submedian, oval to round, $3.0\ \mu\text{m} \times 2.3\ \mu\text{m}$ and $5.1\ \mu\text{m}^2$ in area; erythrocyte nucleus displaced laterally; Nuclear Displacement Ratio (NDR) = 0.04; host cell hypertrophied slightly in length (4.2%) and in area (8.8%), but slightly atrophied in width (5.9%); and host cell nucleus atrophied (18.3%).

Host : *Dendrocopos mahrattensis mahrattensis* (Family Picidae); site of infection: blood.

Distribution : India : Andhra Pradesh (Adilabad district), Assam, Maharashtra and Jammu & Kashmir.

Elsewhere : Portuguese Guinea and Malaysia.

Remarks : Nandi and Mandal (1984) reported this species from this state.

253. *Haemoproteus columbae* Kruse, 1890 (Figs. 393-396)

1890. *Haemoproteus columbae* Kruse, *Arch. Pathol. Anat.*, **120** : p. 359.

Diagnosis : Macrogametocyte halteridial, inner and polar margin amoeboid, outer margin entire, $12.6\ \mu\text{m} \times 3.4\ \mu\text{m}$ and $34.3\ \mu\text{m}^2$ in area, occupying about 60% of the host cell-parasite

complex; pigment yellowish-black, discrete, round, scattered, about 30 granules per parasite; nucleus round-oval, median to submedian, $2.5\ \mu\text{m} \times 1.8\ \mu\text{m}$ and $3.2\ \mu\text{m}^2$ in area; host cell relatively unchanged, host cell nucleus atrophied 25.8% in area.

Host : *Columba livia*; site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district), Delhi, Maharashtra—a cosmopolitan species with worldwide distribution.

Remarks : Bhaskara Rao *et al.* (1992) reported this species in captive pigeon at Nehru Zoological Park, Hyderabad, Andhra Pradesh.

254. *Haemoproteus coraciae* de Mello and Afonso, 1935

(Figs. 397-401)

1935. *Haemoproteus coraciae* de Mello and Afonso, *Proc. Indian Acad. Sci.(B)*, **2** : pp. 67-73.

1986. *Haemoproteus coraciae* de Mello and Afonso: Bishop and Bennett: *Can. J. Zool.*, **64** : pp. 1860-1863.

Materials examined : Sev. exs., Warangal, 13.ii.1979, N. C. Nandi.

Diagnosis : Macrogametocyte moderate in size, measuring $15.0\ \mu\text{m} \times 2.6\ \mu\text{m}$ and $48.5\ \mu\text{m}^2$ in area, occupying more than 50% of the erythrocyte-parasite complex; usually halteridial but sometimes dumbbell-shaped; margins usually entire but occasionally amoeboid; pigment granules large deep brown-yellow and usually scattered randomly throughout the cytoplasm but occasionally grouped in one or more clumps; parasite nucleus small, dense, round or ovoid and situated centrally.

Host : *Coracias benghalensis* (Family Coraciidae); site of infection: blood.

Distribution : India : Andhra Pradesh (Warangal district), Goa and Maharashtra.

Elsewhere : Africa, Asia east to the Philippine Islands.

Remarks : Nandi and Mandal (1984) reported this species from this state.

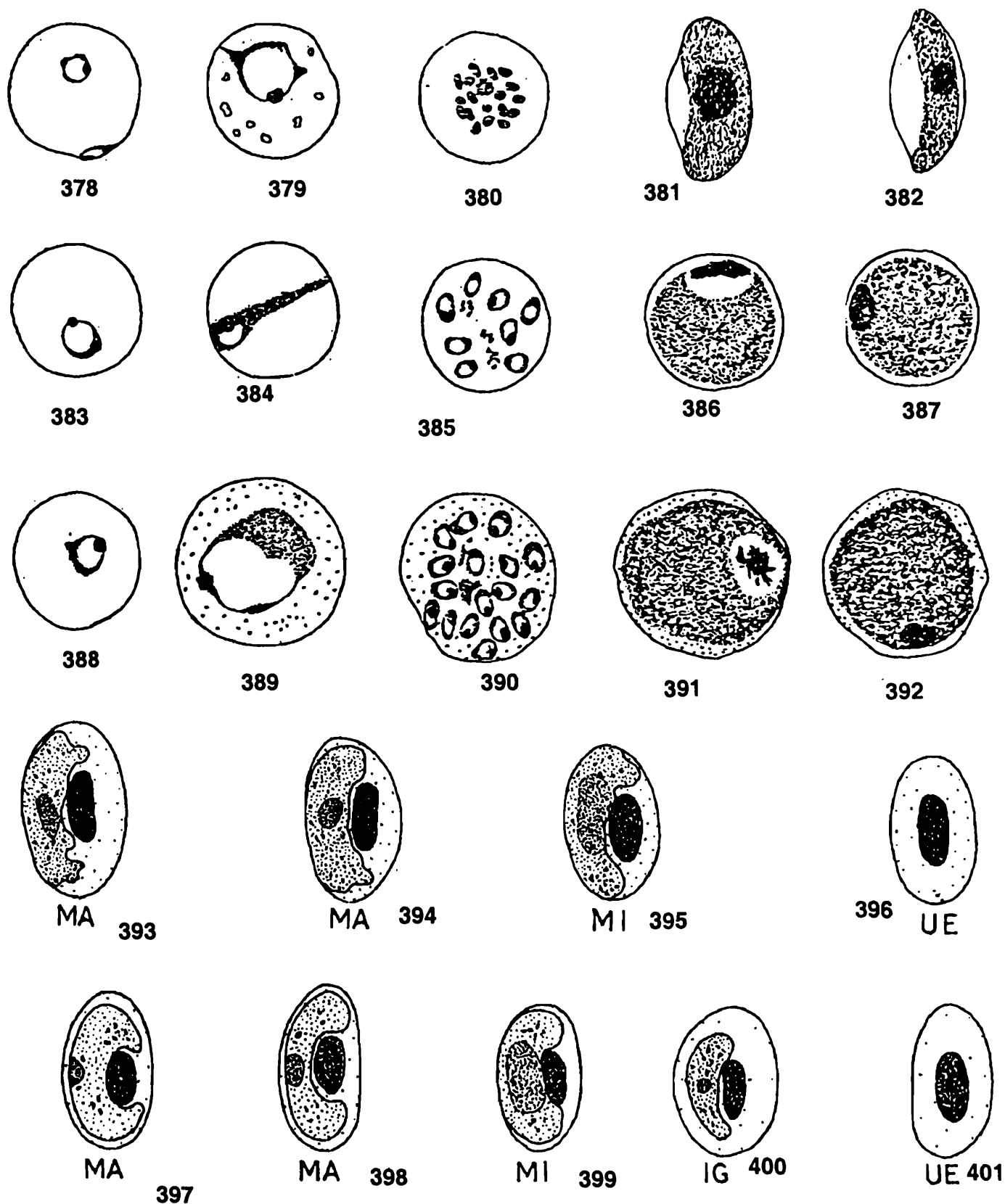
255. *Haemoproteus fringillae* Labbe, 1894

(Fig. 402-405)

1894. *Haemoproteus fringillae* Labbe, *Arch. Zool. Exp. Gen.*, : p. 55.

Material examined : Sev. exs., Warangal, 11.ii.1979, N. C. Nandi.

Diagnosis : Macrogametocyte small, $11.0\text{-}14.0 \times 2.2\text{-}2.6\ \mu\text{m}$, halteridia-shaped, margins entire, bilobed, with a marked constriction at the middle of the convex margin, occupying about 50% of the host cell-parasite complex; nucleus mostly round, $2.1\ \mu\text{m}$ in diameter, central or sub-centrally located at the periphery; pigments dark-yellowish and scattered granules; host cell nucleus rarely displaced to the periphery.



Figs. 378-401. Haemosporidian parasites of Andhra Pradesh : 378-382. *Plasmodium falciparum* (different stages in RBC); 383-387. *P. malariae* (different stages in RBC); 388-392. *P. vivax* (different stages in RBC); 393-396. *Haemoproteus columbae* and 397-401. *H. coraciae*. (MA = macrogametocyte, MI = microgametocyte, UE = uninfected RBC)

Host : *Copsychus saularis* (Linnaeus); site of infection: blood.

Distribution : India : Andhra Pradesh (Warangal district); cosmopolitan in distribution.

Remarks : Nandi and Mandal (1984) identified this species in *Copsychus saularis* (Family Turdidae, Subfamily Turdinae) from Warangal district, Andhra Pradesh based on the key to the haemoproteids of the avian Family Turdidae given by Bennett and Campbell (1972). According to this key *H. fringillae* is a small parasite with a marked constriction centrally, occupying about 50% of erythrocyte cytoplasm and erythrocyte nucleus not displaced to periphery. For a long time '*H. fringillae*/ *H. orizivora*' complex (Peirce, 1984) was used to identify the haemoproteids of many passerine families because of frequent occurrence of both small halteridial parasite ('*fringillae*-like) and larger, broader parasites similar to *H. orizivora* of the family Estrildidae. Recent taxonomic review of the haemoproteids of the avian family Fringillidae, Burry-Caines and Bennett (1992) states that assigning *H. fringillae* to such a broad range of hosts is in error, and it should be limited to the Fringillidae until experimental evidence clearly indicates a wider host spectrum. Thus it is possible that this present species is, in fact, *Haemoproteus fallisi* of the avian subfamily Turdinae. However, in the absence of detailed taxonomic review of passerine families, this species is at present considered as *H. fringillae* based on Bennett and Campbell (1972).

256. *Haemoproteus meropis* (Zargar, 1945)
(Figs. 406-409)

1945. *Haemoproteus meropi* Zargar, *Proc. Indian Acad. Sci.(B)*, **21** : pp. 124-127.

1978. *Haemoproteus meropis* (Zargar): Bennett: *Can. J. Zool.*, **56** : pp. 1721-1725.

Materials examined : Sev. exs., Warangal, 20.ii.1979, N. C. Nandi.

Diagnosis : Macrogametocytes broadly sausage-shaped to halteridial, measuring $13.9\ \mu\text{m}$ x $3.2\ \mu\text{m}$ and $44.5\ \mu\text{m}^2$ in area, constituting 65% or more of the host cell-parasite complex; outline usually entire, somewhat amoeboid; pigment granules prominent, randomly distributed throughout parasite, averaging 14 granules per parasite; parasite occasionally with large, deep purple-staining volutin granules; parasite nucleus median, round to broadly ovoid, occupying about $3.3\ \mu\text{m}^2$ in area; host cell hypertrophied 15% in length, 3% in width, and 18% in area; host cell nucleus slightly displaced laterally; Nuclear Displacement Ratio (NDR) = 0.7.

Host: *Merops orientalis* (Family Meropidae); site of infection : blood.

Distribution : India : Andhra Pradesh (Warangal district), Maharashtra, Orissa and Goa.

Elsewhere : Malaysia, Philippines, Thailand and Africa.

Remarks : Nandi and Mandal (1984) reported this species from this state.

257. *Haemoproteus orizivora* Anschutz, 1909
(Figs. 410-413)

1909. *Haemoproteus orizivora* Anschutz, *Zentrbl. Bakterirol. Parasitenkd. Infektionskr. Hyg. Abt. I. Orig.*, 51 : p. 654.

Material examined : Sev. exs., Warangal, 11.ii.1979, N. C. Nandi; sev. exs., Adilabad, in Feb. 1978, N. C. Nandi.

Diagnosis : Macrogametocyte halteridial, sometimes sausage-shaped, 12.0-15.0 μm x 3.5-4.0 μm , margins entire, occupying about 70% of the host cell-parasite complex; nucleus round or ovoid, central to subterminal, located on the outer margin of the parasite; pigment granules small, scattered, 10-15 yellow to dark-yellow brown granules; host cell hypertrophy more than 30% in area; host cell nuclear atrophy about 10% in area with marked displacement to the periphery.

Host : *Copsychus saularis* (Linnaeus) and *Ploceus philippinus* (Linnaeus); site of infection : blood.

Distribution : India : Andhra Pradesh (Warangal and Adilabad districts); cosmopolitan in distribution.

Remarks : As stated in *Haemoproteus fringillae* above.

258. *Haemoproteus passeris* Kruse, 1890

1890. *Haemoproteus passeris* Kruse. *Arch. Pathol. Anat.*, 120 : pp. 541-560.

1991. *Haemoproteus passeris* Kruse: Bennett and Peirce: *J. nat. Hist.*, 25 : pp. 7-22.

Materials examined : Sev. exs., Warangal, 11.ii.1979, N. C. Nandi.

Diagnosis : Macrogametocyte of medium size, usually halteridial and occasionally broadly sausage-shaped, measuring 13.6 μm x 3.2 μm and 48.2 μm^2 in area, occupying 65-70% of the area of the host erythrocyte-parasite complex; margins entire; pigment granules yellow to yellow-brown, rod-shaped and scattered randomly throughout the cytoplasm, averaging 13 granules per parasite; parasite nucleus round to ovoid or triangular, terminal to sub-terminal in location; host cell hypertrophied 5-10% in length and breadth and 15% in area; host cell nucleus hypertrophied 15% and displaced laterally towards the margin; volutin granules of common occurrence and, when present, effectively concealed the true pigment granules.

Host : *Passer domesticus*: site of infection : blood.

Distribution : India : Andhra Pradesh (Warangal district), Orissa and Goa.

Elsewhere : Throughout the natural distributional range of the family Passeridae.

Remarks : In 1936, de Mello described *Haemoproteus gymnorrhidis* from *Gymnorrhis* (= *Petronia*) *xanthocollis* shot in Goa. In their taxonomic review Bennett and Peirce (1991)

considered *Haemoproteus gymnorhis* a synonym of *Haemoproteus passeris*. Nandi and Mandal (1984) reported this species from this state.

259. *Haemoproteus pastoris* de Mello, 1935
(Figs. 414-417)

1935. *Haemoproteus pastoris* de Mello, *Proc. Indian Acad. Sci. (B)*, **2** : p. 469.

Material examined : Sev. exs., Warangal, 13.ii.1979, N. C. Nandi

Diagnosis : Macrogametocyte halteridial, medium-sized, 11.0-12.5 μm x 2.4-3.0 μm , margins usually entire, sometimes amoeboid occupying about 50% of the host cell-parasite complex; nucleus round to ovoid, sub-median; pigment granules small, scattered, 6-9 yellowish-brown granules; host cell hypertrophy less than 15% in area; host cell nuclear atrophy about 5% in area without marked displacement to the periphery.

Host : *Acridotheres tristis* (Linnaeus) and *Sturnus pagodarum* (Gmelin); site of infection: blood.

Distribution : India : Andhra Pradesh (Warangal district), Goa, Maharashtra and West Bengal.

Elsewhere : Africa, Indonesia, Thailand and Philippine Islands.

Remarks : Nandi and Mandal (1984) reported this species from this state.

260. *Haemoproteus velans* Coatney and Roudabush, 1937

1936. *Haemoproteus velans* Coatney and Roudabush, *Am. Midl. Nat.*, **18** : pp. 1005-1030.

1977. *Haemoproteus velans* Coatney and Roudabush: Greiner, Mandal and Nandi: *J. Parasitol.*, **63** : pp. 651-656.

Materials examined : Sev. exs., Adilabad, Feb., 1978, N.C. Nandi.

Diagnosis : Macrogametocyte completely encircling host cell nucleus, measuring 24.4 μm x 2.9 μm and 66.5 μm^2 in area, occupying 75-80% of the host cell parasite complex; pigment variable, yellow-brown, averaging 18 granules per parasite; volutin granules present, scattered; parasite nucleus median, oval to round, 3.0 μm x 2.3 μm and 5.8 μm^2 in area; erythrocyte nucleus partially displaced laterally; NDR = 0.68; host cell hypertrophied in length (10.8%) and in area (21.0%); host cell nucleus atrophied (19.1%) in area.

Host : *Dendrocopos mahrattensis mahrattensis* (Family Picidae); site of infection: blood.

Distribution : India : Andhra Pradesh (Adilabad district), Assam, Maharashtra and Rajasthan.

Elsewhere : Nearctic and Oriental.

Remarks : Nandi and Mandal (1984) reported this species from this state.

261. *Haemoproteus* sp

Host : *Spizaetus cirrhatus cirrhatus* (Gmelin); site of infection: blood.

Distribution : India: Andhra Pradesh (Adilabad district).

Remarks : Nandi and Mandal (1984) reported this unnamed species from this state.

262. *Haemoproteus* sp.

Host : *Nettapus coromandelianus* (Gmelin); site of infection: blood.

Distribution : India : Andhra Pradesh (Adialabad district).

Remarks : Nandi and Mandal (1984) reported this unnamed species from this state.

Family LEUCOCYTOZOIDAE

Diagnosis: Unpigmented gametocytes in the peripheral blood, schizogony in tissue cells of a vertebrate host, sporogony in insects other than mosquitoes.

Genus *Leucocytozoon* Sambon, 1908

Diagnosis : Unpigmented parasites in erythroblasts, erythrocytes, and (rarely) leucocytes of birds; host cell grossly hypertrophied, fusiform in some species, nucleus of the host cell always distorted and displaced peripherally (the form of distortion frequently of diagnostic value); first schizogonic cycle hepatic, subsequently in other tissues; schizonts with cytomeres; prepatent period short; sporogony in Simuliidae and Ceratopogonidae; oocysts small, unpigmented, usually containing fewer than 100 merozoites, 9-13 μ m in length, one end more pointed than the other.

Key to the species of *Leucocytozoon* in birds

- 1(2) Macrogametocytes dimorphic, with both round and elongate fusiform morphs, elongate morphs occupying 71% of the area of the host cell-parasite complex, parasitic in the avian order Falconiformes..... *L. toddi*
- 2(1) Macrogametocyte dimorphic and morphologically similar to *L. toddi*, elongate morphs occupying 91% of the area of the host cell-parasite complex, parasitic in the avian family Strigidae, order Strigiformes *L. ziemanni*

263. *Leucocytozoon toddi* Sambon, 1908

1908. *Leucocytozoon toddi* Sambon, *J. Trop. Med. Hyg.*, **11** : pp. 325-328.

1977. *Leucocytozoon toddi* Sambon: Greiner and Kocan: *Can. J. Zool.*, **55** : pp. 761-770.

Materials examined : Sev. exs., Adilabad, Feb., 1978, N. C. Nandi.

Diagnosis : Macrogametocyte with both round ($12.1-14.0\ \mu\text{m} \times 9.3-10.0\ \mu\text{m}$) and elongate ($20.5\ \mu\text{m} \times 8.2\ \mu\text{m}$ and $133.2\ \mu\text{m}^2$ in area); cytoplasm with a single large or numerous small vacuoles; nucleus variable, oval to round or elongate, without definite position; host cell nucleus $21.0\ \mu\text{m}^2$ in area, usually applied laterally to gametocyte, occasionally encircled by gametocyte and normally shorter than gametocyte length; infected host cell spindle-shaped with host cell cytoplasm forming wings of variable size, measuring $38.4\ \mu\text{m} \times 10.7\ \mu\text{m}$ and $187.2\ \mu\text{m}^2$ in area; host nuclear index 1.7; parasite index 2.0 and host-parasite index 2.7.

Host : *Elanus caeruleus vociferus* Latham and *Spizaetus cirrhatus cirrhatus* (Gmelin) of the avian family Accipitridae; site of infection: blood.

Distribution : India : Andhra Pradesh (Adilabad district) and Goa.

Elsewhere : Throughout the range of the avian order Falconiformes (Greiner and Kocan, 1977).

Remarks : Nandi and Mandal (1984) reported this species from this state.

264. *Leucocytozoon ziemanni* (Laveran, 1902) Wenyon, 1926

1902. *Haemamoeba ziemanni* Laveran, C.R. Seances Soc. Biol. Fil., **55** : pp. 528-530.

1993. *Leucocytozoon ziemanni* Laveran: Bennett, Earle and Peirce: *Ostrich*, **64** : pp. 67-72.

Materials examined : Sev. exs., Adilabad, Feb., 1978, N. C. Nandi.

Diagnosis : Macrogametocyte with both round and fusiform morphs; *round morph*: parasite small, round to broadly ovoid, occupying 91% of the area of the host cell parasite complex with little evidence of host cell cytoplasm; parasite nucleus round to ovoid, usually with marked karyosome; host cell nucleus short band-like, covering 28% of the periphery of the parasite and occupying 16% of the area of the host cell parasite complex; *fusiform morph*: parasite narrowly elliptical to ovoid, medium size, occupying 75% of the host cell parasite complex; host cell nucleus as a band on one side, each end terminating in small bulbs and covering 50% of the periphery of the parasite; cytoplasmic horns long, slender and sharply pointed.

Host : *Athene brama* (Temminck) (Family Strigidae); site of infection: blood.

Distribution : India: Andhra Pradesh (Adilabad district).

Elsewhere : cosmopolitan in distribution and occurring throughout the range of the Strigidae (Bennett, Earle and Peirce, 1993).

Remarks : Nandi and Mandal (1984) recorded this parasite as *Leucocytozoon danilewskyi* in *Athene brama* from Adilabad, Andhra Pradesh. The name, *Leucocytozoon danilewskyi* Ziemann was considered valid by Fallis *et al.* (1974). However, Bennett *et al.* (1975, 1993) reviewed the status of the genus *Leucocytozoon* and the terminology concerning the

leucocytozoids of the Strigidae and stated that the specific connotation, *L. danilewskyi* was invalid as Ziemann had not described it. As a result, Laveran's designation of *Leucocytozoon ziemanni* for the leucocytozoid of the Strigidae is valid.

Subclass PIROPLASMIA

Order PIROPLASMIDA

Family BABESIIDAE

Diagnosis : Parasites not forming any pigment granules; schizogony in the red blood corpuscles of vertebrates, with division into two or four; size and shape of the parasites variable, but having a tendency to arrangement in couples of pear-shaped individuals.

Genus *Babesia* Starcovici, 1893

1893. *Babesia* Starcovici, *Centranbl. Bakt.* I. Abt., **14** : p. 1.

Diagnosis : Apical complex reduced to a polar ring, rhoptries and subpellicular microtubules, filaments not present on parasitized erythrocytes.

Remarks : Key to the species of this genus is not given as the identification of the species depends on morphology, biology as well as host specificity of the parasites. Besides the species dealt hereunder, Shortt *et al.* (1961) found a *Babesia* parasite in the blood of an Indian gerbil, *Gerbillus indicus* and tested its pathogenecity in monkeys at Osmania University, Hyderabad.

265. *Babesia argentina* Lignieres, 1901

1901 *Babesia argentina* Lignieres, *Ann. Inst. Pasteur*, **15** : p. 121.

Diagnosis : Parasite small, round, pear-shaped or irregular, in pairs with an obtuse angle, measuring 1-1.5 μm in diameter; with vacuoles; situated at the centre of erythrocytes; nucleus red dot-like.

Host : Crossbred cow, *Bos* sp. site of infection : blood.

Distribution : India : Andhra Pradesh (Tirupati, Chittoor district).

Remarks : Padmavathi *et al.* (1974) reported this species in cattle at Tirupati, Andhra Pradesh. The post mortem finding revealed pale conjunctiva, echymotic haemorrhages, oedematous lungs, enlarged dark red liver, distended gall bladder and urinary bladder and congested kidney.

**266. *Babesia bigemina* (Smith and Kilborne, 1893)
(Figs. 418-421)**

1893. *Pyrosoma bigeminum* Smith and Kilborne, *U. S. Dept. Agric. Bur. Anim. Inudst. Bull.*, **1** : p. 177.

1926. *Babesia bigemina* (Smith and Kilborne): Wenyon : *Protozoology*, Vol. II, Bailliere, Tindall and Cox, London, pp. 1-993.

Diagnosis : Parasite large intraerythrocytic, round, oval, irregular, or pyriform, occurring in pairs, individuals of each pair lying closely together forming acute angle; round forms 2-3 μm in diameter, pear-shaped forms 2-4 μm x 1.5-2.0 μm , occasionally 5-6 μm in length, extending across the R. B. C.; multiplication by characteristic budding process, buds remaining attached to their pointed ends.

Host : Cattle, *Bos indicus*; site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district; pers. comm.), Tamil Nadu, Uttar Pradesh and West Bengal.

Elsewhere : Central and South America, Europe, Africa and Australia.

Remarks : This species is highly pathogenic and causing a disease known as 'Red-water fever'

267. *Babesia* sp.

Host : *Bos* sp; site of infection: blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

268. *Babesia* sp.

Host : *Manis* sp; site of infection : blood.

Distribution : India : Andhra Pradesh.

Remarks : Qadri (1962) reported this unnamed species from this state.

269. *Babesia* sp.

Host : Buffalo, *Bubalus bubalis*; site of infection: blood.

Distribution : India : Andhra Pradesh.

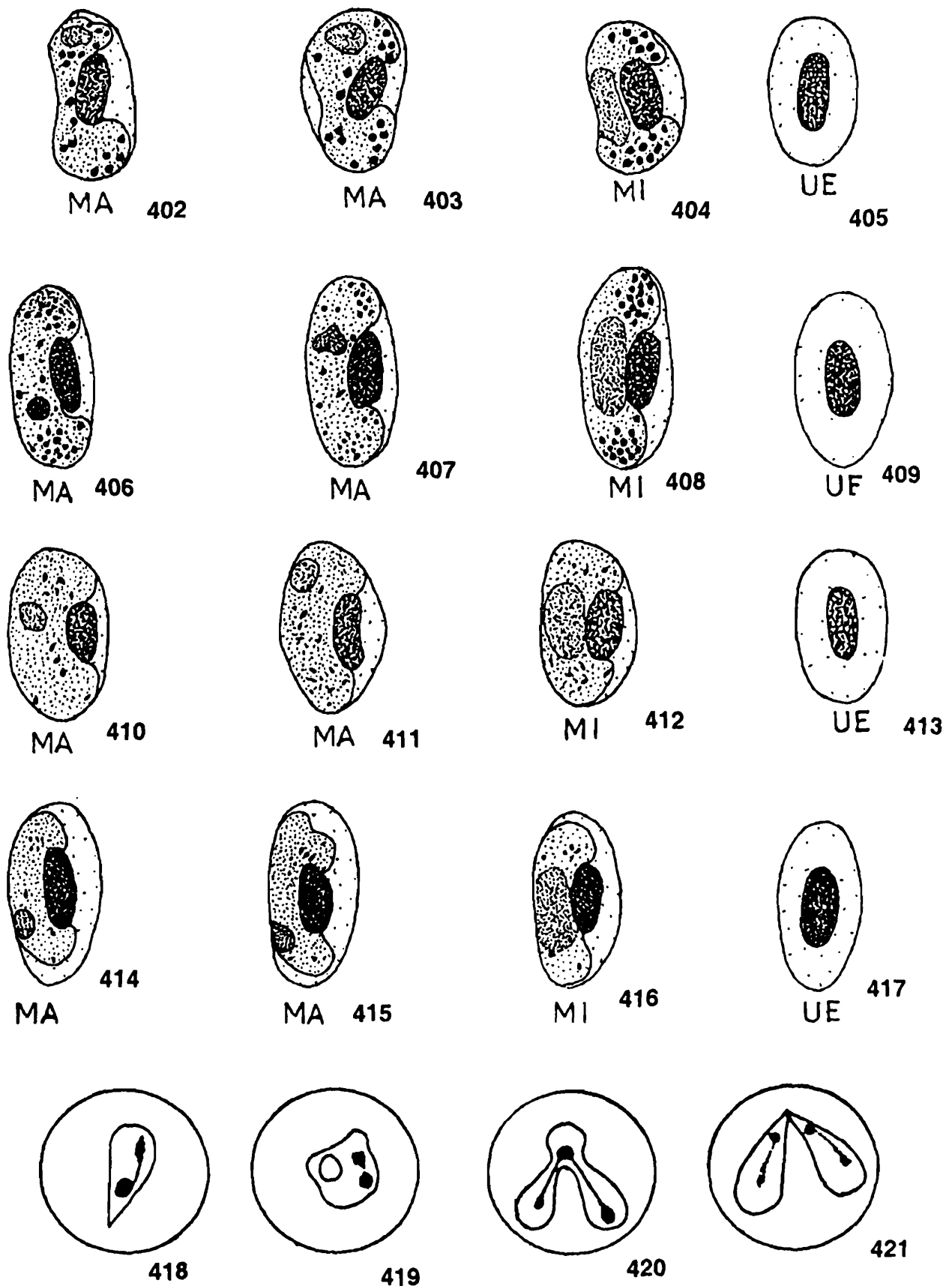
Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

270. *Babesia* sp.

Host : Sheep, *Ovis aires* site of infection: blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state. However, ovine



Figs. 402-421. Haemosporidian parasites of Andhra Pradesh : 402-405. *Haemoproteus fringillae*; 406-409. *H. meropis*; 410-413. *H. orizivora*; 414-417. *H. pastoris* and 418-421. *Babesia bigemina*. (MA = macrogametocyte, MI = microgametocyte, UE = uninfected RBC)

babesiosis in Andhra Pradesh is caused by *Babesia motasi* and *B. ovis*. The disease is characterised by fever, jaundice, haemaglobinurea and progressive anemia (pers. comm.).

271. *Babesia* sp.

Host : Dog, *Canis* sp; site of infection: blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

272. *Babesia* sp.

Host : Puma, *Puma concolor*; site of infection: blood.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

Family THEILERIIDAE

Diagnosis : Parasites without any pigment granules; schizogony in the endothelial cells of blood vessels of vertebrates; finally invading red corpuscles and occurring in various forms, showing no tendency towards paired arrangement.

Genus *Theileria* Bettencourt, Franca and Borgess, 1907

1907. *Theileria* Bettencourt, Franca and Borgess, *Arq. R. Inst. Bact. Camara Pestana*, 1 : p.341.

Diagnosis : Elements of apical complex much reduced, always including only rhoptries; polar ring or conoid lacking, usually without subpellicular microtubules, vector ixodid ticks, parasite in mammals.

Remarks : Theileriosis is a tick-borne disease caused by *Theileria* spp. in domestic animals. Besides, the species recorded hereunder, Khan (1981) diagnosed this disease in a four-month-old female gaur (*Bos gaurus*) at Zoological Park, Hyderabad. The animal initially developed eye opacity, followed by diarrhoea, champing of jaws, pyrexia (105°F) and off feed.

273. *Theileria hirci* Dschunkovsky and Urodshevich, 1924

1924. *Theileria hirci* Dschunkovsky and Urodshevich, *Parasitology*, 16 : pp. 227-235.

Diagnosis : Parasite small, variable in shape such as ring-shaped, bacillary, nail-like, oval or pyriform; occurring singly, in twos or in tripples, even in cross-like forms, in the centre of red blood corpuscle; chromatin granules of varying size and shape; schizogony in the internal organs.

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

Distribution : India : Andhra Pradesh (Hyderabad district), Uttar Pradesh, Punjab.

Remarks : Raghavachari and Reddy (1959) reported acute theileriasis in sheep infected with this species from this state.

274. *Theileria* sp.

Host : Cattle; site of infection : blood.

Distribution : India : Andhra Pradesh

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

275. *Theileria* sp.

Host : Sheep; site of infection : blood.

Distribution : India : Andhra Pradesh

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

276. *Theileria* sp.

Host : Buffalo; site of infection : blood.

Distribution : India : Andhra Pradesh

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

Incertae sedis to Order Piroplasmida

Genus *Anaplasma* Theiler, 1910

1910. *Anaplasma* Theiler, *Bull. Soc. Path. Exot.*, **3** : p. 135.

Diagnosos : Spherical body of chromatin, less than 0.5 μm in diameter, occurring in erythrocytes, ticks acting as vectors, parasitic in mammals.

277. *Anaplasma marginale* Theiler, 1910

1910. *Anaplasma marginale* Theiler, *Bull. Soc. Path. Exot.*, **3** : p. 135.

Diagnosis : Spherical chromatin granular, measuring 0.2-40 μm in diameter, apparently with no cytoplasm, parasitophorous vacuole present, usually formed at the margin of the red cells.

Host : Sheep, Spotted deer and Cattle; site of infection : blood.

Distribution : India : Andhra Pradesh (Ranga Reddy district).

Remarks : Sundaran and Bhaskara Rao (1989) recorded two cases of anaplasmosis in sheep infected with this species in blood for the first time from this state. Heart, spleen, lung, and liver impression smear also revealed the presence of this species with basophilic stippling and macrocytic anemia.

278. *Anaplasma* sp.

Diagnosis : Exotic cattle; site of infection blood.

Distribution : India : Andhra Pradesh.

Remarks : Rao *et al.* (1986) reported this unnamed species from this state.

Phylum MICROSPORA Sprague 1969
(Classification based on Sprague, Becnel and Hazard, 1992)

Class DIHAPLOPHASEA

Order MEIODIHAPLOPHASIDA

Superfamily THELOHANOIDEA

Diagnosis : With spores of one morphological type (homosporous), parasite host cell relations various, spore morphology variable, not uninucleate.

Key to the families

- 1(2) Interfacial envelop present during sporulation, elaborated by sporont, subpersistent as an octosporous vesicle, sporogonial plasmodium variable, spore morphology variable THELOHANIIDAE
- 2(1) Interfacial envelop produced precociously, enclosing more than one sporont, sporophorous vesicle containing usually 8 sometimes multiples of 8 spores DUBOSCQIIDAE

Family THELOHANIDAE Hazard and Oldacre, 1975

1975. *Thelohanidae* Hazard and Oldacre, *U.S. Dept. agric. Tech. Bulletin* No. 1530 : p. 104.

Diagnosis : As in the key.

Key to the genera

- 1(2) Only one sporulation sequence; pansporoblast subspherical, sporogony by endogenous budding accompanied by secretion of granules; 8 sporoblasts produced within a sub-persistent pansporoblastic membrane; spores oval or pyriform without tails, with distinct posterior vacuole *Thelohania*

- 2(1) Octosporus; spores more or less rod-shaped and bent in one plane to form 'C' shaped or in two planes to form spirals *Toxoglugea*

Genus *Thelohania* Henneguy, 1892
(Syn. *Orthothelohania* Codreanu and Balcescu, 1974)

1892. *Thelohania* Thelohan, P., *Bull. Soc. Philom. Paris* 4 : pp. 165-178.

Diagnosis : As in the key.

Key to the species

- 1(2) Spores oval or cylindrical, 5.0–5.4 μm x 2.0–2.5 μm , polar granule crescent-shaped *T. orchestii*
- 2(1) Spores oval 7.2 μm x 3.6 μm ; polar granule small and spherical *T. limbata*

279. *Thelohania limbata* Narasimhamurti, Nazeer Ahmed and Kalavati, 1980
(Figs. 422-426)

1980. *Thelohania limbata* Narasimhamurti, Nazeer Ahmed and Kalavati *Proc. Indian. Acad. Sci.*, **89** (6) : pp. 531-535.

Material examined : Sev. exs., S. Nazeer Ahmed, December 1975, Visakhapatnam (Visakhapatnam district).

Diagnosis : Pansporoblast octosporic, 14.4 μm x 13.2 μm , spores oval, 7.2 μm x 3.6 μm , anterior polaroblast and posterior vacuole clearly seen, polar granule small and spherical, polar filament 120–140 μm , sporoplasm binucleate.

Host : *Tramea limbata* (Odonata, Insecta); site of infection : adipose tissue.

Distribution : India : Andhra Pradesh, Visakhapatnam (Visakhapatnam district).

280. *Thelohania orchestii* Kalavati, 1976
(Figs. 427-432)

1976. *Thelohania orchestii* Kalavati, *Acta Protozool.*, **15**(3) : pp. 293-300.

Material examined : Sev. exs., C. Kalavati, July–October 1970, Visakhapatnam, Visakhapatnam district.

Diagnosis : Meronts with variable number of nuclei, 10.0–12.6 μm x 5.6–7.0 μm , pansporoblast octosporic, spores oval or cylindrical, thick walled, 5.0–5.4 μm x 2.0–2.5 μm , anterior polaroplast and posterior vacuole clearly seen, polar granule crescent-shaped, polar filament 35–40 μm , sporoplasm binucleate.

Host : *Orchestia platensis* (Amphipoda, Crustacea); site of infection : muscles.

Distribution : India : Andhra Pradesh, Visakhapatnam (Visakhapatnam district).

Genus *Toxoglugea* Leger and Hesse, 1924

(Syn. *Toxonema* Leger and Hesse, 1922, *C.R. Acad. Sci.* 174 : 328

Spirospora Leger and Hesse, 1922; *Toxospora*, Kudo, 1925, *Science*, 61 : 366;

Spirospora Kudo, 1925; *Spirillonema*, Wenyon, 1926)

1924. *Toxoglugea* Leger and Hesse, *Trav. Lab. Hydrobiol. Pisc. Univ. Grenoble*, 14 : pp. 49-56.

Diagnosis : As in the key.

281. *Toxoglugea tillargi* Kalavati and Narasimhamurti, 1978

(Figs. 433-437)

1978. *Toxoglugea tillargi* Kalavati and Narasimhamurti, *Acta Protozool.*, 15(3) : pp. 293-300

Material examined : Sev. exs., C. Kalavati, August–October, 1976-1977, Dairy farm stream, Visakhapatnam (Visakhapatnam district).

Diagnosis : Stages of merogony in oenocytes, meronts with variable number of nuclei, 2.8-6.0 μm x 1.6-5.4 μm , pansporoblast octosporic, spores kidney or bean-shaped, thick walled, refractive, 3.5–4.0 μm x 1.0–1.6 μm , anterior polaroplast and posterior vacuole clearly seen, polar granule small, polar filament thin, 45–50 μm .

Host : Larvae of *Tholymis tillarga* (Odonata, Insecta); site of infection : oenocytes.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

Family DUBOSCQIIDAE Sprague, 1977

1977. *Duboscqiidae* Sprague, *Comparative Pathobiology*. Plenum Press. New York 2 : pp. 1-510.

Diagnosis : As in the key.

Genus *Duboscqia* Perez, 1908

1908. *Duboscqia* Perez, *C. R. Soc. Biol.*, 65 : pp. 631-633.

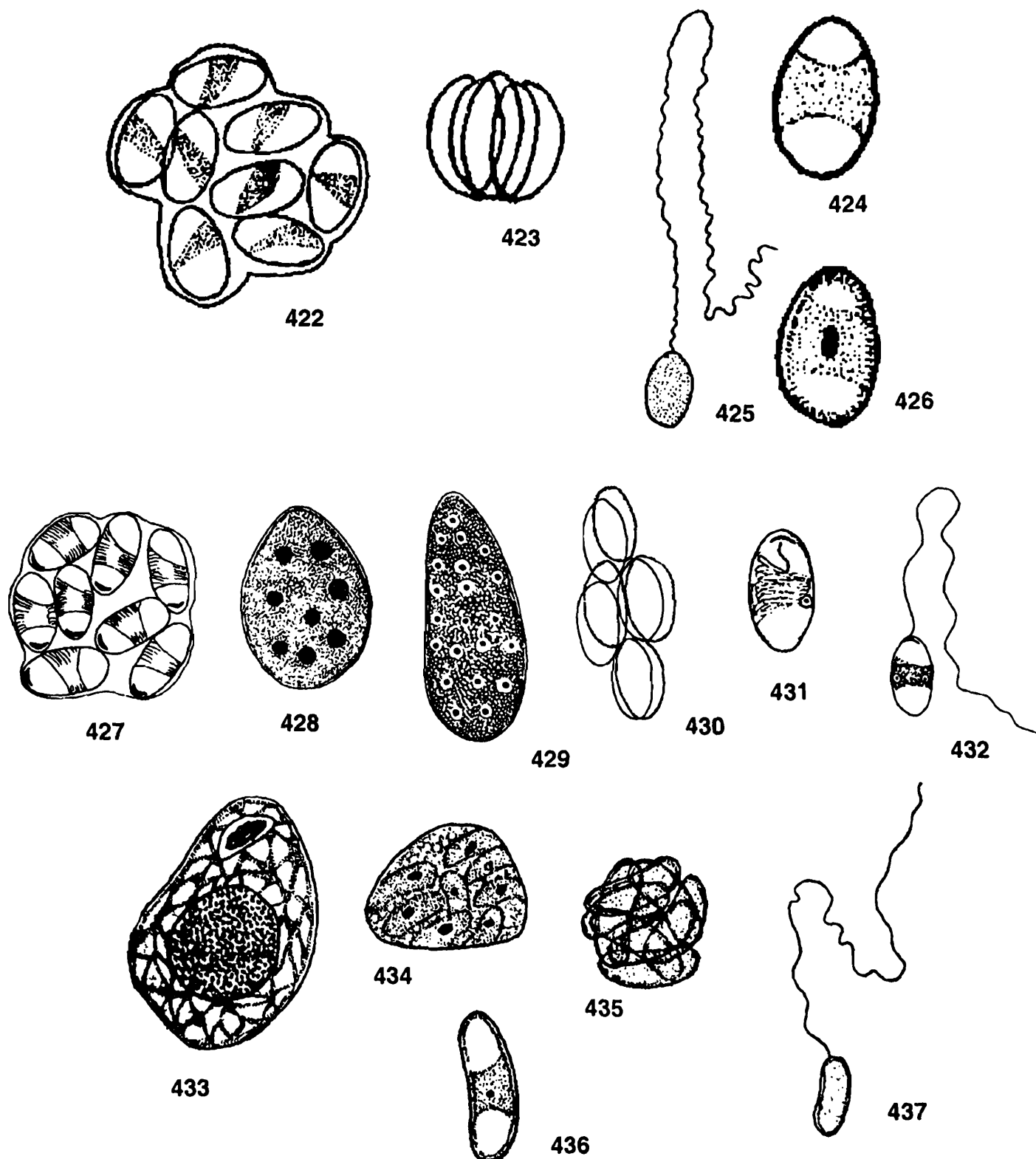
Diagnosis : Sporogony resulting in 16 sporoblasts that develop into 16 spores.

282. *Duboscqia coptotermi* Kalavati and Narasimhamurti, 1976

(Figs. 438-441)

1976. *Duboscqia coptotermi* Kalavati and Narasimhamurti, *J. Parasitol.*, 62 : p. 323.

Material examined : Sev. exs., C. Kalavati, December 1975, (Visakhapatnam, Visakhapatnam district)



Figs. 422-437. Microsporidian parasites of Andhra Pradesh : *Thelohania limbata* : 422. Pansporoblast stained, 423. Pansporoblast-fresh, 424. Spore-fresh, 425. Spore-stained with Giemsa stain, 426. Spore with extruded polar filament; *T. orchestii* : 427. Pansporoblast stained, 428. Sporont, 429. Meront, 430. Pansporoblast-fresh, 431. Spore stained with PAS, 432. Spore with extruded polar filament; and *Toxoglea tillargi* : 433. Oenocyte with spores, 434. Pansporoblast stained, 435. Pansporoblast-fresh, 436. Spore-stained with Giemsa stain, 437. Spore with extruded polar filament.

Diagnosis : Vegetative stages with as many as 16 nuclei, sporogonial plasmodia irregular in outline $23\ \mu\text{m} \times 9.0\ \mu\text{m}$, producing 16 sporoblasts that transform into 16 spores, spores oval to ellipsoid, $5.6\text{--}6.6\ \mu\text{m} \times 2.5\text{--}3.5\ \mu\text{m}$, polar filament $45\text{--}55\ \mu\text{m}$.

Host : *Coptotermes heimi* (Isoptera, Insecta); site of infection : mid gut epithelium.

Distribution : India : Andhra Pradesh, Visakhapatnam (Visakhapatnam district).

Superfamily BURENELLOIDEA Jouvenaz and Hazard, 1978

1978. *Burenelloidea* Jouvenaz and Hazard, *J. Protozool.*, **25** : pp. 24-29.

Diagnosis : Spores of 2 morphological types. "meiospores" and binucleate spore.

Family BURENELLIDAE Jouvenaz and Hazard, 1978

1978. *Burenellidae* Jouvenaz and Hazard, *J. Protozool.*, **25** : pp. 24-29.

Diagnosis : One sporulation sequence 'Thelohania-like' ending with 8 spores in a vesicle, other 'Nosema-like' ending with binucleate isolated spores.

Genus *Burenella* Jouvenaz and Hazard, 1978

1978. *Burenella* Jouvenaz and Hazard, *J. Protozool.*, **25** : pp. 24-29.

Diagnosis : Merogonic stages in the hyaloplasm of host cell, disporous sporulation in hyaloplasm and octosporous sporulation in delicate envelop producing by sporont that becoming an ephemeral sporophorous vesicle.

283. *Burenella* sp.

(Figs. 442-447)

1985. *Burenella* sp. Kalavati and Sandeep, *VI National Congress of Parasitology*, Pant Nagar, India (Abstract).

Material examined : Sev. exs., B.V. Sandeep, November-January 1979-1980, offshore fishing station , Visakhapatnam, Visakhapatnam district.

Diagnosis : Cysts milky white, 1.0-8.0 mm in diameter, two types of sporogonial sequences, disporous and octosporous, seen simultaneously, spores resulting from disporous development, pyriform, refractile, $3.0\text{--}3.2\ \mu\text{m} \times 2.2\text{--}2.4\ \mu\text{m}$, polar granules as two spherical dots, polar filament $40\text{--}60\ \mu\text{m}$, spores developing in octosporous sporulation oval, thin walled, $4.8\text{--}5.2\ \mu\text{m} \times 2.8\text{--}3.0\ \mu\text{m}$, polar granule single with small cleft, polar filament $100.0\text{--}140.0\ \mu\text{m}$.

Host : *Saurida tumbil* Bl. (Pisces); site of infection : visceral peritoneum.

Distribution : India : Andhra Pradesh, (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

Remarks : Kalavati and Sandeep (1985) reported this unnamed species from this state.

Order DISSOCIODIHAPLOPHASEA

Diagnosis : Haploisis by nuclear dissociation resulting in unpaired nuclei, homo or heterosporous.

Superfamily NOSEMATOIDEA Labbe 1899.

1899. *Nosematoidea* Labbe, *Sporozoa* : In Butschli., O. (ed), *Das Tierreich, Freidlender U. Sohn. Berlin*, 5. Lief., pp. 1-180.

Diagnosis : Homosporous, spores binucleate, dissociation occurring after the sporoplasm invading the new host cell; haploisis initiating a short haplophase consisting of gamete production and ending with plasmogamy and nuclear association; plasmogamy, sporogony and spore morphology variable.

Key to the families

1. All stages in host cell cytoplasm; conspicuous xenoma usually not formed, disporous, spores more or less reniform or ovoid NOSEMATIDAE
2. Interfacial envelop either present or absent in sporulation but very delicate and ephemeral, sporont producing 8 or 16 spores, exospore with or without ornamentation CAUDOSPORIDAE
3. Interfacial envelop present, presporogonic proliferation lacking, multisporeous, spore ovoid PSEUDOPLEISTOPHORIDAE
4. Sporulation in host cell cytoplasm, conspicuous xenoma present, disporous, spore bacilliform, with or without cauda MRAZEKIIDAE

Family NOSEMATIDAE Labbe 1899

1899. *Nosematidae* Labbe, *Sporozoa* : In Butschli., O. (ed) *Das Tierreich, Freidlender U. Sohn. Berlin*, 5. Lief., pp. 1-180.

Diagnosis : As in the key.

Genus *Nosema* Naegeli 1857

1857. *Nosema* Naegeli, *Bot. Ztg.*, 15 : pp. 760-761.

Diagnosis : Sporogony by binary fission of sporont; parasites at all stages diffuse in cytoplasm of host cell; spores ovoidal or ovocylindrical.

Key to the species

1. Spores single, oval or pyriform 4.8–6.4 μm x 1.6–3.0 μm , polar granule crescent-shaped, polar filament 80.0–150.0 μm ; parasites of odonates *N. limbata*
2. Spores pyriform, with a constriction at posterior end, 3.0–3.5 μm x 1.5–1.7 μm in size, polar granule small and spherical, polar filament 60.0 – 80.0 μm ; parasites of fish ...
..... *N. bengalis*
3. Spores isolated, pyriform, 3.5–4.0 μm x 1.6–2.0 μm , polar granule crescent-shaped, polar filament 60.0–80.0 μm ; parasites of fish.....*N. priacanthi*
4. Spores pyriform, 5.4–6.2 μm x 3.0–3.2 μm in size, polar granule small and spherical, polar filament wavy, thin, 80.0–100.0 μm ; parasites of fish *N. valamugili*
5. Spores ellipsoid, slightly flattened anteriorly, nuclei 2, in diplokaryon form $7.9 \pm 0.5 \mu\text{m}$ x $4.9 \pm 0.3 \mu\text{m}$, polar filament 190.0 μm , hyperparasite in adult trematodes
..... *N. gigantea*

284. *Nosema bengalis* Weiser, Kalavati and Sandeep, 1981

(Figs. 448-451)

1981. *Nosema bengalis* Weiser, Kalavati and Sandeep, *Acta Protozool.*, 20(2) : pp. 201-208.

Material examined : Sev. exs., C. Kalavati, October-November 1980, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Cysts (xenoma) minute, 500–800 μm in size, thin-walled, sporonts kidney-shaped or broadly oval, binucleate, spores binucleate, pyriform, anterior end pointed, posterior bulbous, with a constriction at posterior end, 3.0–3.5 μm x 1.5–1.7 μm in size, no sign of a pansporoblastic membrane, polar granule small and spherical, polar filament 60.0–80.0 μm .

Host : *Nemipterus japonicus* (Pisces); site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

285. *Nosema gigantea* Canning and Madhavi, 1977

1977. *Nosema gigantea* Canning and Madhavi. *Parasitology*, 75 : pp. 293-300.

Material examined : Sev. exs., R. Madhavi, 1973, Waltair, Visakhapatnam, Visakhapatnam district.

Diagnosis : Sporoblasts ovoid uni- or bi-nucleate, 6.8–10.8 μm x 5.3–9.8 μm , the latter giving rise to binucleate spores, arranged in diplokarya when 2 or 4 nuclei present; spores ellipsoid, slightly flattened anteriorly, nuclei 2, in diplokaryon form $7.9 \pm 0.5 \mu\text{m}$ x $4.9 \pm 0.3 \mu\text{m}$, polar filament 190.0 μm .

Host : *Allocreadium fasciatus* (Digenea, Trematoda); site of infection : parenchyma of the adult.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam, Visakhapatnam district).

286. *Nosema limbata* Narasimhamurti, Nazeer ahmed and Kalavati, 1980
(Figs. 452-454)

1980. *Nosema limbata* Narasimhamurti, Nazeer Ahmed and Kalavati, *Proc. Indian Acad. Sci.*, **89**(6) : pp. 531-535.

Material examined : Sev. exs., S. Nazeer Ahmed, July–August 1974, Waltair, Visakhapatnam (Visakhapatnam district).

Diagnosis : Spore single, oval or pyriform 4.8–6.4 μm x 1.6–3.0 μm , diplokaryotic, polar granule crescent shaped, polar filament 80.0–150.0 μm .

Host : *Tramea limbata* (Odonata, Insecta); site of infection : adipose tissue.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

287. *Nosema priacanthi* Sandeep and Kalavati, 1985
(Figs. 455-458)

1981. *Nosema priacanthi* Sandeep and Kalavati, *Indian J. Parasitol.*, **9** (2) : pp. 253-255.

Material examined : Sev. exs., B.V. Sandeep, October-November 1980, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Cysts (xenoma) minute, irregular, 0.5–1.0 mm in size, embedded in liver tissue, spores isolated, binucleate, refringent, pyriform, anterior end pointed, 3.5–4.0 μm x 1.6–2.0 μm , no sign of a pansporoblastic membrane; polar granule crescent-shaped, sporoplasm in the form of a girdle in the centre, polar filament 60.0–80.0 μm .

Host : *Priacanthus boops* (Pisces); site of infection : liver.

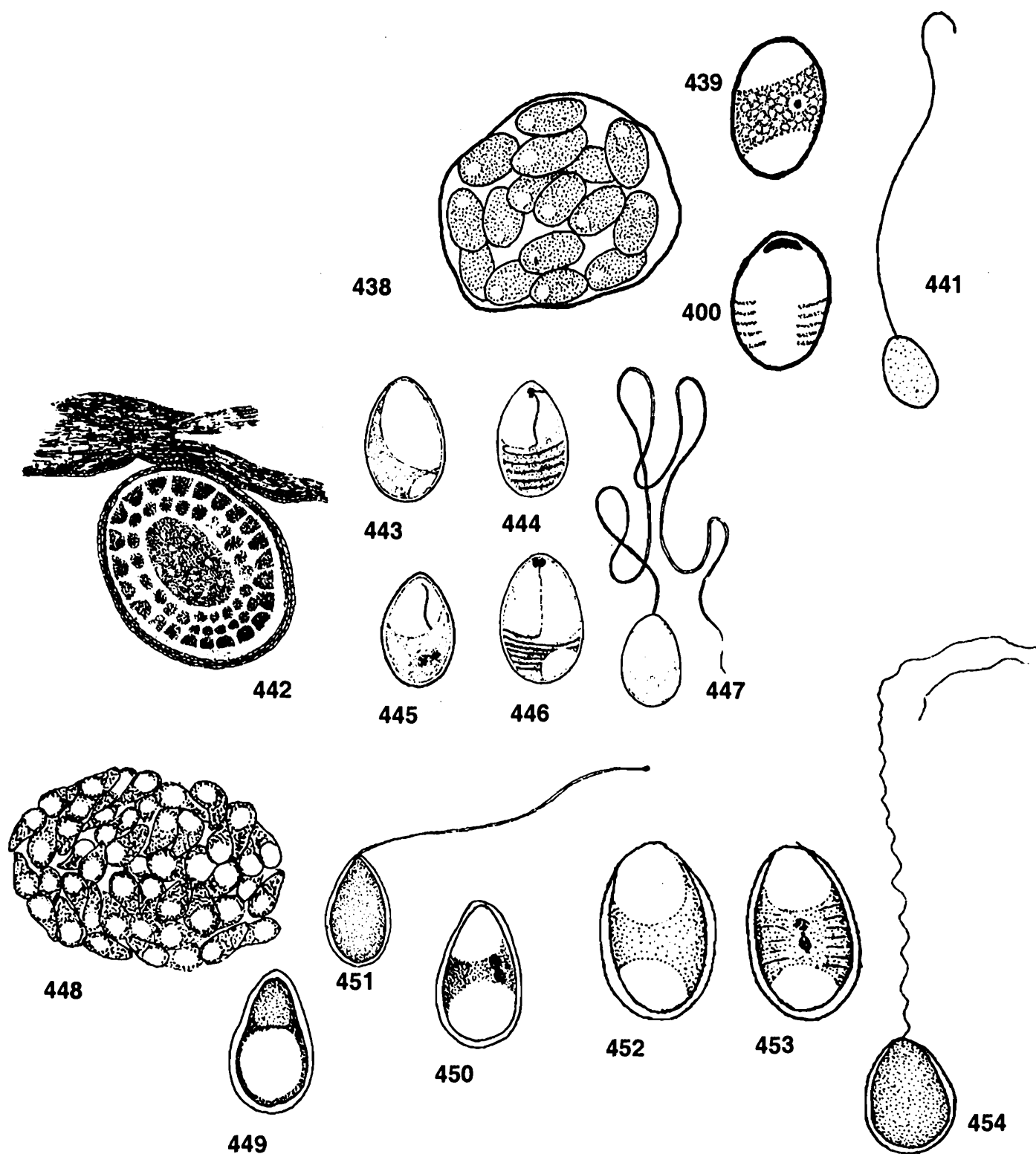
Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

288. *Nosema valamugili* Kalavati and Lakshminarayana, 1982
(Figs. 459-463)

1982. *Nosema valamugili* Kalavati and Lakshminarayana, *Acta Protozool.*, **20** (3-4) : pp. 251-256.

Material examined : Sev. exs., C. Kalavati, October-November 1981, Gosthani estuary, Bheemunipatnam (Visakhapatnam district).

Diagnosis : Xenoma (cysts) spherical or oval, white, minute 150–250 μm in size, thin-walled, sporonts bean-shaped or broadly oval bi- or tetranucleate, spores binucleate, pyriform,



Figs. 438-454. Microsporidian parasites of Andhra Pradesh : *Duboscqia coptotermi* : 438. Pansporoblast-fresh, 439. Spore-stained with Giemsa stain, 440. Spore stained with PAS, 441. Spore with extruded polar filament; *Burenella* sp. : 442. Section of xenoma, 443. Spore-fresh, 444. Spore-stained with Giemsa stain, 445. Spore-stained with PAS, 446. Macrospore-stained with PAS, 447. Spore with extruded polar filament; *Nosema bengalis* : 448. Pansporoblast-fresh, 449. Spore-fresh, 450. Spore-stained with Giemsa stain, 451. Spore with extruded polar filament; and *N. limbata* : 452. Spore-fresh, 453. Spore-stained with Giemsa stain, 454. Spore with extruded polar filament.

anterior end pointed, 5.4–6.2 μm x 3.0–3.2 μm in size, no sign of a pansporoblastic membrane, polar granule small and spherical, polar filament wavy, thin 80.0–100.0 μm .

Host : *Valamugil* sp. (Pisces); site of infection : intestine.

Distribution : India : Andhra Pradesh, (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

289. *Nosema* sp.

Host : *Megalaspis cordyla*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh, (Visakhapatnam district).

Remarks : Narasimhamurti and Kalavati (1979) recorded this unnamed species from this state.

Family CAUDOSPORIDAE Weiser, 1958

1958. *Caudosporidae* Weiser, *I. Int. Conf. Insect Pathol. Biol. Control*, Prague, pp. 277-285.

Diagnosis : As in the key.

Genus *Octosporea* Flu, 1911

1911. *Octosporea* Flu, P., *Gebilde. Centralbl. Bakteriolog. Parasitenk. Infektionskr. Hyg. Abt. I orig.*, **57** : pp. 522-535.

Diagnosis : Sporogony resulting in variable number of sporoblasts; spore diplokaryotic unornamented, short, straight or lightly bent rods.

290. *Octosporea porcelliolus* Kalavati and Narasimhamurti, 1976 emend.

Sprague and Vavra, 1977

(Syn. *Octosporea porcelloloi* Kalavati and Narasimhamurti, 1976)

(Figs. 464-468)

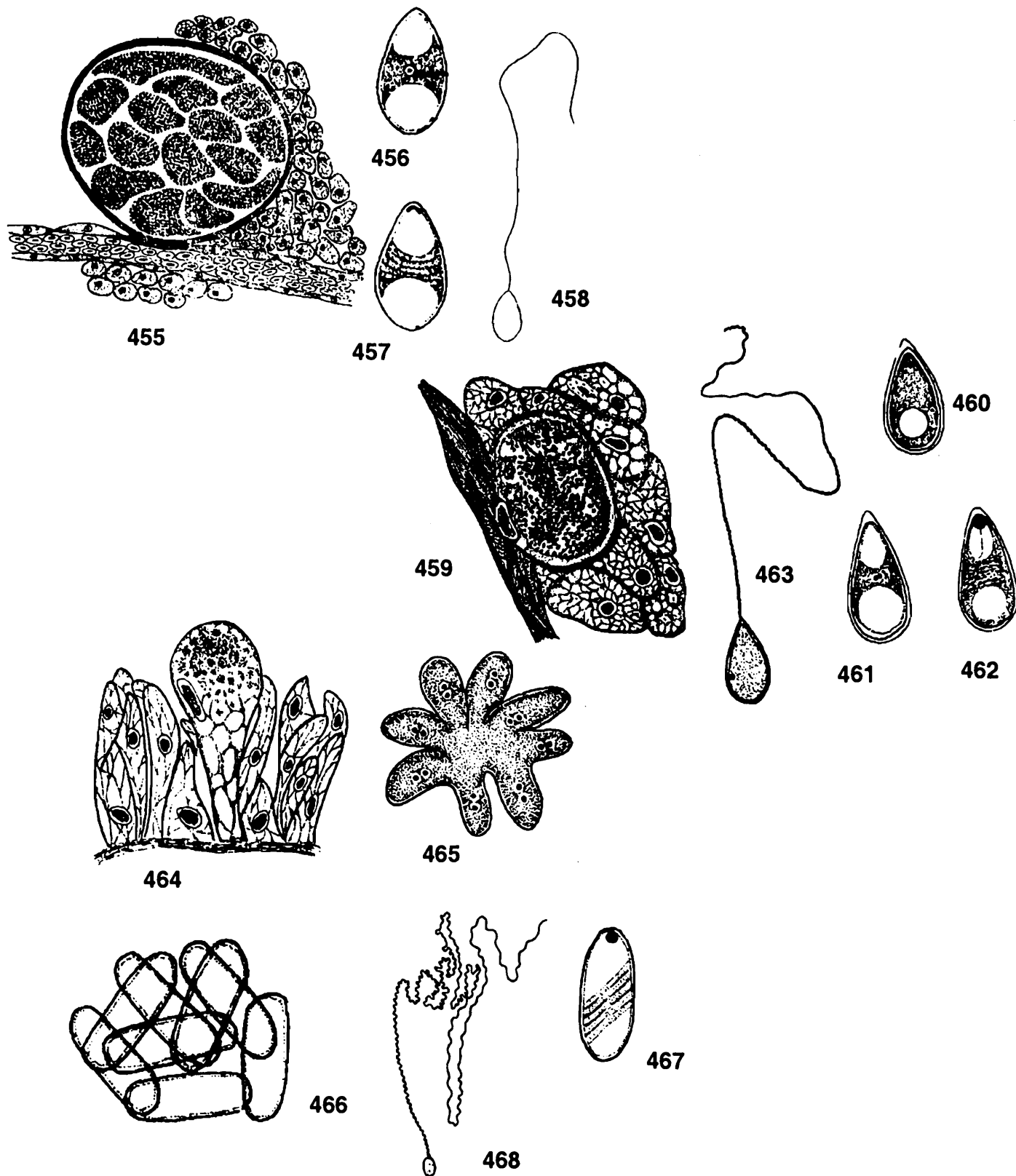
1976. *Octosporea porcelloloi* Kalavati and Narasimhamurti, *Proc. 1st Intern. Colloq. Invert. Pathol.* : p. 391.

1977. *Octosporea porcelliolus* Sprague and Vavra, *Comparative pathobiology*, Plenum Press New York 2 : pp. 1-510.

1978. *Octosporea porcelloloi* Kalavati and Narasimhamurti, *Acta protozool.*, **17**(3) : pp. 455-460.

Material examined : Sev. exs., C. Kalavati, August-October 1976-1977, Visakhapatnam (Visakhapatnam district).

Diagnosis : Plasmodia without a pansporoblastic membrane, pansporoblast 12.0-14.0 μm , usually 8, sometimes variable number of spores formed, sporoblasts arranged in the form of



Figs. 455-468. Microsporidian parasites of Andhra Pradesh: *Nosema priacanthi* : 455. Section of the xenoma, 456. Spore-stained with Giemsa stain, 457. Spore stained with PAS, 458. Spore with extruded polar filament; *N. valamugili* : 459. Section of the xenoma, 460. Spore-fresh, 461. Spore-stained with Giemsa stain, 462. Spore-stained with PAS, 463. Spore with extruded polar filament; and *Octosporea porcelliolus* : 464. Section of the gut showing spores, 465. Sporont, 466. Pansporoblast-fresh, 467. Spore-stained with PAS, 468. Spore with extruded polar filament.

rosette, spores cylindrical, 9.0-10.0 μm x 3.6-4.0 μm , sporoplasm extending like a band, polar granule small, polar filament long, thin, 220.0-300.0 μm .

Host : *Porcellio laevis* Latr. (Isopoda, Crustacea); site of infection : hypodermal cells lining the body wall.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

Remarks : Kalavati and Narasimhamurti (1976) described this species as *Octosporea porcelloloi*. Since the spelling *porcelloloi* derived from the generic name of the host is a *lapus calami* and is an incorrect spelling. Sprague and Vavra (1977) suggested an emendment (Articles 32 & 33 of the code). Hence the specific name is changed as *Octosporea porcelliolus*.

Family PSEUDOPLEISTOPHORIDAE Sprague, 1977

1977. *Pseudopleistophoridae* Sprague and Vavra, *Comparative pathobiology*. Plenum Press New York 2 : pp. 1-510.

Diagnosis : As in the key.

Genus *Steinhausia* Sprague, Ormieres and Mainer, 1972

1972. *Steinhausia* Sprague, Ormieres and Mainer, *J. Invert. pathol.*, 20 : pp. 228-231.

Diagnosis : Sporogonial plasmodia.

291. *Steinhausia spraguei* Kalavati and Narasimhamurti, 1977 (Figs. 469-472)

1977. *Steinhausia spraguei* Kalavati and Narasimhamurti *Riv. Parassitol.*, 37(2) : pp. 291-297.

Material examined : Sev. exs., C. Kalavati, December 1970 and January 1971, Offshore fish landings, off Visakhapatnam (Visakhapatnam district).

Diagnosis : Stages of sporogony intracellular, growing within an envelop, thin walled intracellular cysts oval, 40-45 μm x 20-25 μm seen, sporogony polysporic enclosing 40-50 spores, spores oval with pointed anterior end, 4.5-5.0 μm x 1.8-2.8 μm , binucleate sporoplasm extends like a band, polar granule small, dot-like, polar filament short, thick, 30.0-35.0 μm .

Host : *Sepia elliptica* Hoyle (Cephalopoda, Mollusca); site of infection : excretory cells in the renal appendages.

Distribution : India : Andhra Pradesh, (Offshore fish landings, off Visakhapatnam, Visakhapatnam district).

Family MRAZEKIIDAE Leger and Hesse, 1922

1922. *Mrazekiidae* Leger and Hesse, *C.R. Soc. Boil.*, 79 : pp. 345-348.

Diagnosis : As in the key.

Genus *Mrazekia* Leger and Hesse, 1916

1916. *Mrazekia* Leger and Hesse, *C.R. Soc. Boil.*, **79** : pp. 345-348.

Diagnosis : Sporogony by binary fission, sporoblast with diplokaryon, spore cylindrical with manubrium.

292. *Mrazekia caudata* Naidu, 1959
(Figs. 473)

1959. *Mrazekia caudata* Naidu, *Curr. sci.*, **28** : p. 212.

Diagnosis : Cysts without spores, colourless, immature cysts translucent, greenish grey, spores 23-27 μm x 1.5 μm , caudal end pointed.

Host : *Pristina longiseta longiseta* and *Nais communis* (Oligochaeta); site of infection : coelome.

Distribution : India : Andhra Pradesh (Cuddapah, Cuddapah district).

Class HAPLOPHASEA

Diagnosis : Without diplokarya, nuclei unpaired in all stages, presumed haploid.

Order GLUGEIDA Issi, 1986

1986. *Glugeida* Issi, *Acad. Sci. U.S.S.R. "Protozoology"* (Leningrad), **10** : pp. 6-136.

Diagnosis : Presporogonic proliferation present, spores usually more or less ovoid or pyriform, polaroblast well developed, parasite host cell relations and sporogony variable.

Key to the families

1. Delicate interfacial envelop present; produced by parasite, sometimes becoming a delicate sporophorous vesicle, sporogony polysporoblastic, conspicuous xenoma formed
..... GLUGEIDAE
2. Interfacial envelop consisting mostly or entirely of host material present on meront; envelop close fitting and division during merogony, separating at onset of sporogony, persisting more or less as apolysporous vesicle, sporogony polysporoblastic, conspicuous xenoma not formed PLEISTOPHORIDAE
3. Interfacial envelop lacking, sporogony disporoblastic or with moniliform plasmodia ..
..... UNIKARYONIDAE

Family GLUGEIDAE Thelohan, 1892

1892. *Glugeidae* Thelohan *Bull. Soc. Philom. Paris* 4 : pp. 165-178.

Diagnosis : As in the key.

Key to the genera

1. Xenomas with thick laminated wall, immature stages lying peripherally and oval spore lying centrally in the xenoma, vegetative reproduction by fragmentation of cylindrical plasmodia in polysporous sporophorous vesicle *Glugea*
2. Xenomas with fibrous cover, developmental stages mixed in the xenoma, vegetative reproduction by fragmentation of cylindrical plasmodia, spore oval in polysporous sporophorous vesicle, macrospores may be present *Loma*

Genus *Glugea* Thelohan, 1892

1892. *Glugea* Thelohan, *Bull. Soc. Philom. Paris* 4 : pp. 165-178.

Diagnosis : Disporoblastic sporonts arising by plasmotomy during sporogony; parasite and host cell in a symbiotic relationship and producing a cell hypertrophy tumour.

Key to the species

1. Spores oval with blunt rounded ends 4.8-5.5 μm x 2.4-3.2 μm , polar granule small and spherical, polar filament 80.0-100.0 μm *G. malabaricii*
2. Spores broadly oval with blunt rounded ends, 5.5-6.0 μm x 4.5-5.0 μm , polar granule small and spherical, polar filament 40.0-60.0 μm *G. nemipteri*

293. *Glugea malabaricii* Narasimhamurti, Kalavati and Sandeep, 1985

(Figs. 474-479)

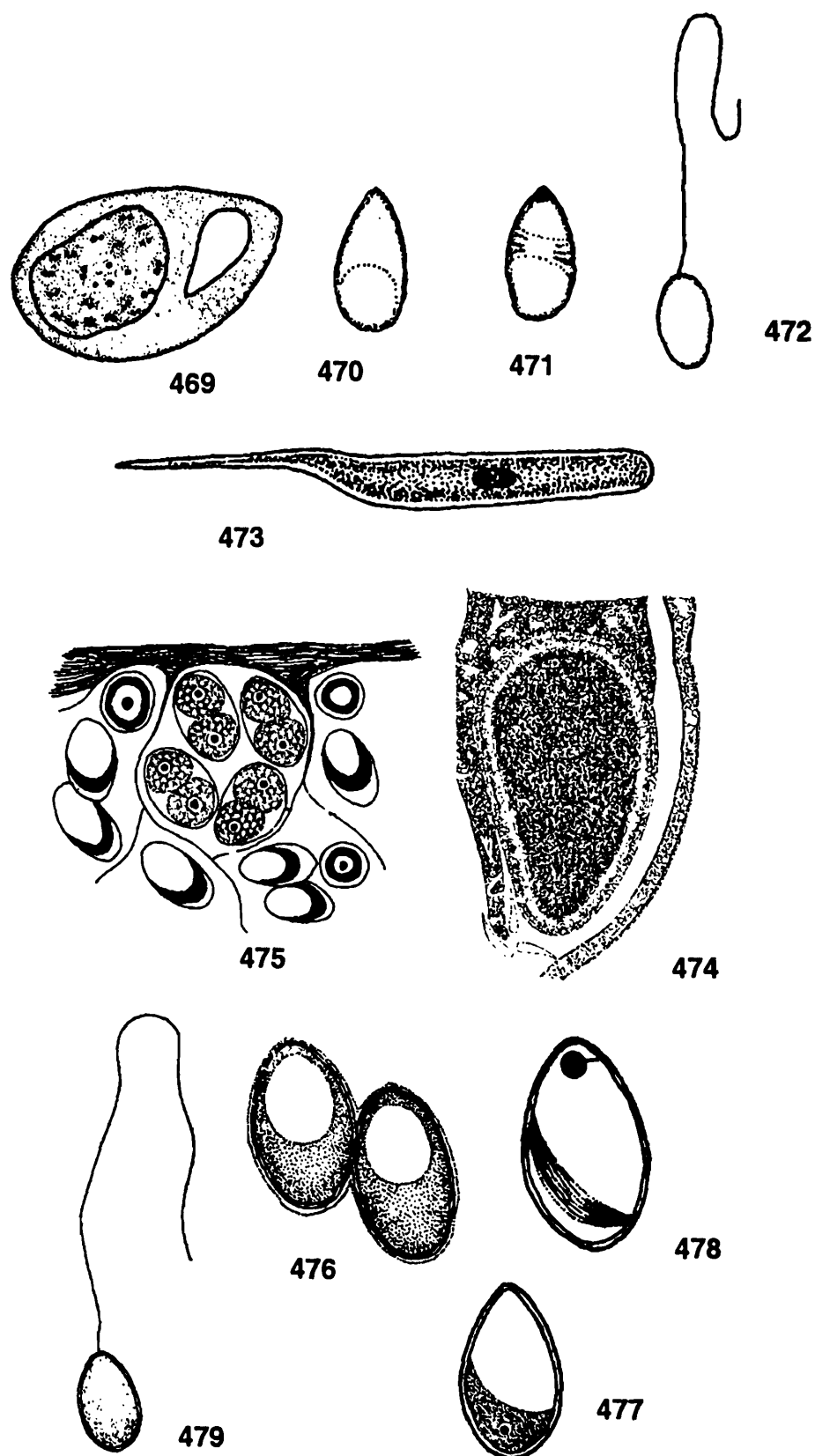
1985. *Glugea malabaricii* Narasimhamurti, Kalavati and Sandeep, *Acta Protozool*, 24 (2) : pp. 153-164.

Material examined : Sev. exs., C. Kalavati, January to November 1978, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Cyst (xenoma) 0.5–1.0 mm embedded in liver; sporoblasts oval in pairs or in large groups.; spores oval with blunt rounded ends, 4.8-5.5 μm x 2.4-3.2 μm , polar granule small and spherical, polar filament 80-100 μm .

Host : *Carangoides malabaricus* (Pisces); site of infection : liver, gonads and viscera.

Distribution : India : Andhra Pradesh, (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).



Figs. 469-479. Microsporidian parasites of Andhra Pradesh : *Steinhausia spraguei* : 469. Excretory cells showing spores, 470. Spore-fresh, 471. Spore-stained with PAS, 472. Spore with extruded polar filament; *Mrazekia caudata* : 473. Spore; and *Glugea malabaricii* : 474. Section of the xenoma, 475. Sporont, 476. Pansporoblast, 477. Spore-stained with Giemsa stain, 478. Spore-stained with PAS, 479. Spore with extruded polar filament.

Remarks : Kalavati *et al.* (1985) studied seasonal variations in the prevalence of infection of this species and reported high prevalence during winter months (November –December).

294. *Glugea nemipteri* Weiser, Kalavati and Sandeep, 1981
(Figs. 480-483)

1981. *Glugea nemipteri* Weiser, Kalavati and Sandeep, *Acta Protozool*, **20** (2), pp. 201-208.

Material examined : Sev. exs., C. Kalavati, October-November 1980, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Cyst (xenoma) grey, oval or spherical 8.0-12.0 mm in size, schizonts growing into elongate cylinders with a series of nuclei arranged in zig-zag rows, sporoblasts formed in an envelop remaining isolated; spores broadly oval with blunt rounded ends 5.5-6.0 μm x 4.5-5.0 μm , polar granule small and spherical, polar filament 40.0-60.0 μm .

Host : *Nemipterus japonicus* (Pisces); site of infection :

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

295. *Glugea* sp.

Host : *Carangrides malabaricus*; site of infection : liver and intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam District).

Remarks : Kalavati and Narasimhamurti (1978) recorded the xenoma of this unnamed species from the state.

Genus *Loma* Morrison and Sprague, 1981

1981. *Loma* Morrison and Sprague, *J. Fish Diseases*, **4** : pp. 15-32.

Diagnosis : As in the key.

Key to the species

1. Spores usually isolated, rarely in pairs, binucleate, refringent, pyriform, 2.8-3.2 μm x 1.8-2.4 μm , polar granule dot-like, polar filament 40.0-50.0 μm *L. trichiuri*
2. Spores pyriform, 4.8-6.84 μm x 3.6-5.6 μm , polar granule dot-like, polar filament uniformly thin, 85.0-100.0 μm *Loma* sp I
3. Spores oval, ends rounded, 3.8-5.6 μm x 2.8-4.2 μm , polar granule crescent-shaped, polar filament uniformly thin, 75.0-92.4 μm *Loma* sp II

296. *Loma trichiuri* Sandeep and Kalavati, 1985
(Figs. 484-487)

1985. *Loma trichiuri* Sandeep and Kalavati, *Indian J. Parasitol.*, **9**(2) : pp. 257-259.

Material examined : Sev. exs., B.V. Sandeep, September-October 1983, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Cysts (xenoma) small, spherical, yellowish, 0.25-0.5 mm in size, spores usually isolated, rarely in pairs, binucleate, refringent, pyriform, narrow anteriorly, broad posteriorly, 2.8–3.2 μm x 1.8–2.4 μm , polaroplast distinct, polar granule dot-like, polar filament 40.0–50.0 μm , sporoblasts developing in a parasitiphorous vacuole.

Host : *Trichiurus savala* (Pisces); site of infection : gills.

Distribution : India : Andhra Pradesh, (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

297. *Loma* sp I
(Figs. 488-490)

1990. *Loma* spI Narasimhamurti, Kalavati, Anuradha and Padma Dorothy, *Proc. I. Workshop on Scientific Results of FORV Sagara Sampada* 5-7th June, 1989, pp. 325-336.

Material examined : Sev. exs., Anuradha and Padma Dorothy, July, 1988, off Masulipatnam, Krishna district.

Diagnosis : Cysts (xenoma) small, spherical, milky white, 0.25-0.5 mm in size, seen embedded in the intestinal muscles, spores pyriform, anterior end sharply pointed, posterior end rounded, 4.8-6.84 μm x 3.6-5.6 μm , polaroplast distinct, polar granule dot-like, polar filament uniformly thin 85.0-100.0 μm , sporoplasm oval in the posterior region.

Host : *Tricopterus* (Pisces); site of infection : intestine.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Masulipatnam, Krishna district).

Remarks : Narasimhamurti *et al.* (1990) reported this unnamed species from this state.

298. *Loma* sp II
(Figs. 491-493)

1990. *Loma* spII Narasimhamurti, Kalavati, Anuradha and Padma Dorothy, *Proc. I. Workshop on Scientific Results of FORV Sagara Sampada* 5-7th June, 1989 : pp. 325-336.

Material examined : Sev. exs., Anuradha and Padma Dorothy, July, 1988, off Masulipatnam, Krishna district.

Diagnosis : Cysts (xenoma) small, spherical, milky white, 0.5-2.0 mm in size, seen attached to the peritoneum of viscera, spores oval, ends rounded, 3.8-5.6 μm x 2.8-4.2 μm , polaroplast

distinct, polar granule crescent-shaped, subterminal, polar filament uniformly thin, 75.0-92.4 μm , sporoplasm band-like.

Host : Scianeid (unidentified) (Pisces); site of infection : visceral peritoneum.

Distribution : India : Andhra Pradesh (Bay of Bengal. off Masulipatnam, Krishna district).

Remarks : As for preceding unnamed species.

Family PLEISTOPHORIDAE Doflein 1901

1901. *Pleistophoridae* Doflein, *Die protozoen als paraisten und krankheitserreger und biologischen Gesichtspunkten dargetsell*, Gustav Fisher, Jena, 274 pp.

Diagnosis : As in the key.

Genus *Pleistophora* Gurley, 1893 (Syn. *Plistophora*)

1893. *Pleistophora* Gurley, *Bull. U.S. Fish Comm. for 1891*, 11 : pp. 407-420.

Diagnosis : Sporogony resulting in an inconstant but typically large number of sporoblasts, sporoblast uninucleate, pansporoblastic membrane subpersistent as polysporous vesicle, mostly parasites of fish and insects.

Key to the species

1. Pansporoblast always containing more than 16 spores; spores oval, 5.4-2.0 μm with a vacuole at either end, parasite of insects *P. waltirens*
2. Pansporoblast irregular enclosing 50-64 spores; spores oval, 7.2 μm x 3.2 μm , polar filament 35-45 μm , parasite of insects *P. eretesi*
3. Pansporoblast containing 32-48 spores; spores oval with rounded corners, 6.5-8.5 μm x 2.3 μm , polar filament 45-50 μm , parasite of insects *P. blatellae*
4. Pansporoblast spherical, 18-32.0 μm enclosing 16-48 spores; spores oval, 8.0-9.0 μm x 5.0-5.4 μm , polar filament 170.0-180.0 μm , parasite of insects *P. ganapatii*
5. Pansporoblast spherical, containing variable number of spores; spores elongately oval, 5.4-6.0 μm x 1.8-2.2 μm , polaroplast not clear, polar filament 70.0-80.0 μm , parasite of insects *P. weseri*
6. Xenoma large, pansporoblast irregular, enclosing several spores; spores oval, refractile, 3.6-4.2 μm x 2.0-2.2 μm , polar filament 50 μm ; parasite of fish *P. sauridae*
7. Xenoma relatively small with a thick outer layer; pansporoblast irregular enclosing up to 360 spores ; spores oval, slightly tapering anteriorly, 4.8-5.4 μm x 1.8-2.5 μm , polar granule 'Λ' shaped; polar filament 20-25 μm ; parasite of snake *P. atretii*

299. *Pleistophora atretii* Narasimhamurti, Kalavati and Nazeer Ahmed, 1982
(Figs. 494-498)

1982. *Pleistophora atretii* Narasimhamurti, Kalavati and Nazeer Ahmed, *Acta Protozool.*, **21**(1) : pp. 127-137.

Material examined : Sev. exs., C. Kalavati, November 1970, fishlanding at offshore fishing station, Visakhapatnam, Visakhapatnam district.

Diagnosis : Xenoma (cyst) opaque, white, 700-1250 μm with a thick outer layer; pansporoblast irregular enclosing variable number of (up to 360) spores ; spores oval, slightly tapering anteriorly, 4.8-5.4 μm x 1.8-2.5 μm , refractive with rigid wall; PAS positive polar granule 'Λ' shaped, seen at the anterior end, polar filament 20-25 μm .

Host : *Atretium schistosum* (Ophidia, Reptilia); site of infection : visceral muscles adjacent to vertebral column.

Distribution : India : Andhra Pradesh, (Gudivada, Krishna district).

300. *Pleistophora blatellae* Narasimhamurti and Kalavati, 1978
(Figs. 499-503)

1978. *Pleistophora blatellae* Narasimhamurti and Kalavati, *Acta Protozool.*, **17**(3) : pp. 461-466.

Material examined : Sev. exs., C. Kalavati, August 1976, Visakhapatnam, Visakhapatnam district.

Diagnosis : Pansporoblast irregular 20-28 μm x 16-20 μm with delicate membrane enclosing 32-48 spores; spores oval with rounded corners 6.5-8.5 μm x 2.3 μm , polaroplast large and clear; PAS positive polar granule seen at the anterior end; polar filament 45-50 μm .

Host : *Blatella germanica* (Dictyoptera, Insecta); site of infection : epithelium of malpighian tubules.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

301. *Pleistophora carangoidi* Narasimhamurti and Sonabai, 1977

1977. *Pleistophora carangoidi* Narasimhamurti and Sonabai, *Proc. 5th Int. Congr. Protozool.*, p. 192.

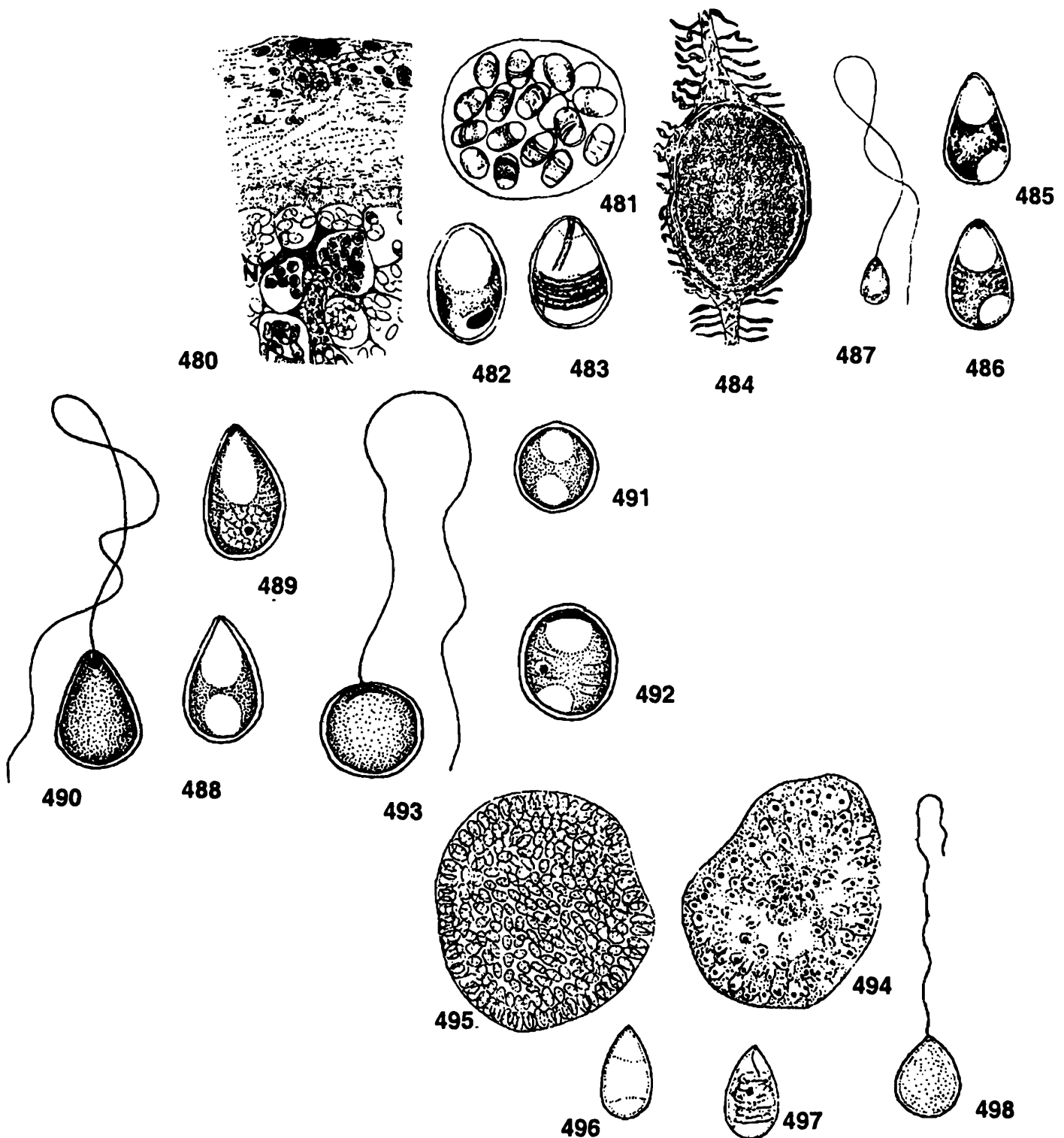
Host : *Carangoides malabaricus*; site of infection : body muscle.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : This species is treated herein as '*nomen nudum*'

302. *Pleistophora eretesi* Kalavati and Narasimhamurti, 1976
(Figs. 504-507)

1978. *Pleistophora eretesi* Kalavati, C and Narasimhamurti, C.C. *Acta Protozool.*, **15**(2) : pp. 139-142.



Figs. 480-498. Microsporidian parasites of Andhra Pradesh : *Glugea nemipteri* : 480. Section of the xenoma, 481. Mature spore in the vacuole, 482. Spore-stained with Giemsa stain, 483. Spore-stained with PAS; *Loma trichiuri* : 484. Section of the xenoma, 485. Spore-fresh, 486. Spore-stained with PAS, 487. Spore with extruded polar filament; *Loma* sp. 1 : 488. Spore-fresh, 489. Spore-stained with Giemsa stain, 490. Spore with extruded polar filament; *Loma* sp. 2 : 491. Spore-fresh, 492. Spore-stained with Giemsa stain, 493. Spore with extruded polar filament; and *Pleistophora atretii* : 494. Sporogonial plasmodium, 495. Pansporoblast, 496. Spore-fresh, 497. Spore-stained with Giemsa stain, 498. Spore with extruded polar filament.

Material examined : Sev. exs., C. Kalavati, January and February 1972-1973, Visakhapatnam, Visakhapatnam district.

Diagnosis : Pansporoblast irregular reaching a maximum of 35 μm with delicate membrane enclosing 50-64 spores; spores oval 7.2 μm x 3.2 μm , polaroplast large and clear; PAS positive polar granule seen at the anterior end, polar filament 35-45 μm .

Host : *Eretes sticticus* (Coleoptera, Insecta); site of infection : epithelium of mid gut.

Distribution : India : Andhra Pradesh, Visakhapatnam, Visakhapatnam district.

303.. *Pleistophora ganapatii* Kalavati, 1976.
(Figs. 508-511)

1976. *Pleistophora ganapatii* Kalavati, *Acta Protozool.*, **15**(4) : pp. 411- 422.

Material examined : Sev. exs., C. Kalavati, July 1969 to March 1971, Visakhapatnam, Visakhapatnam district.

Diagnosis : Sporogonial plasmodia irregular with variable number of nuclei; pansporoblast spherical, 18-32.0 μm ; with delicate membrane enclosing 16-48 spores; spores oval, 8.0-9.0 μm x 5.0-5.4 μm , polaroplast large and clear; PAS positive polar granule large bilobed seen at the anterior end; polar filament 170.0-180.0 μm .

Host : *Odontotermes horni* (Isoptera, Insecta); site of infection : epithelium foregut.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

304. *Pleistophora sauridae* Narasimhamurti and Kalavati, 1972
(Figs. 512-515)

1972. *Pleistophora sauridae* Narasimhamurti and Kalavati, *Proc. Indian Acad. Sci.*, **76**(4) : pp. 165-170.

Material examined : Sev. exs., C. Kalavati, November 1970, fish landings at offshore fishing station, Visakhapatnam, Visakhapatnam district.

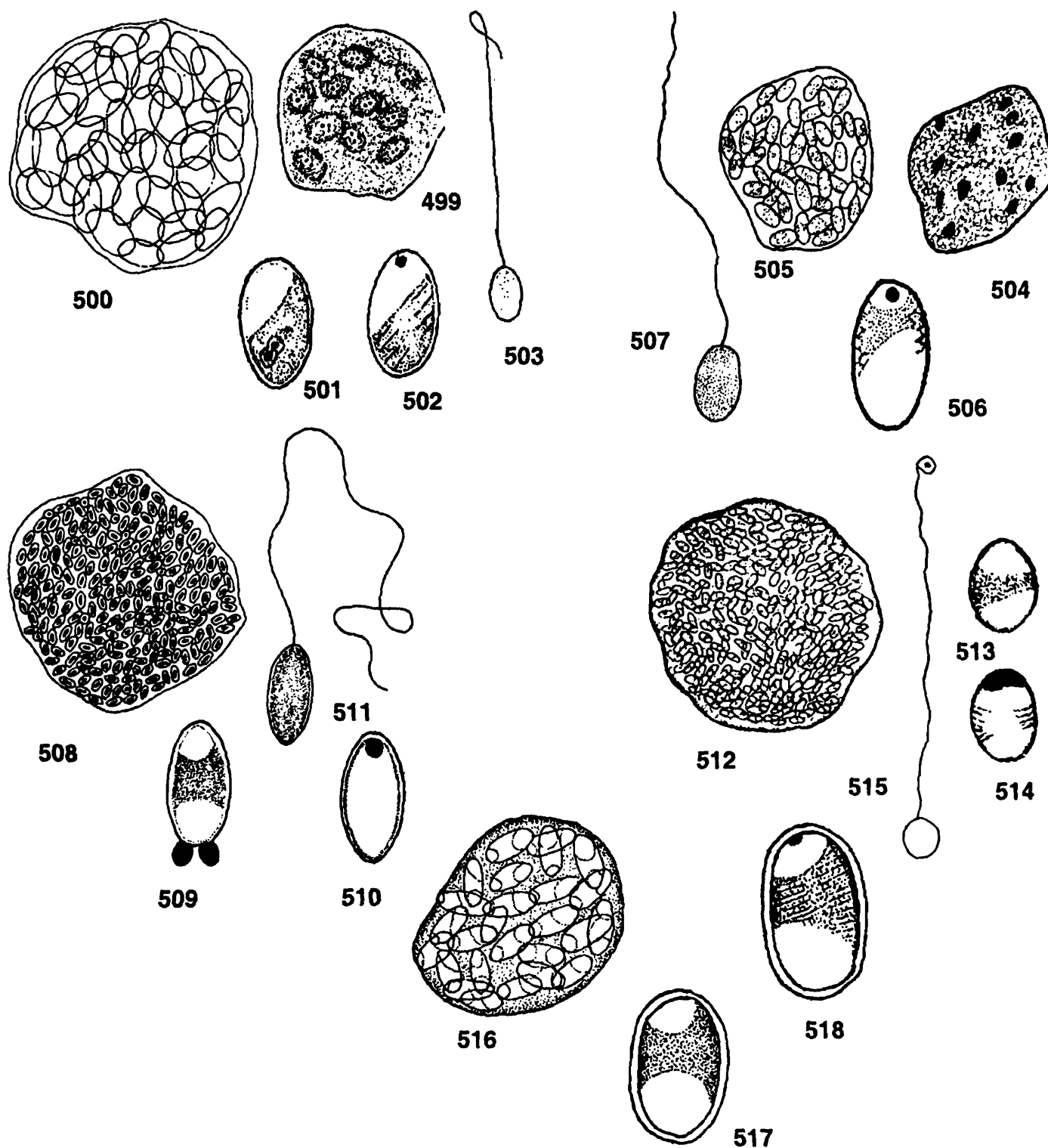
Diagnosis : Xenoma (cyst) large, opaque, white, 1.0-2.0 mm, pansporoblast irregular with delicate membrane enclosing several spores ; spores oval, refractile, 3.6-4.2 μm x 2.0-2.2 μm , polaroplast large and clear; PAS positive polar granule seen at the anterior end ; polar filament 50 μm .

Host : *Saurida tumbil* (Pisces); site of infection : visceral muscles.

Distribution : India : Andhra Pradesh (off Visakhapatnam, Visakhapatnam district).

305. *Pleistophora waltirensis* Kalavati and Ganapati, 1971
(Figs 516-518)

1971. *Pleistophora waltirensis* Kalavati and Ganapati, *Soc. Invert. Pathol. News letter*, **3** : p. 22.



Figs. 499-518. Microsporidian parasites of Andhra Pradesh : *Pleistophora blatellae* : 499. Sporogonial plasmodium, 500. Pansporoblast, 501. Spore-stained with Giemsa stain, 502. Spore-stained with PAS, 503. Spore with extruded polar filament; *P. eretesi* : 504. Sporogonial plasmodium, 505. Pansporoblast, 506. Spore-stained with PAS, 507. Spore with extruded polar filament; *P. ganapatii* : 508. Pansporoblast, 509. Spore-stained with Giemsa stain, 510. Spore stained with PAS, 511. Spore with extruded polar filament; *P. sauridae* : 512. Pansporoblast, 513. Spore-fresh, 514. Spore-stained with PAS, 515. Spore with extruded polar filament; and *P. waltirensis* : 516. Pansporoblast, 517. Spore-fresh, 518. Spore-stained with Giemsa stain.

Material examined : Sev. exs., C. Kalavati, January-August 1970, Visakhapatnam, Visakhapatnam district.

Diagnosis : Pansporoblast 9.0-25.0 μm with thin membrane containing variable number of spores, always more than 16; spores oval, 5.4-2.0 μm , with a vacuole at either end.

Host : *Euborellia plebeja* (Dermoptera, Insecta); site of infection : epithelium of malpighian tubules.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

306. *Pleistophora weiseri* Kalavati, 1976
(Figs. 519-522)

1976. *Pleistophora weiseri* Kalavati, C., *Acta Protozool.*, 15(4) : pp. 411-422.

Material examined : Sev. exs., C. Kalavati, August 1971, Visakhapatnam, Visakhapatnam district.

Diagnosis : Sporogonial plasmodia irregular, 7.0-10.0 μm x 2.0-3.0 μm , with variable number of nuclei, pansporoblast spherical, containing variable number of spores; spores generally elongately oval, 5.4-6.0 μm x 1.8-2.2 μm , polaroplast not clear; PAS positive polar granule distinctly seen at the anterior end, polar filament 70.0-80.0 μm .

Host : *Coptotermes heimi* (Isoptera, Insecta); site of infection : epithelium of foregut.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

307. *Pleistophora* sp.

Host : *Dussumeria acuta*; site of infection : liver tissue.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Narasimhamurti and Kalavati (1979) recorded this unnamed species from this state.

Family UNIKARYONIDAE Sprague, 1977

1977. *Unikaryonidae* Sprague and Vavra, *Systematics of the microsporidia*. In Bulla, L.A., Cheng, T.C. eds *Comparative pathobiology*. Plenum press New York 2 : pp. 1-510.

Diagnosis : As in the key.

Genus *Unikaryon* Canning, Lai and Lie, 1974

1974. *Unikaryon* Canning, Lai and Lie, *J. Protozool.*, 21 : pp. 19-25.

Diagnosis : Disporoblastic, nuclei unpaired throughout life cycle, cell hypertrophy tumour not formed.

308. *Unikaryon allocreadii* Canning and Madhavi, 1977

1977. *Unikaryon allocreadii* Canning and Madhavi, *Parasitology*, **75** : pp. 293-300.

Material examined : Sev. exs., R. Madhavi, 1973, Waltair, Visakhapatnam, Visakhapatnam district.

Diagnosis : Early sporonts spindle-shaped, binucleate, mature sporonts dumbbell-shaped $5.2 \pm 0.4 \mu\text{m} \times 2.3 \pm 0.2 \mu\text{m}$, fresh spores oval, slightly asymmetrical, one side flatter than the other, uninucleate, $3.5 \pm 0.2 \mu\text{m} \times 2.7 \pm 0.2 \mu\text{m}$, polar filament $30 \mu\text{m}$.

Host : *Allocreadium fasciatus* (Digenea, Trematoda); site of infection : parenchyma of the adult.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam, Visakhapatnam district).

TAXA INCERTAE SEDIS

Family GURLEYIDAE

Genus *Gurleya* Doflein, 1898

(Syn. *Marsoniella*, Lemmerman, 1900, *Bert. Dtsch. Bot. Ges.*, pp. 18-273)

1898. *Gurleya* Doflein, *Die protozoen als paraisten und krankheitserreger und biologischen Gesichtspunkten dargetellt*, Gustav Fisher, Jena, 274 pp.

Diagnosis : 4 spores produced in a transitory pansporoblast.

309. *Gurleya spraguei* Kalavati 1976

(Figs. 523-527)

1976. *Gurleya spraguei* Kalavati, *Acta Protozool.*, **15**(4) : pp. 411-422.

Material examined : Sev. exs., C. Kalavati, January 1968–February 1969, Visakhapatnam, Visakhapatnam district.

Diagnosis : Sporogonial plasmodia irregular with variable number of nuclei; pansporoblast with 4 spores characteristically arranged, $18-32.0 \mu\text{m}$, with delicate membrane; spores oval, refractive, $4.0-4.5 \mu\text{m} \times 2.0-2.5 \mu\text{m}$, polaroplast large and clear; PAS positive polar granule large trilobed seen at the anterior end; polar filament $75.0-85.0 \mu\text{m}$.

Host : *Macrotermes estharae* (Isoptera, Insecta); site of infection : adipose tissue.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

Family INDETERMINABLE

Genus *Stempellia* Leger and Hesse, 1910

1910. *Stempellia* Leger and Hesse, *C.R. Acad. Sci.*, **150** : pp. 411-414.

Diagnosis : Tetrasporous sporonts (producing pyriform spores) and octosporous sporonts (producing ovoid spores) occurring in about equal numbers; rarely monosporous (?).

310. *Stempellia odontotermi* Kalavati, 1976
(Figs. 528-532)

1976. *Stempellia odontotermi* Kalavati, C. *Acta Protozool.*, 15(4) : pp. 411-422.

Material examined : Sev. exs., C. Kalavati, December 1969, Visakhapatnam, Visakhapatnam district.

Diagnosis : Meronts irregular 6.0-12.0 μm x 3.5-10.0 μm , pansporoblast with 2, 4 or 8 spores, spores oval with a slightly pointed anterior end, variable in size, small spore measuring 4.2 μm x 3.0 μm and large spores 12.6 μm x 4.0 μm ; PAS positive polar granule small, spherical, seen at the anterior end; polar filament 300.0-380.0 μm .

Host : *Odontotermes* sp. (Isoptera, Insecta); site of infection : epithelial cells of foregut.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

Genus *Microsporidium*

Remarks : The microsporidian spores for which no characters are available for a generic diagnosis of the parasite, are usually referred to the collective genus *Microsporidium*. As such it has no formal status in taxonomy (Sprague, 1977; Canning and Lom, 1986; Canning, 1993) and hence generic diagnosis is not given.

311. *Microsporidium sauridae* (Narasimhamurti and Kalavati)
Sprague 1977
(Syn. *Nosema sauridae* Narasimhamurti and Kalavati, 1972)
(Figs. 533-536)

1977. *Microsporidium sauridae* Sprague, *Systematics of the Microsporidia*. In Bulla, L.A., Cheng, T.C. eds *Comparative Pathobiology*. Plenum press New York 2 : pp. 1-510.

1972. *Nosema sauridae* Narasimhamurti and Kalavati, *Proc. Indian Acad. Sci.* 76(4) : pp. 165-170.

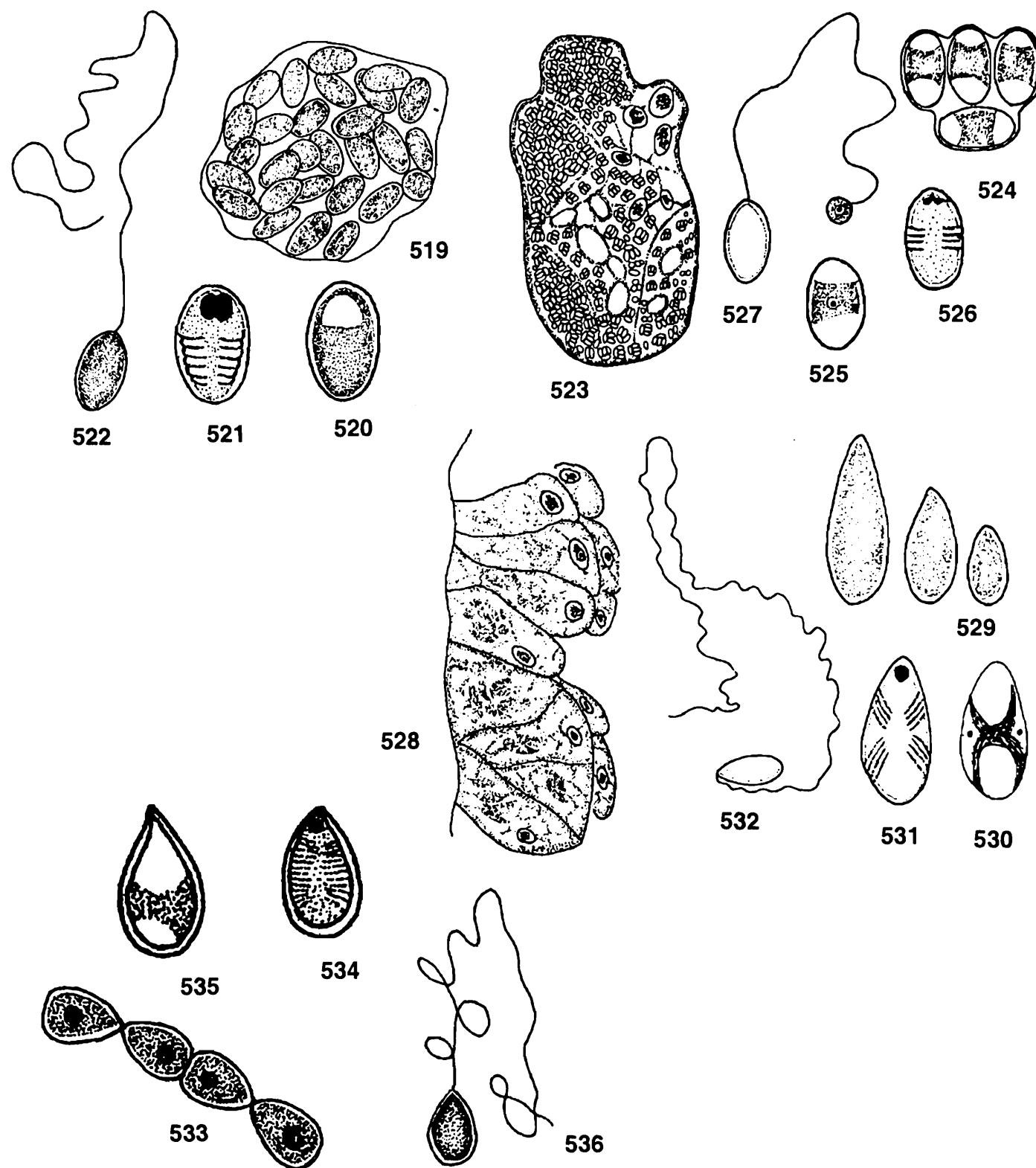
Material examined : Sev. exs., C. Kalavati, November 1970, fish landings at offshore fishing station, Visakhapatnam, Visakhapatnam district.

Diagnosis : Xenoma (cyst) large, opaque, white, 1.0-2.0 mm, sporoblast diplokaryotic, isolated, spores binucleate, pyriform, 2.3-3.8 μm x 1.8-2.0 μm , polaroplast large and clear; PAS positive polar granule small, dot-like, seen at the anterior end, polar filament 150.0-180.0 μm .

Host : *Saurida tumbil* (Pisces); site of infection : visceral muscles.

Distribution : India : Andhra Pradesh (off Visakhapatnam, Visakhapatnam district).

Remarks : Narasimhamurti and Kalavati (1972) described the species as *Nosema sauridae*. Sprague and Vavra (1977) while revising the classification and species descriptions erected a new genus *Microsporidium* to accommodate those species which did not fit into the taxonomic descriptions of the existing genera. Sprague and Vavra (*op.cit*) transferred *Nosema sauridae* Narasimhamurti and Kalavati to the genus *Microsporidium* renaming it as *Microsporidium sauridae*.



Figs. 519-536. Microsporidian parasites of Andhra Pradesh : *Pleistophora weiseri* : 519. Pansporoblast, 520. Spore-fresh, 521. Spore-stained with PAS, 522. Spore with extruded polar filament; *Gurleya spraguei* : 523. Infected adipose tissue, 524. Pansporoblast, 525. Spore-stained with Giemsa stain, 526. Spore stained with PAS, 527. Spore with extruded polar filament; *Stempellia odontotermi* : 528. Section of the gut showing spores, 529. Spore variations, 530. Spore-stained with Giemsa stain, 531. Spore-stained with PAS, 532. Spore with extruded polar filament; and *Microsporidium sauridae* : 533. Chain of sporoblasts, 534. Spore-fresh, 535. Spore-stained with PAS, 536. Spore with extruded polar filament.

Phylum ASCETOSPORA
 Class HAPLOSPOREA
 Order MEIODIHAPLOPHASIDA
 Family COELOSPORIDAE

Diagnosis : Simple uninucleate spore; parasite inhabiting body cavity.

Genus *Coelosporidium* Mesnil and Merchoux, 1897

1897. *Coelosporidium* Mesnil and Marchoux, *C. R. Acad. Sci.*, Paris, **125** : p. 323.

Diagnosis : Small body, forming cysts; spores resembling microsporidian spores, but without a polar filament; inhabiting coelom of arthropods.

Key to the species

- 1(2) Cysts spherical, 25 μm in diameter; 70-80 ovoid spores *C. schmackeriae*
 2(1) Cysts spherical, 16-27 μm in diameter, 40-60 ovoid spores *C. oithonae*

312. *Coelosporidium schmackeriae* Ganapati, Narasimhamurti and
 Santha Kumari, 1964
 (Figs. 537-541)

1964. *Coelosporidium schmackeriae* Ganapati, Narasimhamurti and Santha Kumari, *Proc. Indian Acad. Sci.*, **50** (5) : pp. 309-314.

Material examined : Sev. exs., Santhakumari, July-October 1962, Bay of Bengal, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Development coelozoic; multinucleate plasmodia undergoing multiplication by repeated plasmotomy; spore formation by fragmentation into uninucleate bodies; cysts spherical, 25.0 μm in diameter, enclosing 70-80 spores; spores ovoid, 3.0 μm x 2.5 μm ; with rigid double layered envelop

Host : *Schmackeria serricaudata* Kr. (Copepoda, Crustacea); site of infection : body cavity.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

2. *Coelosporidium oithonae* Narasimhamurti and Kalavati, 1976
 (Figs. 542-545)

1976. *Coelosporidium oithonae* Narasimhamurti and Kalavati, *Proc. Indian Acad. Sci.*, **86** (1) : pp. 20-25.

Material examined : Sev. exs., C. Kalavati, November 1969, Bay of Bengal, off Visakhapatnam, Visakhapatnam district.

Diagnosis : Development coelozoic; plasmodia irregular, 25.4 μm x 12.5 μm , with as many as 200 nuclei undergoing multiplication by repeated plasmotomy; spore formation by fragmentation into uninucleate bodies; cysts spherical, 16.0-27.0 μm in diameter, enclosing 40-60 spores; spores ovoid, uninucleate 4.8 μm x 1.6 μm .

Host : *Oithona rigida* (Copepoda, Crustacea); site of infection : body cavity.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

Family NEPHRIDIOPHAGIDAE

Diagnosis : Simple uninucleate spores; parasite inhabiting Malpighian tubules.

Genus *Nephridiophaga* Ivanic, 1937

1937. *Nephridiophaga* Ivanic, *La cellule*, **45** : pp. 291-327.

Diagnosis : Typically intracellular parasite with simple spores; development part intracellular and part haemocoelomic; inhabiting epithelial tissue of Malpighian tubules.

314. *Nephridiophaga xenoboli* Ganapati and Narasimhamurti, 1960 (Figs. 546-549)

1960. *Nephridiophaga xenoboli* Ganapati and Narasimhamurti, *Parasitology*, **50** : pp. 581-585.

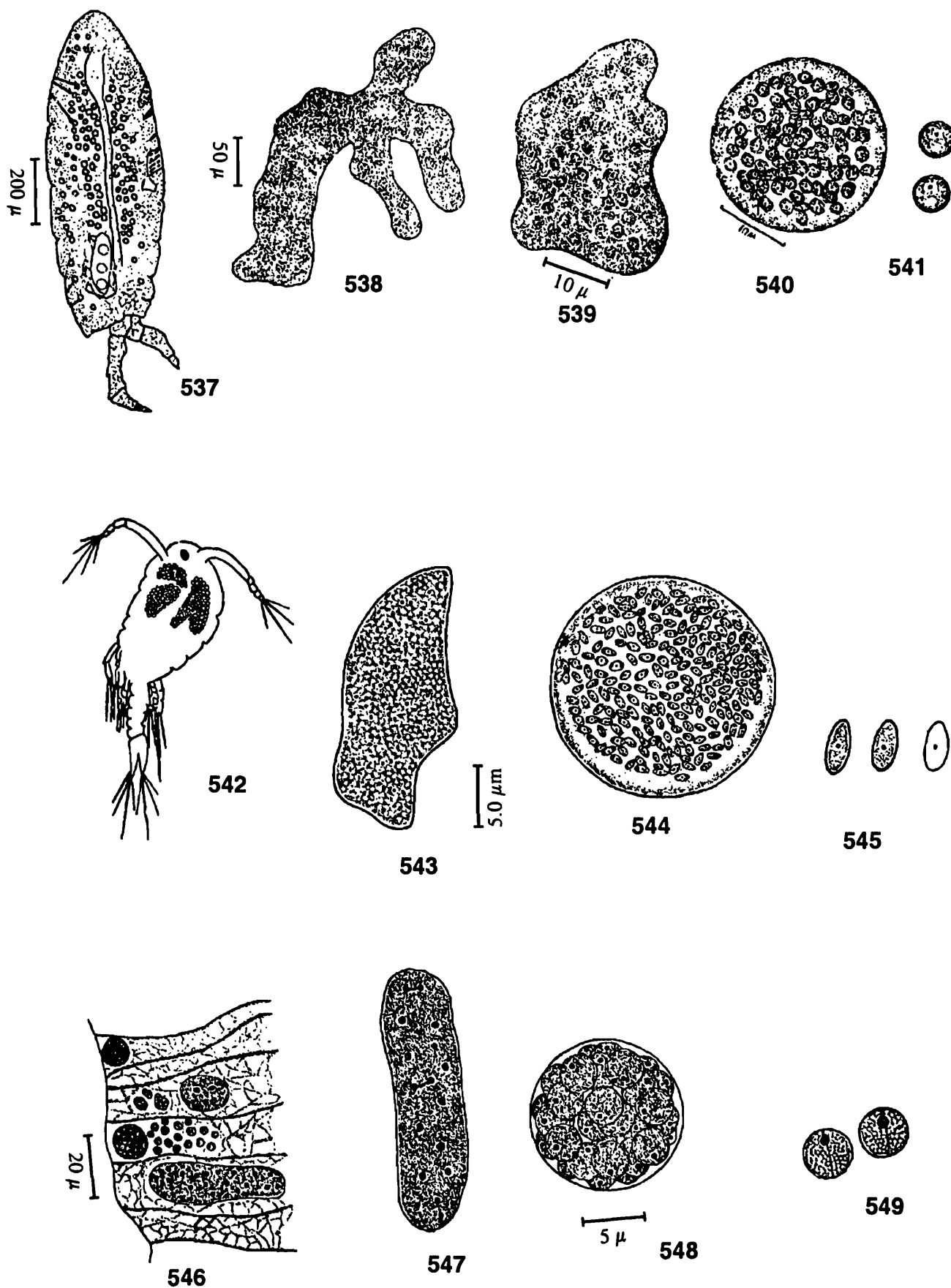
Material examined : Sev. exs., Narasimhamurti, 1959, Visakhapatnam, Visakhapatnam district.

Diagnosis : Development intracellular, multinucleate plasmodia producing uninucleate gametes by endogenous budding in the center of the plasmodium, sporoblast formed as result of fusion of 2 such gametes, cysts mulberry-like formed within the epithelium, spores spherical, bivalved, 3.0 μm in diameter, two valves fusing longitudinally forming a suture.

Host : *Xenobolus carnifex* (Myriapoda, Arthropoda); site of infection : gut epithelium.

Distribution : India : Andhra Pradesh, (Visakhapatnam, Visakhapatnam district).

Remarks : Although Purrini and Weiser (1990), resurrected the family Coelosporidae, the two genera *Coelosporidium* and *Nephridiophaga* were not considered as members of the phylum Haplosporea in the recent classifications of protists by Corliss, 1984; Lee *et al.*, 1985; Perkins, 1990; Hausmann and Haulsmann, 1996 and Cavalier-Smith, 1998 since they do not have the distinct characters, namely, haplosporosomes and spore orifice. They were, however, not transferred to any other phyla. Lange (1993) established the protozoan nature of the genus *Nephridiophaga* but preferred to retain them as 'protista of *incertae sedis*'. Patterson (1999) considered coelosporids and nephridiophagids as taxa with clear ultrastructural identity but without any agreement with other taxa. Hence, not included in any phyla.



Figs. 537-549. Ascetosporan parasites of Andhra Pradesh : 537-541. *Coelosporidium schmackeriae*; 542-545. *C. oithonae* and 546-549. *Nephridiophaga xenoboli*.

Phylum MYXOZOA Grasse, 1960

(Classification according to Lom and Noble, 1984; Revised Lom and Dykova, 1992)

Class MYXOSPOREA Butschli, 1881

Order BIVALVULIDA Schulman, 1959.

Sub order VARIISPORINA Lom and Noble, 1984

Key to the Families

1. Spores with polar capsules located at either pole or widely separated..... 3
2. Spores with polar capsules located at the anterior pole 4
- 3.1 Spores spindle-shaped/sigmoid or crescentic; polar capsules located along the sutural plane in the opposite ends; sutural line longitudinal, straight or curved MYXIDIIDAE
- 4.1 Spores with 2 polar capsules 5
- 4.2 Spores with 2 or 4 polar capsules 6
- 4.3 Spores with 1 polar capsule..... 7
- 5.1 Spores spherical to irregularly ellipsoidal, bilaterally symmetrical; sutural line straight; polar capsules wide apart in sutural plane, capsular foramina directed away from each other ORTHOLINEIDAE
- 5.2 Spores spherical or inversely pyramidal with or without caudal or lateral projections; polar capsules anterior, spherical or sub-spherical and perpendicular to sutural line; sutural line sinuous, often '8' shaped SINUOLINEIDAE
- 5.3 Spores with shell valves elongated, drawn out in the plane perpendicular to sutural line; sutural line transverse, central and straight; shell valves symmetrical or asymmetrical; polar capsule spherical or sub-spherical, perpendicular to sutural line CERATOMYXIDAE
- 5.4 Spores spherical or pyramidal with tapering anterior end or elongated often with appendages; polar capsules located at the anterior tip, perpendicular to straight sutural line SPHAEROSPORIDAE
- 6.1 Spores spherical, sub-spherical or elongated with or without caudal appendages; sutural line straight, meridional, bisecting the spore; polar capsules 4, at the apex, either one pair in the level of the sutural line and second pair perpendicular or both pairs diagonally beyond the level of suture. CHLROMYXIDAE
- 6.2 Spores thin walled, asymmetrical, elongated in sutural plane; shell valves unequal; sutural

line curved; polar capsules 2 to 4, conspicuously small at the apex
 PARVICAPSULIDAE

- 7.1 Spores with asymmetric, unequal, smooth shell valves and single elongated polar capsule
 with a few longitudinal coils of the filament AUERBACHIDAE

Family MYXIDIIDAE Thelohan, 1892

1892. *Myxidiidae* Thelohan, *Bull. Soc. Philon.*, 4 : pp. 165-178.

Diagnosis : As in the key.

Key to the genera

1. Spores fusiform, straight or slightly crescentic or sigmoid with more or less pointed ends; shell valves smooth or with ridges; sutural line straight, bisecting the spore; 2 pyriform polar capsules lying one at either end of the spore; capsular foramina lying in the sutural plane at or near the end of the spore and usually open in opposite directions; sporoplasm binucleate, located between the capsules, usually coelozoic, occasionally histozoic in marine and freshwater fishes, rarely in amphibians Genus *Myxidium*
2. Spores ellipsoidal in sutural view, slightly bent or semicircular in valvular view, with rounded or bluntly pointed ends; sutural line straight, curved or sinuous; polar capsules almost spherical, usually open slightly subterminally and both to one side; sporoplasm binucleate, coelozoic in marine and freshwater fishes Genus *Zschokkella*
3. Spore semicircular in valvular view and fusiform in sutural view; sutural ridge oblique slightly arched with raised edges; spore valves striated with lid-like structure at the opening of the polar capsules; polar capsules oval or spherical either divergent or convergent; parasites of amphibians Genus *Parazschokkella*

Genus *Myxidium* Bütschli 1882
 (= *Cystodiscus* Lutz, 1889)

1882. *Myxidium* Bütschli, *Klass ordn., des tierreiches, Protozoa*, vol. 1, pp. 590-603.

1889. *Cystodiscus* Lutz, *Centrbl. Bakteriolog. u. Parasitenk.*, vol. 5 : pp. 84-88.

Diagnosis : As in the key.

Key to the species

1. Spores fusiform with flat ends; valves striated; 11.4–13.6 μm x 5.4–7.1 μm .. *M. aori*
2. Spores rectangular/dumbbell-shaped with rounded ends; 9.6-14.4 μm x 4.8-8.0 μm ...
 *M. papernae*

315. *Myxidium aori* Lalitha Kumari, 1969
(Figs. 550-552)

1969. *Myxidium aori* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153-225.

Diagnosis : Spores fusiform with flat ends, slightly curved, with one side more convex than the other. 11.4-12.6 μm x 5.4-6.4 μm in size; valves uniformly thick, asymmetrical with 8-10 striations; sutural ridge wide and straight; sutural line fine; polar capsules 2, located one at each pole, oval or pyriform 3.6-4.1 μm x 2.1-2.7 μm ; polar filament forming 4-5 oblique coils while inside the capsule, 73-118 (94.5) μm when extended; sporoplasm granular, homogenous, occupying the space between the capsules.

Host : *Macrones aor* (= *Aorichthys aor*); site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Hyderabad city; Hyderabad district and Warangal, Warangal district).

316. *Myxidium papernae* Padma Dorothy and Kalavati, 1992
(Figs. 553 & 554)

1992. *Myxidium papernae* Padma Dorothy and Kalavati, *Uttar Pradesh. J. Zool.*, **12**(1) : pp. 15-19.

Material examined : Sev. exs., Gosthani estuary and backwaters of Visakhapatnam, Visakhapatnam district; May 1986, K. Padma Dorothy.

Diagnosis : Pansporoblast disporous; spores transparent, rectangular with rounded ends or dumbbell-shaped; lateral walls concave; 9.6-14.4 (11.04) μm x 4.8-8.0 (7.04) μm ; valves equal, striated. 4-5 striations seen on each valve; polar capsules 2, spherical, terminal at either end of the spore; capsular foramina located at the tip of a beak-like projection. 3.2-4.8 (3.36) μm in diameter; polar filament 16.1- 2.7 (22.5) μm ; sporoplasm hyaline, binucleate occupies the entire spore cavity.

Host : *Liza macrolepis*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Gosthani Estuary, Bheemunipatnam and backwaters of Visakhapatnam, Bay of Bengal, Visakhapatnam district).

Genus *Zschokkella* Auerbach, 1910

1910. *Zschokkella* Auerbach., *Zool. Anz.*, **35** : pp. 240-256.

Diagnosis : As in the key.

Key to the species

1(2). Polar capsules spherical without neck

- 1.1 Spores oval, transversely striated, 9-12 striae, 11.18-15.48 μm x 7.74-10.32 μm
 *Z. ganapatii*
- 2(1). Polar capsules spherical with a neck
- 2.1 With short neck; spores hemispherical /gibbous; valves striated, 10-12 striae, 9.3-12.9 μm x 4.3-7.1 μm *Z. labeonis*
- 2.2 With prominent neck; spores ellipsoidal/gibbous, 12.9-14.3 μm x 5.0-7.1 μm
 *Z. ophicephali*

317. *Zschokkella ganapatii* Padma Dorothy and Kalavati, 1992
 (Figs 555-557)

1992. *Zschokkella ganapatii* Padma Dorothy and Kalavati, *Uttar Pradesh. J. Zool.*, **12** (1) : pp. 15-19.

Material examined : Sev. exs., Gosthany estuary, Visakhapatnam district; November, 1987, K. Padma Dorothy.

Diagnosis : Pansporoblast disporous; spores oval, 11.18-15.48 (12.84) μm x 7.74 - 10.32 (9.81) μm ; valves thick, refringent, transversely striated. 9-12 striations seen; sutural ridge 'S' shaped; polar capsules spherical, one at either end, sub-terminal; capsular foramina diagonally opposite with thick cushion-like annuli. 2.58-4.3 (3.41) μm ; polar filaments making 3-4 coils while inside the capsule, 28.0-40.0 (34.1) μm when extended; sporoplasm hyaline lightly stained, intercapsular.

Host : *Liza macrolepis*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Gosthani Estuary, Bheemunipatnam and Bay of Bengal, Visakhapatnam, Visakhapatnam district).

318. *Zschokkella labeonis* Lalitha Kumari, 1969
 (Figs. 558-560)

1969. *Zschokkella labeonis* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153-225.

Diagnosis : Spores hemispherical or gibbous in valvular view and ellipsoidal in sutural view, 9.3-12.9 (10.3) μm x 4.3-7.1 (6.2) μm in size; valves uniformly thick, asymmetrical with 10-12 striae curved and running parallel to sutural line, converging at the poles; sutural line oblique, sinuous, elongated and 'S' shaped in sutural view; polar capsules 2, located one at each pole, spherical with short neck. 2.9-4.3 (3.7) μm x 2.1-3.6 (2.9) μm ; polar filament forming 4-5 oblique coils while inside the capsule, 30-42 μm when extended; sporoplasm finely granular forming a compact mass below the capsules.

Host : *Labeo nigripinnis*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

319. *Zschokkella ophicephali* Lalitha Kumari, 1969
(Figs. 561-562)

1969. *Zschokkella ophicephali* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153-225.

Material examined : Sev. exs., Srungavarapukota, Visakhapatnam district; July, 1978. B. Saratchandra.

Diagnosis : Pansporoblasts monosporous; spores gibbous-shaped in valvular view and ellipsoidal in sutural view, one side straight and the other curved; poles pointed; $12.9\text{--}14.3\ \mu\text{m} \times 5.0\text{--}7.1\ \mu\text{m}$ in size; valves uniformly thick, asymmetrical with 10–12 striae; sutural line oblique, sinuous, elongated and 'S' shaped in sutural view; polar capsules 2, located one at each pole, spherical with prominent neck. $3.6\text{--}3.9\ \mu\text{m} \times 2.9\text{--}3.2\ \mu\text{m}$; polar filament forming 6–7 coils while inside the capsule; sporoplasm finely granular, trapezoidal forming a compact mass between the capsules.

Host : *Channa* (= *Ophicephalus*) *striatus*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district; Srungavarapukota, Visakhapatnam district).

320. *Zschokkella* sp.

1951. *Zschokkella* sp. Qadri, *Trans. R. Soc. trop. Med. Hyg.*, **44**, pp. 356-357.

Host : *Heteropneustes* (= *Saccobranchus*) *fossilis*; site of infection : gale bladder.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Qadri (1951) reported this species from the above said host.

Genus *Parazschokkella*, Kalavati and Narasimhamurti, 1987

1987. *Parazschokkella* Kalavati and Narasimhamurti, *Acta Protozool.*, **26** (2) : pp. 189-194.

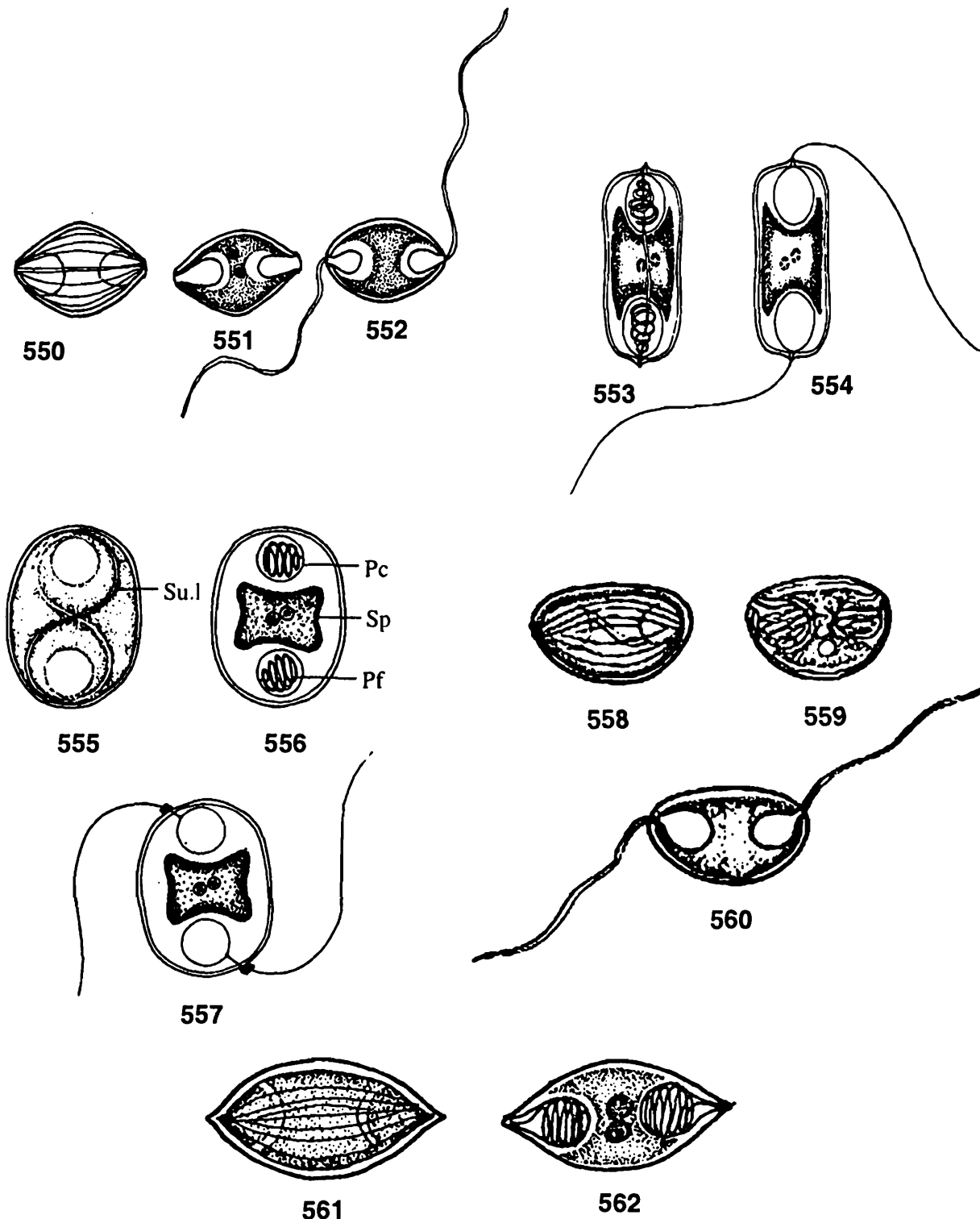
Diagnosis : As in the key.

321. *Parazschokkella melanosticti* Kalavati and Narasimhamurti
(Figs. 563-566)

1987. *Parazschokkella melanosticti* Kalavati and Narasimhamurti, *Acta Protozool.*, **26** (2) : pp. 189-194.

Material examined : Sev. exs., Machilipatnam, Krishna district. April 1982; Y. Usharani. Visakhapatnam, Visakhapatnam district, Vizianagaram, Vizianagaram district; C. Kalavati March 1984.

Diagnosis : Pansporoblast disporous; spores semicircular in valvular view; anterior end broad and flat, posterior rounded; fusiform with rounded ends in sutural view, $6.0\text{--}7.0\ (6.5)\ \mu\text{m} \times 9.6\text{--}10.5\ (9.8)\ \mu\text{m} \times 6.0\text{--}6.4\ (6.2)\ \mu\text{m}$ in size; valves equal, striated. 8-12 transverse striations seen; corners at the anterior end thickened; sutural ridge, raised, arched or 'S'



[Figs. 550-764. Myxozoan parasites of Andhra Pradesh showing spores with polar capsule (Pc/PC), polar filament (Pf), sporoplasm (Sp/SP), sutural line (Su.l), striations (Str), spore body (Spb), lateral appendage (Lat. appn), intercapsular appendix (INT. Cap. app, I Cap.), iodophilous vacuole (Iv), sutural ridge (SR), sporoplasm nucleus (SN), caudal appendage (CA), nucleus (N), perietal fold (PF), mucous envelope (Mu, env), caudal process (CP).]

Figs. 550-562. Myxozoan parasites of Andhra Pradesh : 550-552. *Myxidium aori*; 553-554. *M. papernae*; 555-557. *Zschokkella ganapatii*; 558-560. *Z. labeonis* and 561- 562. *Z. ophicephali*.

shaped; polar capsules 2, divergent, oval with a short neck at opposite poles, 2.0-2.5 (2.2) μm x 1.6-2.0 (1.8) μm ; polar filament showed 2-3 coils while inside the capsule; ribbon-like, flat, club-shaped distally and 26-30 (28.0) μm when extended; sporoplasm oval or bean-shaped in the posterior part of the spore.

Host : *Bufo melanostictus*, site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district; Vizianagaram, Vizianagaram district and Machilipatnam, Krishna district).

Family ORTHOLINEIDAE Lom and Noble, 1984

1984. *Ortholineidae* Lom and Noble, *Folia Parasitologia (Praha)*, **31** : pp. 193-205.

Diagnosis : As in the key.

Genus *Ortholinea* Schulman, 1962

1962 *Ortholinea* Schulman, *Myxosporidia* : In *Oprederitel' presnovodnykh Ryb SSSR IZD.* Moscow/Leningrad. pp. 47-130.

Diagnosis : Spherical or sub-spherical spores slightly flattened in sutural plane; polar capsules sub-spherical to pyriform; sporoplasm binucleate; coelozoic in urinary tract of marine fishes, rarely histozoic; polar capsules spherical with a neck.

322. *Ortholinea visakhapatnamensis* Padma Dorothy and Kalavati, 1993 (Figs. 567-571)

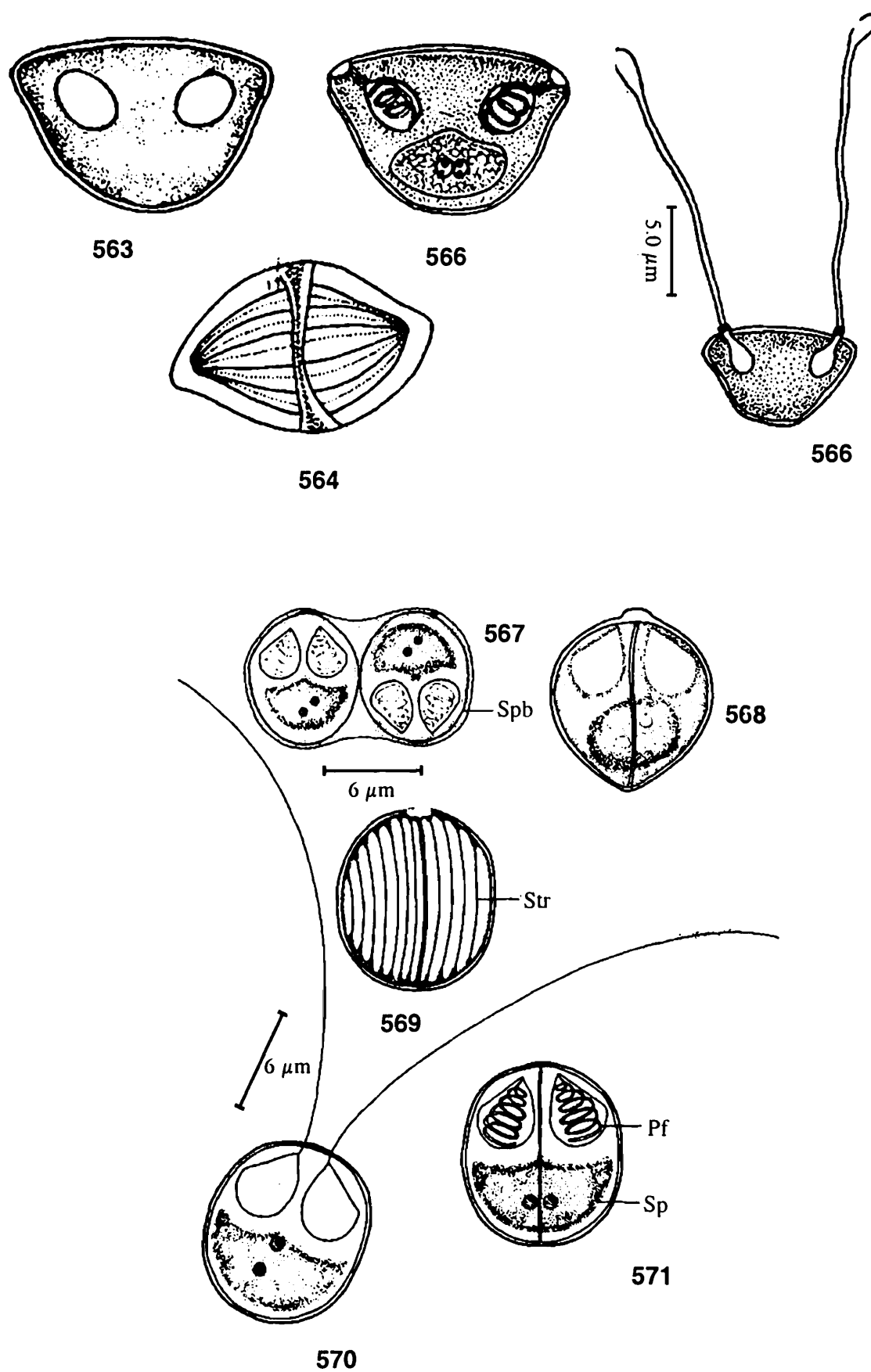
1993. *Ortholinea visakhapatnamensis* Padma Dorothy and Kalavati, *Riv. Parassitol.*, **10** (54) 3 : pp. 461-465.

Material examined : Sev. exs., Visakhapatnam backwaters, Bay of Bengal, Visakhapatnam district, December 1987, K. Padma Dorothy.

Diagnosis : Cysts elongate or oval 0.7-1.3 μm x 0.5-0.9 μm ; pansporoblasts disporous; spores spherical 5.16-6.0 (5.9) μm in diameter or broadly triangular (6.88 μm x 5.1 μm) with bluntly pointed posterior end; anterior end broad, corners round; valves equal, striated, 8 longitudinal striations seen; sutural line straight, prominent; polar capsules subspherical to pyriform, 2.6-3.5 (3.0) μm x 1.7-2.6 (2.2) μm parallel on either side of sutural line; capsular foramina widely separated with a deeply stained thickening in between; polar filaments making 5-6 coils while inside the capsule, 17.6-24.0 (19.9) μm when extended; no iodophilous vacuole; sporoplasm hyaline extending into intercapsular region, occupying the entire spore cavity.

Host : *Liza macrolepis*; site of infection : visceral peritoneum.

Distribution : India : Andhra Pradesh (Visakhapatnam backwater region, Bay of Bengal, Visakhapatnam district).



Figs. 563-571. Myxozoan parasites of Andhra Pradesh : 563-566. *Parazschokkella melanosticti* and 567-571. *Ortholinea visakhapatnamensis*.

Family SINUOLINEIDAE Schulman, 1959

1959. *Sinuolinedae* Schulman, *Tr. Karelsk. fil. An. SSSR. Vopr. Parazitol. Karelii.*, pp. 33-47.

Diagnosis : As in the key.

Key to the genera

1. Spores spherical or sub-spherical, sutural line straight or sinuous; shell valves bearing hollow lateral appendages, the cavity of which discontinuous with spore cavity; polar capsules anterior, sub-terminal, coelozoic Genus *Davisia*
2. Spores inversely pyramidal 3
- 3.1 Spores inversely pyramidal in sutural view, ellipsoidal in lateral view, ends pointed extending backwards; sutural line sinuous; anterior end of the shell valve drawn out into a wing-like projection containing valvogenic nucleus; polar capsules spherical Genus *Bipteria*
- 3.2 Spores inversely pyramidal with anterior wing-like projection of shell valves; in addition a 'keel' like extension running meridionally along the sutural line; polar capsules spherical Genus *Neobipteria*

Genus *Davisia* Laird, 1953

1953. *Davisia* Laird, *Trans. Roy. Soc. N.Z.*, **81** : pp. 265-356.

Diagnosis : As in the key.

Key to the species

1. Spores oval 3
2. Spores crescent-shaped, spore body triangular or oval 4.8-11.2 μm x 19.8-36.2 μm ; polar capsules spherical *D. murtii*
- 3.1 Spores flattened, oval; lateral appendages equal, hollow with broad end; 32.2-42.2 (37.01) μm x 11.4-15.8 (12.6) μm *D. cynoglossi*
- 3.2 Spores oval, lateral appendages hollow, unequal filaments, 120-176 μm x 13-14 μm *D. filiformis*

323. *Davisia cynoglossi* Narasimhamurti, Kalavati,
Anuradha and Padma Dorothy
(Figs. 572-574)

1990. *Davisia cynoglossi* Narasimhamurti *et al.*, *Proc. First. Workshop Scient. Result. FORV Sagarasampada*, 1989 : pp. 325-336.

Material examined : Sev. exs., off Masulipatnam, Krishna district; 10.vii.1988, I. Anuradha and K. Padma Dorothy.

Diagnosis : Spores flattened, bent with hollow lateral appendages having distinct junction to spore body; proximal portion of appendage broad; distal end narrow and oval; spore body oval. 12.6-16.8 (14.24) μm x 11.4-15.8 (12.6) μm ; lateral appendage 20.8-36.4 μm x 10.4-18.2 (14.5) μm , total width of the spore 32.2-42.2 (37.01) μm ; valves thin; sutural line distinct, slightly wavy; polar capsules oval. 5.8-6.8 (6.2) μm x 2.8-4.2 (3.4) μm in size; polar filament 22.4-28.6 (24.8) μm in length; sporoplasm oval, granular, binucleate.

Host : *Cynoglossus* sp.; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Bay of Bengal, Lat. 15°58' N Long. 81°31'E, off Masulipatnam, Krishna district).

324. *Davisia filiformis* Padma Dorothy, Kalavati and Vaidehi, 1998
(Figs 575-576)

1998. *Davisia filiformis* Padma Dorothy *et al.*, *Riv. Parassitol.*, **15** (55) : pp. 67-72.

Material examined : 2 exs., Visakhapatnam, Visakhapatnam district, December 1991, C. Kalavati.

Diagnosis : Pansporoblast disporous; spore body oval with distinct joints of lateral appendages, demarcated by a deeply stained cushion-like-structure; total width 120-176 μm ; spore body 16-20 μm x 13-14 μm ; valves thin, smooth; sutural line thin, straight; lateral appendages unequal, long, hollow, filamentous; polar capsule pyriform, 8-10 μm x 6-8 μm ; polar filament forming 2 to 3 coils while inside the capsule; sporoplasm hyaline filling the entire spore cavity.

Host : *Thriposocles setirostris*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam).

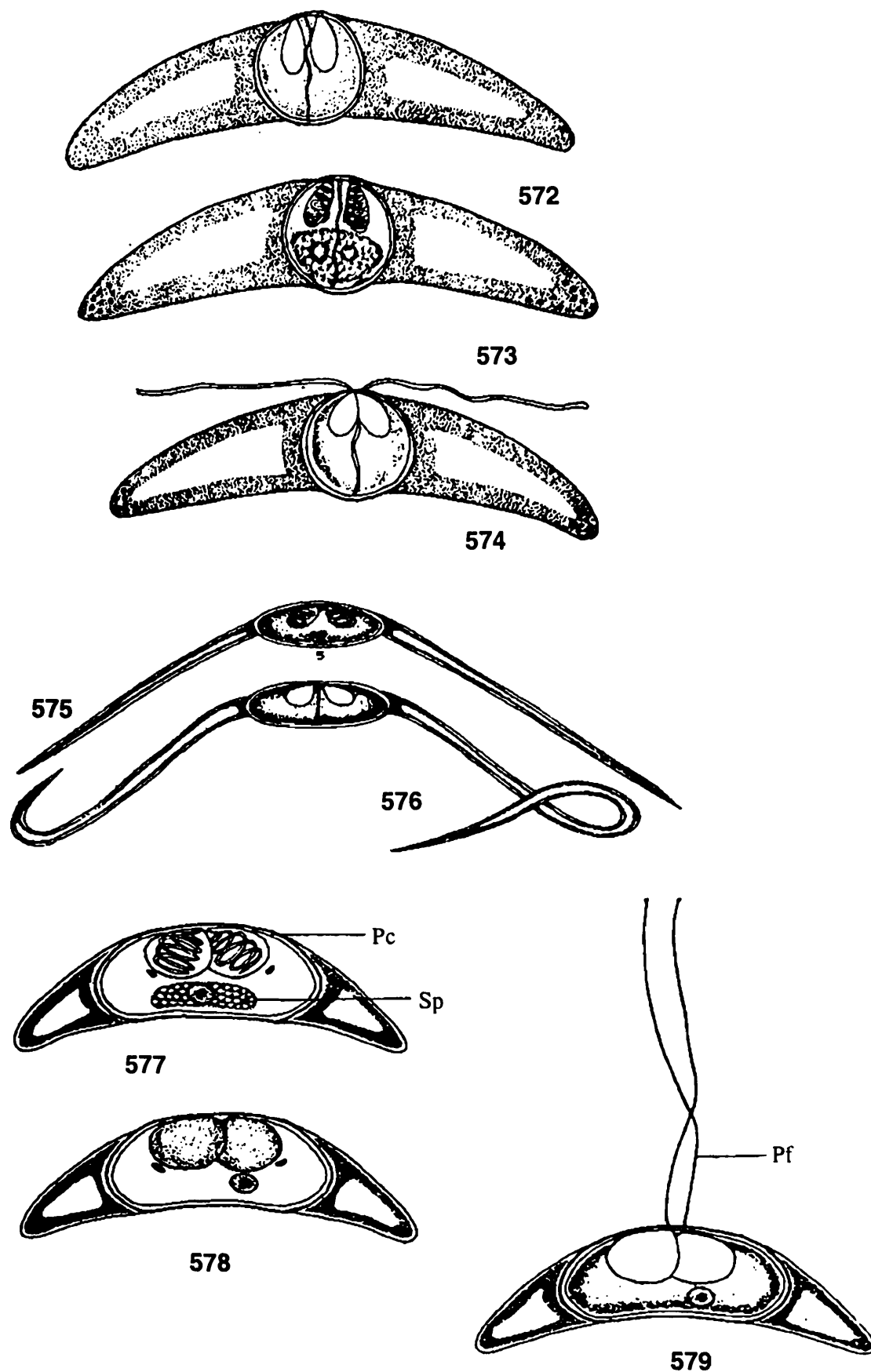
325. *Davisia murtii* Padma Dorothy and Kalavati, 1994
(Figs. 577-579)

1987. *Davisia* sp. Padma Dorothy and Kalavati, *Proc. Nat. Sem. Freshwater aquaculture* : p. 42.

1994. *Davisia murtii* Padma Dorothy and Kalavati, *Indian J. Fish.* **42**(1) : pp. 38-48.

Material examined : Sev. exs., Bheemunipatnam, Bay of Bengal, Visakhapatnam district, March 1986-June 1987, K. Padma Dorothy.

Diagnosis : Trophozoites small, round or oval; pansporoblast disporous; spore crescent-shaped with a triangular or oval spore body; 11.2-17.6 (13.86) μm x 4.8-11.2 (7.31) μm ; sutural line wavy; valves smooth; lateral appendages hollow, equal, 4.2-9.6 (6.6) μm , and distal end blunt; polar capsules spherical, overlapping, 3.2-4.8 (4.56) μm in diameter; polar filaments making 4-5 coils while inside the capsule, 15-30 μm when extended.



Figs. 572-579. Myxozoan parasites of Andhra Pradesh : 572-574. *Davisia cynoglossi*; 575-576. *D. filiformis* and 577-579. *D. murtii*.

Host : *Liza macrolepis*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (off Bheemunipatnam, Bay of Bengal, Visakhapatnam district).

Genus *Bipteria* Koveleva, Zubchenko and Krasin 1983

1983. *Bipteria* Koveleva, Zubchenko and Krasin, *Parazitologiya*, **17** : pp. 195-202.

Diagnosis : As in the key.

326. *Bipteria indica* Kalavati and Anuradha, 1995
(Figs. 580-582)

1990. *Bipteria indica* Anuradha, Ph.D. thesis (unpublished), Andhra University, India.

1990. *Bipteria indica* Padma Dorothy Ph.D. thesis (unpublished), Andhra University, India.

1995. *Bipteria indica* Kalavati and Anuradha, *Acta Protozool.*, **34** : pp. 307-309.

Material examined : Sev. exs., off Bheemunipatnam and Visakhapatnam, Visakhapatnam district, May 1987-April 1988, I. Anuradha.

Diagnosis : Pansporoblast disporous; spores inversely pyramidal; anterior end broad, corners rounded; posterior end narrow, blunt; two delicate wing-like appendages arising from the anterior region of spore and extending almost up to posterior end enclosing the spore body, 5.6-6.8 (5.8) μm x 5.4-6.8 (5.7) μm x 4.8-5.2 (5.0) μm in size; valves thin, smooth, refractive; sutural line curved at posterior end; polar capsules spherical, widely spaced; 1.8-2.6 (2.0) μm in diameter; polar filament forming 5-6 coils while inside the capsule, 16.0-20.0 (18.0) μm when extended; sporoplasm homogenous, hyaline occupying the entire extracapsular cavity; iodophilous vacuole absent.

Hosts : *Mugil cephalus* and *Liza macrolepis*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (off Bheemunipatnam, Visakhapatnam, Bay of Bengal, Visakhapatnam district); Chilka Lake, Orissa.

Genus *Neobipteria* Koveleva, Zubchenko and Krasin, 1983

1983. *Neobipteria* Koveleva, Zubchenko and Krasin, *Parazitologiya*, **17** : pp. 195-202.

Diagnosis : As in the key.

327. *Neobipteria coromandelensis* Narasimhamurti, Kalavati,
Anuradha and Padma Dorothy, 1990
(Figs. 583-584)

1990. *Neobipteria coromandelensis*. Narasimhamurti et al., *Proc.I. workshop. Scient. Resul. FORV Sagarsampada* 1989 : pp. 325-336.

Material examined : Sev. exs., Bay of Bengal, off Masulipatnam, Krishna district, 10.vii.1988, I. Anuradha and K. Padma Dorothy.

Diagnosis : Triangular, posterior end pointed, anterior flattened with a small depression at the center $4.8-6.8$ (5.9) μm $\times$ $7.2-10.4$ (8.76) μm ; sutural line thick, straight; a pair of median, keel-like membranes arising from the sutural line; valves smooth, symmetrical, with 2 ring-like appendages at the center; polar capsules spherical, $2.6-3.4$ (3.18) μm in diameter; polar filament forming 6-7 coils while inside the capsule, $36.8-52.6$ (43.75) μm when extended; sporoplasm homogenous, oval, binucleate; no iodophilous vacuole.

Host : *Nemipterus mesoprion*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Masulipatnam (Lat. $15^{\circ}58'$ N Long. $81^{\circ}31'E$), Krishna district).

Family CERATOMYXIDAE Doflein, 1899

1899. *Ceratomyxidae* Doflein, *Zool. Zentrbl.* **6** : pp. 361.379.

Diagnosis : As in the key.

Key to the genera

- 1(2) Spores oval, ellipsoidal, arcuate or elongated in the direction perpendicular to sutural plane; length of individual shell valve not exceeding the axial diameter of spore, but significantly more than one half of the diameter; capsular foramina near sutural plane; sporoplasm mostly one, binucleate, sometimes 2, uninucleate Genus *Leptotheca*
- 2(1) Spores elongated, crescent-shaped or arcuate; shell valves conical always exceeding in length the axial diameter of the spore; polar capsules sub-spherical, equal or unequal; sporoplasm binucleate, not filling the spore cavity completely Genus *Ceratomyxa*

Genus *Leptotheca* Thelohan, 1895

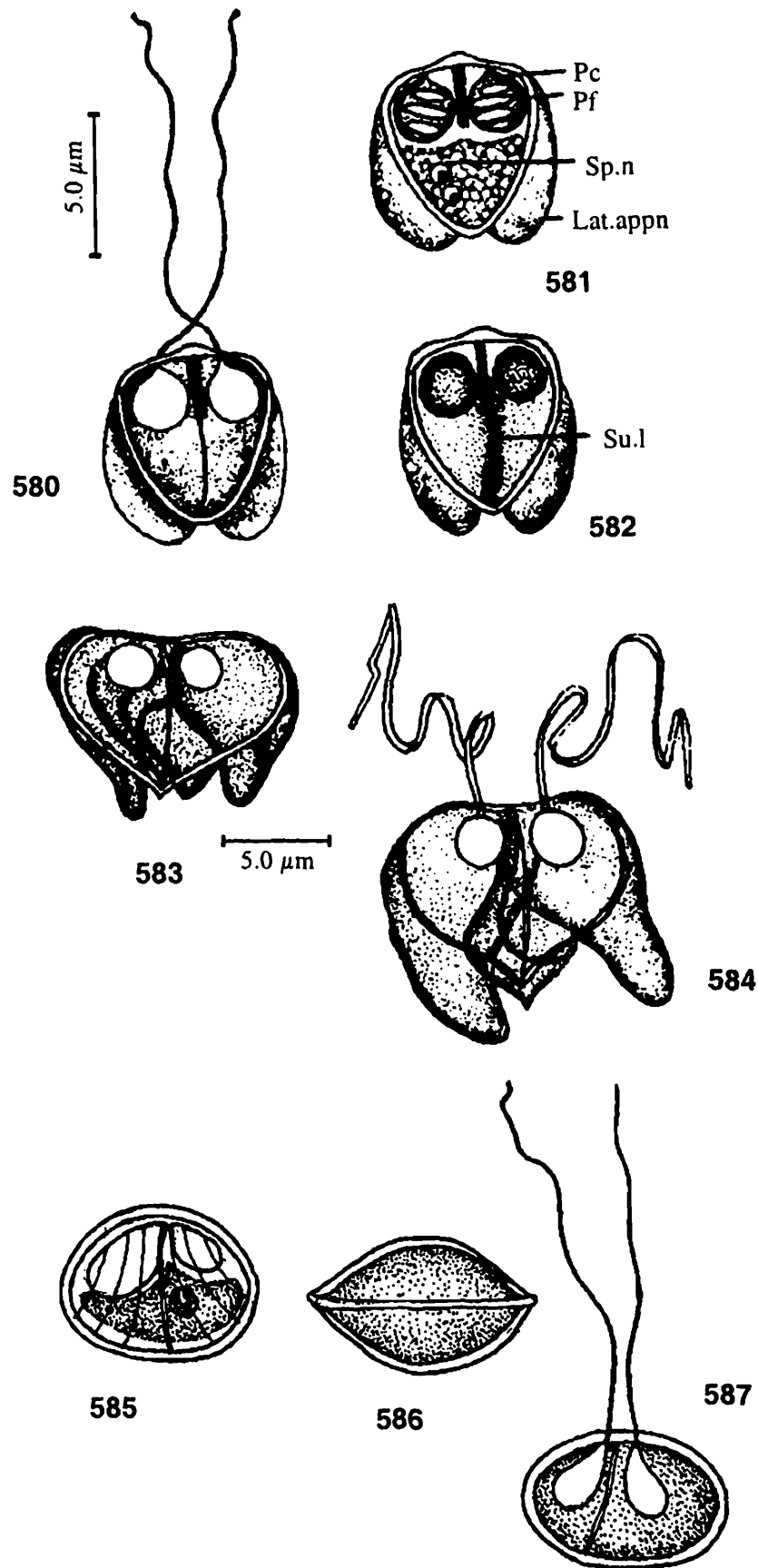
1895. *Leptotheca* Thelohan, *Bull. Sci. Fr. Belg.*, **26** : pp. 100-394.

Diagnosis : As in the key.

328. *Leptotheca asymmetrica* Lalitha Kumari, 1969 (Figs. 585-587)

1969. *Leptotheca asymmetrica* Lalitha Kumari, *Riv. Parassitol.*, **30**(3) : pp. 153-225.

Diagnosis : Spores elliptical or oval, $5.7-7.9$ (6.8) μm $\times$ $8.6-10.0$ (9.4) μm in size, breadth being more than sutural diameter, ends rounded; valves usually thick, characteristically ornamented with three longitudinal striae converging towards the sutural ridge and a horizontal



Figs. 580-587. Myxozoan parasites of Andhra Pradesh : 580-582. *Bipteria indica*; 583-584. *Neobipteria coromandelensis* and 585-587. *Leptotheca asymmetrica*.

transverse striation; polar capsules unequal, pyriform, 4.3–5.4 (4.9) μm x 2.9–4.3 (3.1) μm and 3.6–4.3 (4.0) μm x 2.1–2.9 (2.8) μm opening through independently; polar filaments unequal, 32–41 (37.7) μm and 27–32 (29.8) μm in length; sporoplasm clear, finely granular, forming a compact mass and occupying little space behind the large polar capsule.

Host : *Osteochilus neilli*; site of infection : gills, gall bladder and intestine.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

Genus *Ceratomyxa* Thelohan, 1892

1892. *Ceratomyxa* Thelohan, *Bull. Soc. Philm.* 4 : pp. 165–178.

Diagnosis : As in the key.

Key to the species

1. Spores transversely elongated, shell valves unequal 3
2. Spores transversely elongated, shell valves equal 4
- 3.1 Spores arcuate, asymmetrical, 9.2–11.8 (10.36) μm x 36.4–45.8 (41.6) μm ; valves smooth, unequal; polar capsules spherical, unequal *C. dissimilaris*
- 4.1 Spores transversely elongated, flat, compressed, 2.75–4.0 (3.7) μm x 12.9–19.8 (16.7) μm ; valves smooth; polar capsules large, sub-spherical *C. kudo*
- 4.2 Spores hat-shaped, 14.2–18.4 (16.2) μm x 68.6–82.4 (74.2) μm ; valves smooth; polar capsule spherical *C. sagarsampadae*
- 4.3 Spores transversely elongated, 8.6–10.32 (9.53) μm x 81.7–98.7 (88.58) μm ; valves thick, smooth, drawn out laterally with pointed ends; polar capsules oval *C. thrissoclesi*

329. *Ceratomyxa dissimilaris* Narasimhamurti, Kalavati, Anuradha and Padma Dorothy, 1990 (Figs.588–589)

1990. *Ceratomyxa dissimilaris* Narasimhamurti *et al.*, *Proc.I. Workshop. Scient. Resul. FORV Sagarsampada*, 1989 : pp. 325–336, figs 15–16.

Material examined : Sev. exs., Bay of Bengal, off Kalingapatnam, Srikakulam district, 16.vii.1988, I. Anuradha and K. Padma Dorothy.

Diagnosis : Pansporblast disporous; spores arcuate, asymmetrical, transversely elongated with slightly bent oval ends; 9.2–11.8 (10.36) μm x 36.4–45.8 (41.6) μm ; spore valves smooth, unequal, 17.6–22.4 (19.2) μm and 20.8–26.8 (22.4) μm ; sutural line straight; polar capsules spherical, unequal, 3.0–5.2 (4.82) μm and 2.4–3.8 (3.56) μm in diameter; polar filaments forming 3–4 coils while inside the capsule, 24.4–32.2 (28.6) μm and 34.8–38.4 (36.2) μm when extended; sporoplasm, irregular with numerous eosinophilic granules, extending into lateral arms, usually displaced towards larger valve.

Host : *Nemipterus mesoprion*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (off Kalingapatnam, Bay of Bengal Srikakulam district).

330. *Ceratomyxa kudoi* Kalavati and Anuradha, 1993
(Figs. 590-592)

1993. *Ceratomyxa kudoi* Kalavati and Anuradha, *Uttar Pradesh J. Zool.* **13** (2) : pp. 148-152.

Material examined : Sev. exs., Gosthani estuary and Visakhapatnam harbour, Visakhapatnam district, July- August 1987, I. Anuradha.

Diagnosis : Pansporoblasts disporous, oblong with filiform pseudopodia at either end; spores transversely elongated, compressed, flat, and ribbon-like with rounded lateral ends; anterior end pointed, posterior with small indentation; $2.75-4.0$ (3.7) μm x $12.9-19.8$ (16.7) μm ; Length : Width ratio 1:5.0-5.6; valves smooth and equal; sutural line distinct and straight; polar capsules large, sub-spherical, terminal, $1.5-2.5$ (2.0) μm ; polar filament forming 4-5 coils while inside the capsule and $10.0-15.5$ (13.2) μm when extended; sporoplasm granular extending into valves; iodophilous vacuole absent. 2 characteristic hallows (vacuole?) seen one each valve.

Host : *Valamugil cunnesius*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Gosthani estuary and Visakhapatnam harbour, Visakhapatnam district).

331. *Ceratomyxa sagarsampadae* Narasimhamurti, Kalavati,
Anuradha and Padma Dorothy, 1990
(Figs. 593-594)

1990. *Ceratomyxa sagarsampadae* Narasimhamurti Kalavati, Anuradha and Padma Dorothy *Proc. I. Workshop. Scient. Resul. FORV Sagarsampada*, 1989 : pp. 325-336.

Material examined : Bay of Bengal, off Masulipatnam, Krishna district., 10.vii.1988, I. Anuradha and K. Padma Dorothy.

Diagnosis : Pansporblast disporous; spores transversely elongated and hat-shaped; $14.2-18.4$ (16.2) μm x $68.6-82.4$ (74.2) μm in size; valves thick and smooth; sutural line wavy; polar capsules spherical, sub-terminal, $8.4-9.86$ (8.52) μm ; polar filaments forming 6-7 coils while inside the capsule, $48-68.4$ (59.76) μm when extended; both the filaments extruding through a common foramen forming a cross; sporoplasm hyaline extending below the capsules in the entire spore cavity; no iodophilous vacuole.

Host : *Cynoglossus* sp.; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Bay of Bengal (Lat. $15^{\circ}58'$ N Long. $81^{\circ}31'E$). off Masulipatnam, Krishna district).

332. *Ceratomyxa thrissoclesi* Padma Dorothy, Kalavati and Vaidehi, 1998
(Figs. 595-596)

1998. *Ceratomyxa thrissoclesi* Padma Dorothy *et al.*, *Riv. Parassitol.*, **15** (59) : pp. 67-72.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district, February, 1992, C. Kalavati.

Diagnosis : Pansporoblast disporous; spores transversely elongated, 8.6-10.32 (9.53) μm x 81.7-98.7 (88.58) μm ; valves thick, smooth, drawn out laterally, ends pointed; sutural line straight; polar capsule oval, 3.44-5.16 (4.57) μm x 3.4-4 (3.58) μm ; polar filament making 3-4 coils while inside the capsule, 30-45 (35.0) μm when extended; sporoplasm hyaline, binucleate, heart-shaped.

Host : *Thrissocles muystasc*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

Family SPHAEROSPORIDAE, Davis, 1917

1917. *Sphaerosporidae* Davis, *Bull. Bur. Fish.*, **35** : pp. 201-243.

Diagnosis : As in the key.

Key to the genera

- 1 Spores spherical or sub-spherical, valvular diameter not exceeding significantly the sutural diameter; sutural ridge often prominent; polar capsule sub-spherical or pyriform; two uninucleate sporoplasms; mono or disporous trophozoites... Genus *Sphaerospora*
- 2 Spores sub-spherical enclosed in a membranous veil which in immature spores twisted in 2 cords around the spore; sutural ridge prominent anteriorly; polar capsules pyriform; sporoplasm binucleate; trophozoite di or polysporous Genus *Palliatius*
- 3 Spores elongated with pointed anterior end; shell valves often ridged and extending posteriorly into a caudal appendage; polar capsule pyriform with or without an iodophilous vacuole; trophozoite di or polysporous Genus *Myxobilatus*

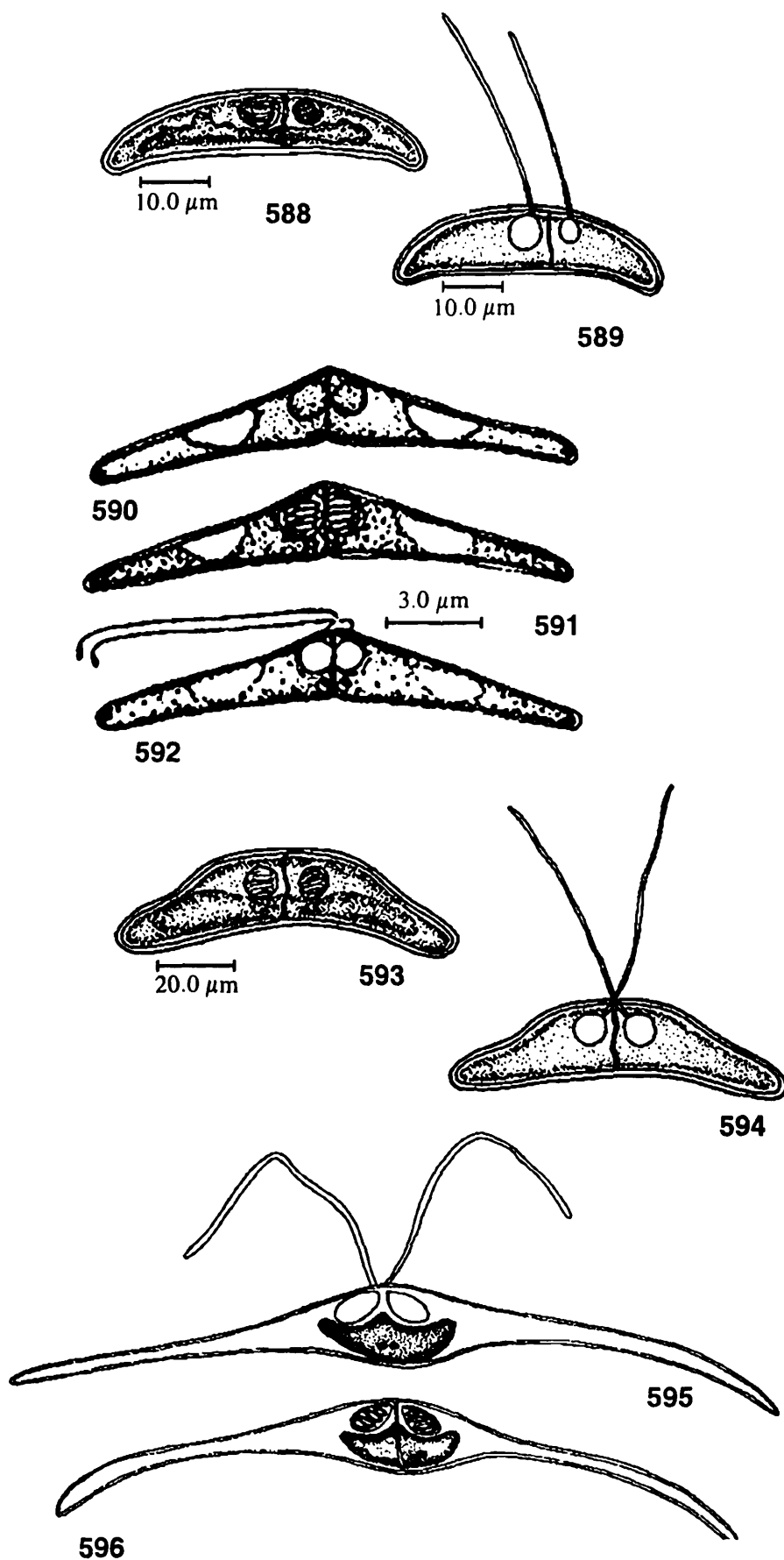
Genus *Sphaerospora* Thelohan, 1892

1892. *Sphaerospora* Thelohan, *Bull. Soc. Philm.*, **4** : pp. 165-178.

Diagnosis : As in the key.

333. *Sphaerospora mayi* Moser, Kent and Dennis, 1989
(Figs. 597-599)

1989. *Sphaerospora mayi* Moser, Kent and Dennis, *Aust. J. Zool.*, **37** : pp. 11-13.



Figs. 588-596. Myxozoan parasites of Andhra Pradesh : 588-589. *Ceratomyxa dissimilaris*; 590-592. *C. kudoii*; 593-594. *C. sagarsampadae* and 595-596. *C. thrissoclesi*.

1991. *Sphaerospora mayi* : Anuradha, Ph. D Thesis; (Unpublished), Andhra University, India.

1992. *Sphaerospora mayi* : Kalavati and Anuradha, *Proc. zool. Soc., Calcutta*, **45** (Suppl A) :-pp. 107-113.

Material examined : Sev. exs., Visakhapatnam harbor, Visakhapatnam district, March–December, 1987, I. Anuradha.

Diagnosis : Pansporoblast disporous; spores spherical or subspherical, 4.0-5.4 (4.5) μm ; valves with strong striations; sutural ridge straight, prominent, tapering to a fine point at the posterior end; polar capsule sub-spherical, parallel to sutural ridge, terminal, filling the entire anterior half, 2.0-2.5 (2.2) μm x 1.8-2.0 (1.9) μm ; polar filament forming 5-6 coils while inside the capsule; intercapsular appendix prominent, deeply stained, rod-like; 2 uninucleate sporoplasms, one on either side of sutural ridge; polar filament 18-26 (23.0) μm in length; developmental stages in blood having pseudoplasmodia with variable number of nuclei.

Host : *Mugil cephalus*; site of infection: intestinal epithelium, visceral peritoneum, gill epithelium and blood.

Distribution : India : Andhra Pradesh (Visakhapatnam harbour, Visakhapatnam district) and Heron island, Australia.

Remarks : Kalavati and Anuradha (1992) recorded this species from this state.

Genus *Palliatius* Schulman, Koveleva and Dubina, 1979

1979. *Palliatius* Schulman, Koveleva and Dubina, *Parazitologiya* (Leningrad), **13**(1) : pp. 71-79.

Diagnosis : As in the key.

**334. *Palliatius indicus* Padma Dorothy and Kalavati, 1998
(Figs. 600-604)**

1998. *Palliatius indicus* Padma Dorothy and Kalavati, *Proc. Zool. Soc., Calcutta*, **51**(1) : pp. 60-64.

Material examined : 2 exs., Bheemunipatnam, Bay of Bengal, Visakhapatnam district, February, 1987, K. Padma Dorothy.

Diagnosis : Development monosporous; spores oval; anterior end broad; posterior end bluntly tapering; a smooth membranous envelope arising at the anterior end extending to the posterior end encircling the spore; a pair of broad triangular 'keel' like appendage present along sutural ridge on either side of the spore enclosing the spore body like a parachute; 9.1-10.5 (9.84) μm x 7.0-7.7 (7.02) μm in size; valves thin, smooth and unequal; sutural ridge prominent, slightly curved, extending as small curved spine; polar capsules 2, pyriform, convergent, terminal, 3.5-4.2 (4.1) μm x 2.8-3.5 (3.05) μm ; tip of the capsule deeply stained as a small plug-like structure; polar filament making 4-5 coils while inside the capsule, 14.4-22.5 (17.79) μm long; sporoplasm dumb-bell shaped, homogeneous, granular.

Host : *Liza macrolepis*; site of infection : pancreas.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Bheemunipatnam, Visakhapatnam district).

Remarks : The parasite induced reduction in islets of langerhans with consequent impairment of glucose metabolism. Infected fish showed weight loss and appeared morbid.

Genus *Myxobilatus* Davis, 1917

1917. *Myxobilatus* Davis, *Bull. Bur. Fish.* **35** : pp. 201-243.

Diagnosis : As in the key.

Key to the species

- 1(2) Spores variable; occur in 2 different types; 8.5-12.5 μm x 4.6-6.16 μm in size
*M. mastacembeli*
- 2(1) Spores elongate, oval, 11.2-14.4 μm x 4.8-3.2 μm . in size.....*Myxobilatus* sp.

335. *Myxobilatus mastacembeli* Qadri and Lalitha Kumari, 1965 (Figs. 605-606)

1965. *Myxobilatus mastacembeli* Qadri and Lalitha Kumari, *Riv. Parassitol.*, **26** : pp. 73-77.

Diagnosis : Trophozoites milky-white, spherical about 1 mm; development disporous; spores flat, 2 types; smaller spores pyriform, others elongated; anterior end blunt, narrow; posterior end round; valves thin, transparent, 8.5-12.5 (9.0) μm x 4.6-6.16 (4.8) μm ; two filamentous caudal processes present, 15-28 (19.0) μm long; polar capsules 2, terminal, pyriform, 3.1-3.9 (3.7) μm x 1.5-1.9 (1.65) μm ; sporoplasm granular, occupying the space behind the polar capsules; iodophilous vacuole large, posterior.

Host : *Mastacembelus armatus*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Local fish market, Hyderabad city, Hyderabad district).

336. *Myxobilatus* sp. (Figs. 667-609)

Material examined : Sev. exs., Kakinada, Rajamundry, East Godavari district. 18.viii.1987, I. Anuradha.

Diagnosis : Trophozoites opaque, small 750-950 μm ; spores elongate, oval, 11.2-14.4 (13.08) μm x 4.8-3.2 (4.03) μm , bifurcated at the posterior end; spore valves smooth, thin; polar capsules unequal, pyriform, 3.2-4.8 μm x 0.8-1.2 μm and 2.4-4.0 μm x 1.6 μm , placed

at different levels; iodophilous vacuole large, spherical, posterior; polar filament making 4 coils while inside the capsule; sporoplasm oval, binucleate.

Host : *Clarias batrachus*; site of infection : palate.

Distribution : India : Andhra Pradesh (Kakinada, Rajamundry, East Godavari district).

Remarks : Anuradha and Kalavati (1987) reported this species of protozoan parasite from the palate of the catfish *Clarias batrachus* and identified up to generic level. Specific identity of this taxon is yet to be ascertained.

Family CHLOROMYXIDAE, Thelohan, 1892

1892. *Chloromyxidae* Thelohan, *Bull. Soc. Philm.*, **4** : pp. 165-178.

Diagnosis : As in the key.

Genus *Chloromyxum* Mingazzini, 1890

1890. *Chloromyxum* Mingazzini, *Bull. Soc. Nat. Napoli*, **4** : pp. 160-164.

Diagnosis : As in the key.

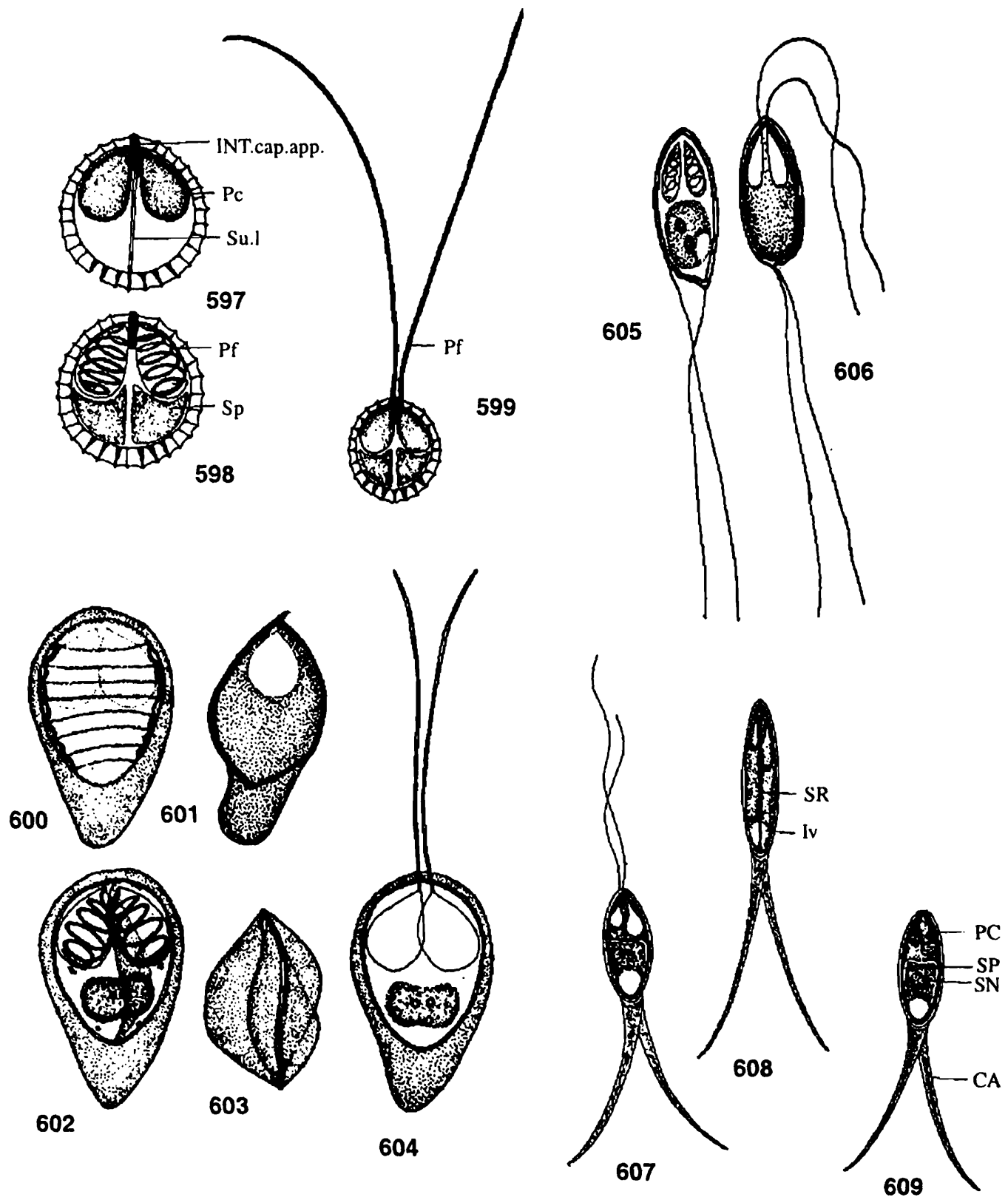
Key to the species

1. Spores spherical 3
- 2 Spores inverted, pyriform, 18.0-22.0 μm x 16.5-21.0 μm ; shell valves equal with fine striations; polar capsule elongated/pyriform, unequal..... *C. mitchelli*
- 3.1 Spores spherical, 5.7-7.1 μm ; shell valves with 8-10 longitudinal striations; polar capsule unequal, pyriform or flask-shaped *C. hoarei*
- 3.2 Spores spherical, 10.8-12.0 μm ; shell valves smooth; polar capsule equal, pyriform ..
..... *C. tripathii*

337. *Chloromyxum hoarei* Lalitha Kumari, 1969 (Figs. 610-612))

1969. *Chloromyxum hoarei* Lalitha Kumari, *Riv. Parassitol.*, **30**(3) : pp. 153-225.

Diagnosis : Spores spherical in valvular view and oval in sutural view, 5.7–7.1 (6.4) μm in diameter; spore valves equal and uniform, with 8-10 longitudinal striations; sutural ridge broad, thick, projecting out of the spore valves and appearing like a knob; polar capsules 4, unequal, pyriform or flask-shaped, 2.5–3.5 (2.9) μm x 1.4–2.1 (1.8) μm and 1.4–2.1 (1.8) μm x 1.0–1.8 (1.4) μm , subterminal and one of the capsules often curved; polar filaments unequal forming 4–5 coils within the capsule; sporoplasm granular and homogenous.



Figs. 597-609. Myxozoan parasites of Andhra Pradesh : 597-599. *Sphaerospora mayi*; 600-604. *Pallidus indicus*; 605-606. *Myxobilatus mastacembeli* and 607-609. *Myxobilatus* sp.

Host : *Labeo nigripinnis*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Hyderabad city. Hyderabad district and Warangal, Warangal district).

338. *Chloromyxum mitchelli* Kalavati and Narasimhamurti, 1984
(Figs. 613-616)

1984. *Chloromyxum mitchelli* Kalavati and Narasimhamurti, *Acta protozool.*, **23** (2) : pp. 135-144.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district, June–July 1983, C. Kalavati.

Diagnosis : Spores inverted, pyriform, anterior end broad, posterior end round, 18.0-22.0 (21.0) μm x 16.5-21.0 (20.5) μm ; valves equal, symmetrical with fine translucent striations; sutural ridge thin, straight; polar capsules 4, terminal, unequal; 2 large capsules, elongated, 6.5-8.5 (8.0) μm x 2.0-2.5 (2.2) μm ; polar filament showed 8 coils while inside the capsule, 75-80 (78.0) μm when extended; smaller capsules 2, pyriform. 4.5-5.5 μm x 1.2-2.0 μm ; polar filament forming 5 coils while inside the capsule, 45-55 (50.0) μm in length when extended; sporoplasm irregular in the posterior point of the spore.

Host : *Therapon jarbua*; site of infection : kidney.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

339. *Chloromyxum tripathii* Kalavati and Narasimhamurti, 1984
(Figs. 617-621)

1984. *Chloromyxum tripathii* Kalavati and Narasimhamurti, *Acta. Protozool.*, **23**(2) : pp. 135-144

Material examined : Sev. exs., Elamanchili, East Godavari district, 28.ii.1983, C. Kalavati.

Diagnosis : Pansporoblasts disporous; spore spherical, 10.8-12.0 (11.2) μm in diameter; valves equal, smooth with 3-4 parietal folds at the capsular end; sutural ridge straight, prominent; polar capsules 4, pyriform, terminal 4.2-5.0 (4.8) μm x 2.1-2.6 (2.4) μm ; polar filament forming 5-6 coils while inside the capsule, 23-34 (32.0) μm in length when extended; sporoplasm hat-shaped, located beneath the polar capsules, extending into intercapsular region; no iodophilous vacuole.

Host : *Therapon jarbua*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Elamanchili, East Godavari; Visakhapatnam, Visakhapatnam district and Srikakulam, Srikakulam district).

Family PARVICAPSULIDAE Schulman, 1953

1953. *Parvicapsulidae* Schulman, Zool. Zh., **32** : pp. 384-394.

Diagnosis : As in the key.

Genus *Parvicapsula* Schulman, 1953

1953. *Parvicapsula* Schulman, Zool. Zh., **32** : pp. 384-394.

Diagnosis : As in the key.

340. *Parvicapsula hoffmanni* Padma Dorothy and Kalavati, 1993
(Figs. 622-626)

1993. *Parvicapsula hoffmani* Padma Dorothy and Kalavati, *Acta Protozool.*, **32** : 123-125.

Material examined : Sev. exs., Visakhapatnam harbour, Bay of Bengal, Visakhapatnam, Visakhapatnam district. 4.xii.1987, K. Padma Dorothy.

Diagnosis : Cysts small, opaque white, oval, 125-156 μm x 107-130 μm ; spore broadly oval, anterior end flat, posterior narrow, 8.5-10.32 (9.4) μm x 5.6-6.46 (5.89) μm ; valves thin, smooth, unequal and curved; large valve convex dorsally and concave ventrally, extending into a blunt lappet-like projection posteriorly; smaller valve fitting into the concavity of larger valve; sutural line thin, curved; polar capsule 2, small, pyriform, convergent, located at right angles to each other, 3.0-3.8 (3.46) μm in size; polar filaments making 4-5 coils while inside the capsule, 13.7-18.9 (15.65) μm when extended; sporoplasm hyaline, homogenous, 'comma' shaped.

Host : *Liza macrolepis*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam harbour, Visakhapatnam, Visakhapatnam district).

Family AUERBACHIDAE Evadachimova, 1973

1973. *Auerbachidae* Evadachimova, *Parazitologiya*, **15** : pp. 168-170.

Diagnosis : As in the key.

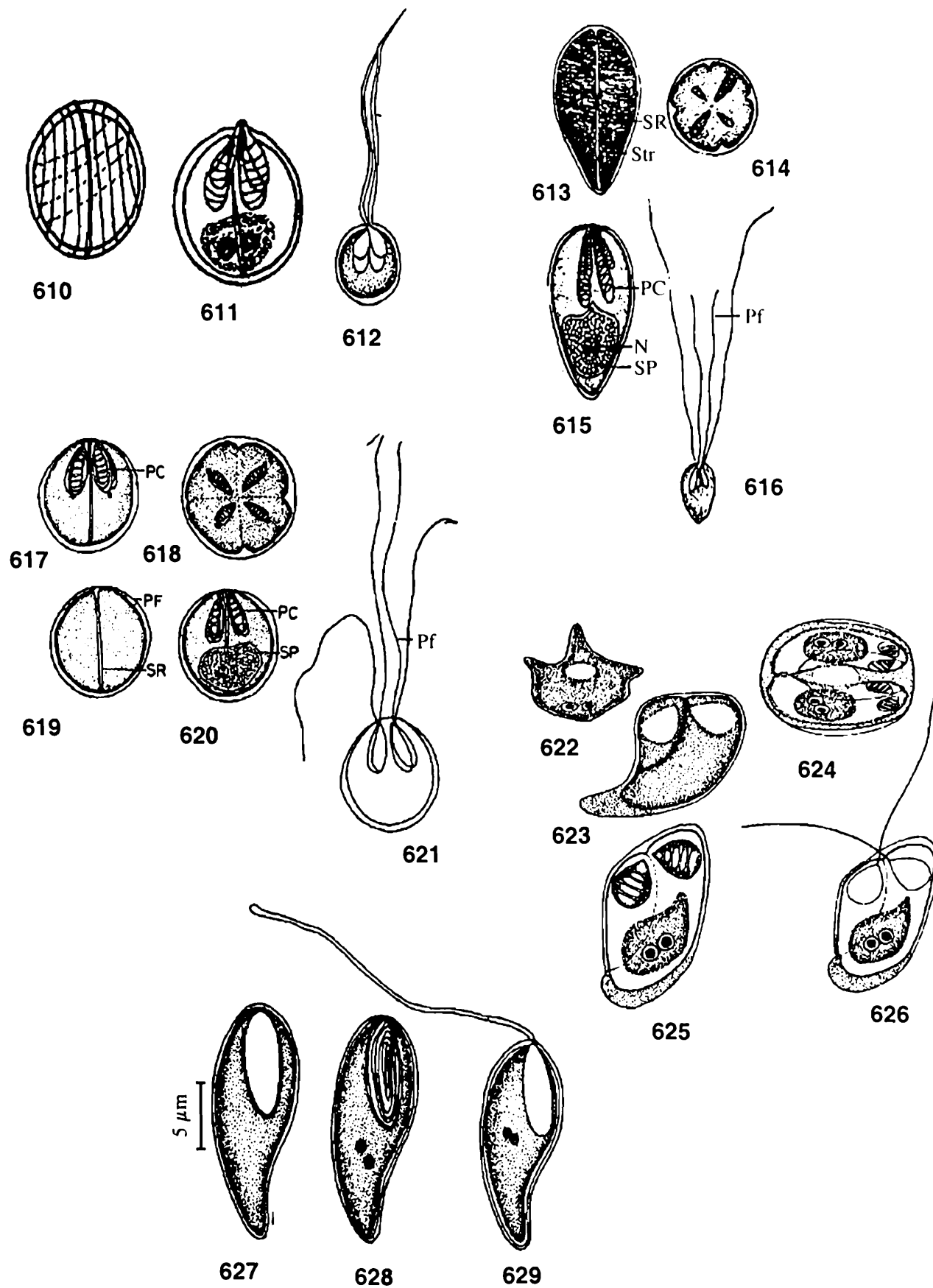
Genus *Auerbachia* Meglitsch, 1968

1968. *Auerbachia* Meglitsch, *Proc. Iowa. Acad. Sci.*, **75** : 397-401.

Diagnosis : As in the key to the family (same as for family).

341. *Auerbachia chorinemusi* Padma Dorothy, Kalavati and Vaidehi, 1998
(Figs. 627-629)

1998. *Auerbachia chorinemusi* Padma Dorothy et al., *Riv. Parassitol.*, **15**(55) : pp. 67-72.



Figs. 610-629. Myxozoan parasites of Andhra Pradesh : 610-612. *Chloromyxum hoareii*; 613-616. *C. mitchelli*; 617-621. *C. tripathii*; 622-626. *Parvicapsula hoffmanni* and 627-629. *Auerbachia chorinemusi*.

Material examined : Sev. exs., Bay of Bengal, off Visakhapatnam, Visakhapatnam district, August, 1991, K. Padma Dorothy.

Diagnosis : Spores club-shaped, anterior end broadly oval, posterior end narrow gently curved into a short, blunt caudal prolongation. 15.48-18.0 (16.2) μm x 6.0-9.46 (7.19) μm ; valves unequal, smooth, thin also covering the caudal prolongation; polar capsule single, elongated, median and oblique in position; 7.74-9.46 (8.64) μm x 3.44-5.16 (3.82) μm ; capsular foramina subterminal; polar filament showed 2 or 3 longitudinal coils while inside the capsule; sporoplasm binucleate, homogeneous, filling the entire spore cavity including caudal prolongation; polar filament long, flat ribbon-like with a globular tip.

Host : *Chorinemus* sp.; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Bay of Bengal, off Visakhapatnam, Visakhapatnam district).

Suborder PLATYSPORINA Kudo, 1919, emend

Family MYXOBOLIDAE Thelohan, 1892

1892. *Myxobolidae* Thelohan, *Bull. Soc. Philm.*, 4 : pp. 165-178.

Diagnosis : Spore flattened parallel to the straight sutural line forming an elevated ridge may be drawn out into long projections; one of the polar capsules may be smaller; most species having an 'iodinophilous vacuole'; as a rule forming large histozoic trophozoites (cysts) with numerous spores.

Remarks : Landsberg and Lom (1991), reduced the genus *Myxosoma* Thelohan 1892 and synonymised it with genus *Myxobolus* Butschli, 1882. Accordingly they suppressed the family Myxosomatidae.

Key to the genera

1. Spores without any caudal appendage or caudal projection 3
2. Spores with caudal appendage or caudal projection 4
- 3.1 Spores ellipsoid, oval or rounded in valvular view and biconvex in sutural view; shell valves smooth; sutural line straight; two mostly pyriform polar capsules; sometimes one missing; sporoplasm binucleate often with iodophilous vacuole; histozoic; trophozoite large, polysporous with pansporoblast formation Genus *Myxobolus*
- 3.2 Spores pyriform, pear-shaped or ellipsoid in valvular view, pear-shaped or pyriform in sutural view; shell valves smooth; single pyriform, pear-shaped, subspherical polar capsule; binucleate sporoplasm mostly with spherical polysaccharide inclusion; trophozoites large, polysporous with pansporoblast formation Genus *Thelohanellus*

4. Spores rounded, ellipsoid or spindle-shaped in valvular view, biconvex in sutural view; both the valves continuing as caudal projections, which sometimes opposed; shell valves smooth; 2 elongated polar capsules; sporoplasm binucleate with spherical polysaccharide inclusion; histozoic; trophozoites large, polysporous with pansporoblast formation Genus *Henneguya*
5. Spores with single or bifurcated caudal appendage 6
- 6.1 Spore with single caudal appendage, not a continuation of shell valves; caudal appendage adherent to spore; polar capsule 2, pyriform; histozoic Genus *Unicauda*
- 6.2 Spores flattened, pyriform, caudal appendage independent, bifurcated and fitted to the posterior end of the spore; single, elongated polar capsule; sporoplasm binucleate with spherical polysaccharidal inclusion; trophozoites large, polysporous; histozoic Genus *Phlogospora*

Genus *Myxobolus* Butschli, 1882

1882. *Myxobolus* Butschli *Myxosporidia* : In *Bronn's Klass ordn., des tierreiches, Protozoa* vol. 1, pp. 590-603.

Diagnosis : As in the key.

Remarks : Like Lom and Noble (1984) and Gupta and Khera (1988), Landsberg and Lom (1991) also reduced the genus *Myxosoma* Thelohan 1892 and synonymised it with genus *Myxobolus*, Butschli, 1882. Accordingly the genus *Myxosoma* is considered a synonym of the genus *Myxobolus*.

Key to the Species

1. Polar capsules equal 3
2. Polar capsules unequal 8
- 3.1 Spore pyriform 4
- 3.2 Spore oval or oblong 5
- 3.3 Spore spherical or subspherical 6
- 3.4 Spore pear-shaped 7
- 4.1 Spores pyriform; anterior end broad, posterior narrow, bluntly curved, 9-10 μm x 8.0-8.5 μm ; polar capsules 2, circular with a distinct neck *M. (=Gyrospora) crucifila*
- 4.2 Spores pyriform, 9.3-11.5 (10.1) μm x 5.0-8.0 (5.9) μm ; shell valves equal with 4-6 ridges at the posterior end; polar capsules 2, equal, pyriform, subterminal; no iodophilous vacuole *M. hyderabadense*
- 5.1 Spores oval with compressed sides, 8.6-10.7 (9.8) μm x 6.4-7.9 (7.1) μm ; polar capsules 2, equal, flask-shaped with tilted neck; iodophilous vacuole large, oval or spherical *M. ampullaceus*

- 5.2 Spores oval with prominent knobs at the anterior end. 6.3-7.9 (7.2) μm x 4.3-6.4 (5.4) μm ; polar capsules 2, equal, oval with prominent neck *M. potaili*
- 5.3 Spores oval, 12.5-13.5 (12.8) μm x 8.6-9.5 (9.0) μm ; polar capsules 2, pear-shaped, equal, subterminal; no iodophilous vacuole *M. bengalensis*
- 5.4 Spores elongated, oval, anterior end pointed, characteristically angular in sutural view, 8.6-10.3 (9.55) μm x 6.9-8.6 (7.83) μm ; polar capsules 2, equal, drop-shaped; intercapsular appendix subterminal, triangular; no iodophilous vacuole *M. anili*
- 5.5 Spores oval with round ends in valvular view, lenticula with 2 knob-like processes in sutural view, 10.6-13.5 (11.5) μm x 9.6-11.2 μm ; shell valves striated; polar capsules 2, equal, subterminal, pyriform. *M. spinocurvatura*
- 5.6 Spores oval or spherical, 5.2-6.9 (6.28) μm x 4.3-6.9 (5.65) μm ; shell valves equal with 5 diagonal striations; polar capsules 2, pyriform, equal; no iodophilous vacuole
..... *M. macrolepi*
- 5.7 Spores broadly oval, enveloped in a thin indistinct mucus envelop with 5-6 bluntly pointed posterior processes, 6.9-8.6 (7.74) μm x 5.6-6.5 (6.02) μm ; polar capsules 2, oval or pyriform... *Myxobolus* sp.
- 6.1 Spores spherical or slightly oval with rounded ends, 9.3-10.7 (10.0) μm x 8.6-10.0 (9.4) μm ; shell valves asymmetrical with 2 striations; polar capsules 2, elongated, subterminal; intercapsular ridge prominent; iodophilous vacuole oval, large *M. psiloshynchi*
- 6.2 Spores spherical. 8-11.0 (9.0) μm in diameter; shell walls with wavy striations; polar capsules oval, equal; 2 iodophilous vacuoles on either side of bowl-shaped sporoplasm *M. bivacuolatus*
- 6.3 Spores spherical or slightly oval with outer mucus membrane and 2 equatorial protuberances, 4.8-5.2 (5.1) μm in diameter; polar capsules equal, pyriform, terminal; no iodophilous vacuole *M. mugicephalus*
- 6.4 Spores spherical or oval, 9.8-10.2 (10.1) μm x 12.0-13.5 (13.0) μm ; sutural ridge extending before the valves like a knob; polar capsules 2, oval, equal, 5.0-6.0 (5.6) μm x 2.5 μm ; iodophilous vacuole large *M. tripathii*
- 6.5 Spores subspherical. 11.3-12.4 μm x 10.3 μm , polar capsule pyriform, 6.18 μm x 3.09 μm , with their ends drawn into a short narrow tube, single iodophilous vacuole
..... *M. clarii*
- 6.6 Spores spherical, 6.0-7.3 (6.74) μm in diameter; polar capsules 2, equal, pyriform ...
..... *M. sphaeralis*
- 7.1 Spores pear-shaped, 4.6-5.2 (4.9) μm x 9.0-9.5 (9.3) μm ; outer mucus envelop forming 2 prominent lateral lappets; polar capsules 2, equal, parallel, pear-shaped with long neck
..... *M. lizae*

- 8.1 Spore pyriform 9
- 8.2 Spore oval or oblong 10
- 8.3 Spore pear-shaped 11
- 9.1 Spores pyriform or ovoid; anterior end narrow, pointed; posterior end rounded; polar capsules 2 or 3, unequal, pyriform; no iodophilous vacuole *M. indiae*
- 9.2 Spores pyriform or ellipsoid; anterior end narrow; posterior end rounded with 3-6 parietal folds; 11.1-15.7 (13.5) μm x 5.7-8.6 (6.4) μm ; polar capsules 2, unequal, pyriform; no iodophilous vacuole *M. andhrae*
- 9.3 Spores pyriform; anterior end narrow, bent to one side; 12.4-15.0 (13.5) μm x 7.1-10.0 (8.6) μm ; 8-10 parietal folds; polar capsules 2, unequal, pyriform with prominent neck; iodophilous vacuole, large, central *M. osmaniae*
- 10.1 Spores oval; anterior end narrow, blunt; posterior end rounded; 11.4-12.9 (6) μm x 8.6-10.0 μm ; polar capsules large, oval, unequal with ducts *M. seshadrii*
- 10.2 Spores oblong or oval with rounded ends, 8.0-11.4 (9.6) μm x 6.4-7.9 (7.0) μm , polar capsules 2, unequal, elongated, pyriform, subterminal. Iodophilous vacuole oval, large in the posterior region *M. pinnaurati*
- 10.3 Spores elongated 14.5-18.0 (17.2) μm x 6.0-6.5 (6.3) μm ; polar capsules 2, elongated, pear-shaped, unequal; no iodophilous vacuole *M. channi*
- 10.4 Spores oval, enclosed in a thick mucus coat, 6.0-7.6 (7.2) μm x 5.16-5.84 (5.6) μm ; polar capsules unequal, pyriform; intercapsular appendix present; no iodophilous vacuole *M. episquammalis*
- 10.5 Spores oval with broad posterior and truncated anterior ends, 7.1-9.6 (8.4) μm x 5.0-6.4 (6.0) μm ; polar capsules unequal, pyriform, one very small *M. koli*
- 11.1 Spores pear-shaped with truncated anterior end; 11.2-12.4 (11.8) μm x 6.8-7.2 (7.0) μm ; polar capsules 2, unequal, dissimilar, small capsule rudimentary, terminal ... *M. esomi*

342. *Myxobolus ampullaceus* Lalitha Kumari, 1969
(Figs. 630-632)

1969. *Myxobolus ampullaceus* Lalitha Kumari, *Riv. Parassitol*, 30(3) : pp. 153-225.

Diagnosis : Trophozoites whitish, small; spores oval with slightly compressed sides; anterior end narrower than the posterior; 8.6–10.7 (9.8) μm x 6.4–7.9 (7.1) μm in size; spore valves thin, symmetrical and uniformly thick with markings on posterior margin; polar capsules 2, equal, flask-shaped with tilted neck region, 5–6.4 (5.8) μm x 2.5–2.9 (2.8) μm in size, subterminal, intercapsular ridge absent; polar filaments unequal, forming 5-6 tight coils while inside the capsule; sporoplasm granular, homogenous occupying the place behind the polar capsule; iodophilous vacuole large, oval or spherical.

Host : *Barbus kolus*; site of infection : dorsal and ventral fins.

Distribution : India : Andhra Pradesh (Local market in Hyderabad city, Hyderabad district).

343. *Myxobolus andhrae* (Lalitha Kumari, 1969)

Landsberg and Lom 1991

(Figs. 633-635)

1969. *Myxosoma andhrae* Lalitha Kumari, *Riv. Parassitol*, **30**(3) : pp. 153-225.

1991. *Myxobolus andhrae* (Lalitha Kumari) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165-186.

Diagnosis : Trophozoites about 1.0 mm in diameter; pansporoblast disporous; spores pyriform or ellipsoidal, 12.1–15.7 (13.5) μm x 5.7–8.6 (6.4) μm in size, anterior end narrow, blunt, posterior end rounded with 3–6 parietal folds and sometimes drawn out into an appendage; spore valves equal with 4–6 ridges at the posterior end; sutural ridge broad at the posterior region and narrowing down anteriorly; sutural line median and straight; polar capsules 2, unequal, pyriform, 8.6–10.0 (9.0) μm x 1.4–2.1 (1.7) μm and 7.1–9.3 (8.3) μm x 1.4–2.1 (1.7) μm in size, subterminal and one of the capsules often curved; polar filaments equal, forming 9 coils within the capsule; sporoplasm granular, homogenous, extending into inter capsular space up to anterior pole; iodophilous vacuole absent.

Host : *Channa* (= *Ophicephalus*) *punctatus*; site of infection : surface wall of the intestine.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

344. *Myxobolus anili* Sarkar, 1989

(Figs. 636-638)

1989. *Myxobolus anili* Sarkar, *Proc. Zool. Soc., Calcutta*, **42** : pp. 71-74.

1992. *Myxobolus anili* : Padma Dorothy and Kalavati, *Proc. zool. Soc., Calcutta*, **45** : pp. 197-204.

Material Examined : Sev. exs., Bheemunipatnam, Visakhapatnam district, July, 1987, K. Padma Dorothy.

Diagnosis : Trophozoites oval, cream coloured, 560-615 μm x 206-288 μm ; spores elongated, oval; anterior end slightly pointed, characteristically angular in sutural view, 8.6-10.3 (9.55) μm x 6.9-8.6 (7.83) μm ; sutural ridge broad thick, slightly curved and band like; polar capsules 2, equal, drop-shaped, convergent, 2.58-3.44 (3.33) μm x 1.7-2.6 (2.52) μm in size; intracapsular appendix subterminal, triangular; polar filaments forming 4-5 coils while inside the capsule, 18.1-29.2 (23.24) μm when extended; sporoplasm semilunar; iodophilous vacuole absent.

Host : *Liza macrolepis*; site of infection : intestinal villi.

Distribution : India : Andhra Pradesh (Bheemunipatnam, Visakhapatnam, Visakhapatnam district) and West Bengal.

Remarks : Padma Dorothy and Kalavati (1992) reported this species from this state.

345. *Myxobolus bengalensis* Chakravarty and Basu, 1948
(Figs. 639-641)

1948. *Myxobolus bengalensis* Chakravarty and Basu, *Proc. Zool. Soc. Bengal*, **1** : p. 23.

1988. *Myxobolus bengalensis* : Lakshminarayana, M. Phil dissertation, (Unpublished) Andhra University, India.

Material examined : Sev. exs., Chilakaluri peta, Guntur district, August–September 1986, D. Lakshminarayana.

Diagnosis : Trophozoites small, spherical, 160-170 μm ; pansporoblast disporous; spores slightly oval, 8.0-9.6 (8.52) μm x 4.9-6.0 (5.51) μm ; shell valves smooth; sutural ridge prominent; polar capsules equal, 4.5-6.0 (5.28) μm x 12.5-3.2 (3.0) μm ; polar filaments forming 3-4 coils while inside the capsule; polar filaments long, 50-80 (75.0) μm in length; sporoplasm binucleate, homogenous, crescent-shaped.

Host : *Catla catla*; site of infection : gills and branchiae.

Distribution : India : Andhra Pradesh (Tanks near Chilakaluripeta, Guntur district) and West Bengal.

Remarks : Lakshminarayana (1988) recorded this species from this state.

346. *Myxobolus bivacuolatus* Narasimhamurti and Kalavati, 1986
(Figs. 642-645)

1986. *Myxobolus bivacuolatus* Narasimhamurti and Kalavati, *Arch. Protistenk.*, **131** : pp. 153-157.

Material examined : Sev. exs., Eluru, West Godavari district, January, 1985, C. Kalavati.

Diagnosis : Cysts amber coloured, translucent, oval, 4.0-6.0 μm x 2.0-3.0 μm ; spores spherical, 8.0-11.0 (9.0) μm in diameter; valves with wavy parallel striations, symmetrical, double walled, inner thick and outer thin; sutural ridge wavy with 3 parietal folds seen on either side; polar capsules oval, equal, 3.0-4.5 (4.2) μm x 2.6-4.0 (3.0) μm ; opening independently; polar filament making 6-7 coils while inside the capsule; polar filament 18-24 (22.5) μm ; 2 iodophilous vacuoles, 1.8-2.0 μm ; in diameter seen on either side of sporoplasm; sporoplasm bowl-shaped, homogenous.

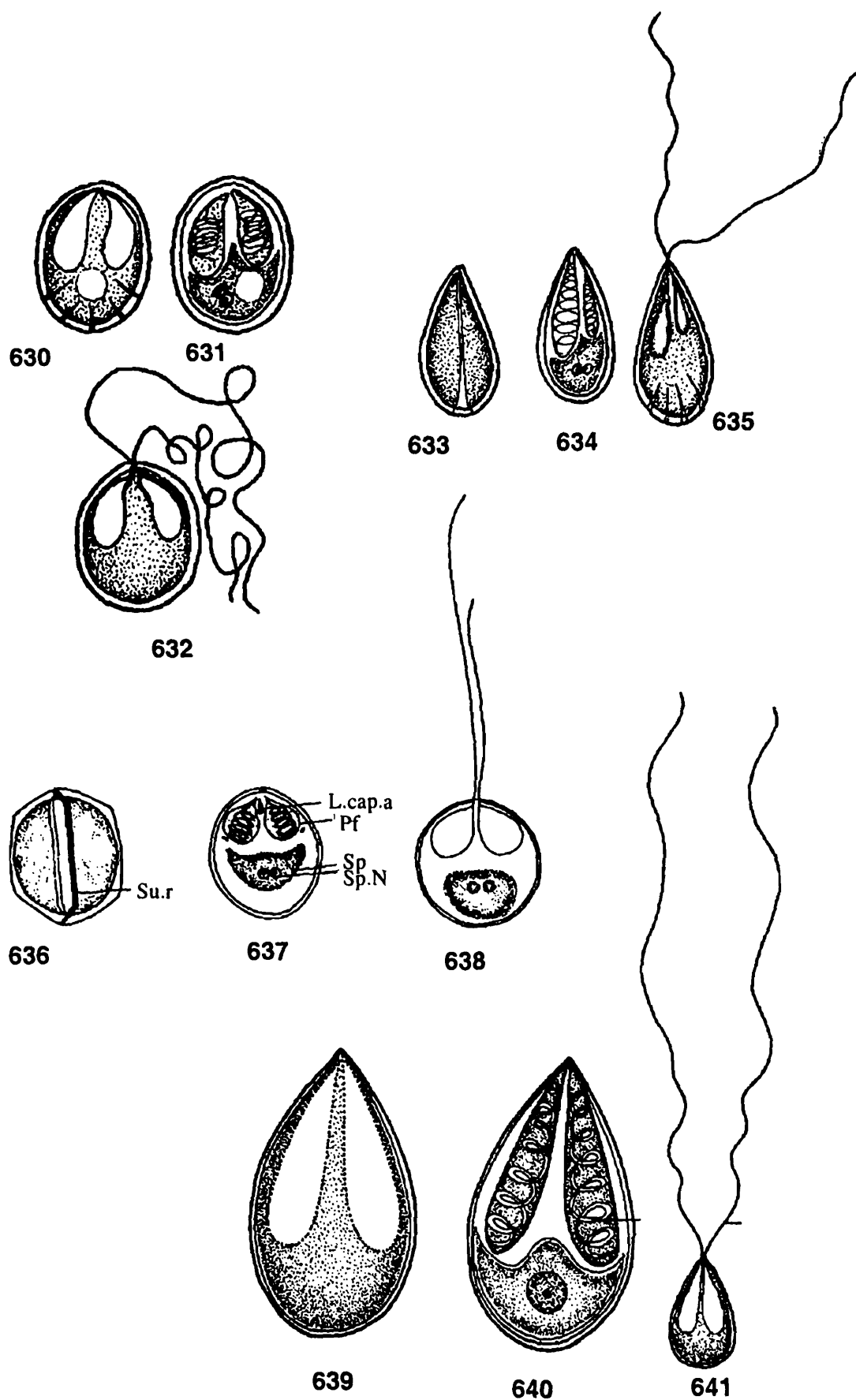
Host : *Clarias batrachus*; site of infection : intestinal wall.

Distribution : India : Andhra Pradesh (Eluru, West Godavari district).

347. *Myxobolus channai* (Kalavati, Sandeep and Narasimhamurti, 1981)
Landsberg and Lom, 1991
(Figs. 646-648)

1981. *Myxosoma channai* Kalavati *et al.*, *Proc. Indian. Acad. Sci.*, **90B**(1) : pp. 61-78.

1991. *Myxobolus channai* Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165-186.



Figs. 630-641. Myxozoan parasites of Andhra Pradesh : 630-632. *Myxobolus ampullaceus*; 633-635. *M. andhrae*; 636-638. *M. anili* and 639-641. *M. bengalensis*.

Material examined : Sev. exs., Srungavarapukota, Elamanchili, Visakhapatnam, Visakhapatnam district, February–April, 1979, C. Kalavati.

Diagnosis : Trophozoites spherical or oval. 0.8-1.2 mm in size; spores elongated, oval; anterior end bluntly pointed, posterior rounded. 14.5-18.0 (17.2) μm x 6.0-6.5 (6.3) μm ; valves smooth, equal; sutural ridge prominent, median; polar capsules 2, elongate, pear-shaped, unequal. 9.0-10.8 (10.2) μm x 2.8-3.2 (3.0) μm and 7.2-8.8 (7.5) μm x 2.8-3.2 (3.0) μm in size; polar filament in large capsule, thin, making 8 coils while inside the capsule, 20-28 (26.5) μm ; sporoplasm triangular, binucleate, below the capsules; iodophilous vacuole not seen.

Host : *Channa punctata*; site of infection : fins, body muscles, kidney and liver.

Distribution : India : Andhra Pradesh (Srungavarapukota, Elamanchili, Visakhapatnam, Visakhapatnam district).

348. *Myxobolus clarii* Chakravarty, 1943
(Figs. 649-651)

1943. *Myxosoma channi* Chakravarty, *Proc. Indian Acad. Sci.*, **18**(2) B : p. 31.

Diagnosis : Spores subspherical in front view, lenticular in lateral view, measuring 11.3-12.4 μm x 10.3 μm ; shell comparatively thick with equal valves; sutural ridge distinct; polar capsules pyriform with their ends drawn into a short narrow tube, 6.18 μm x 3.09 μm ; polar filament 50 μm long ; iodophilous vacuole single, spherical, 3 μm in diameter; cyst broadly oval, opaque, white, 780-755 μm x 604-877 μm in dimension.

Host : *Clarias batrachus*; site of infection : viscera (as cyst).

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Lalitha Kumari (1969) reported the occurrence of this species as cyst on viscera in 37 out of 56 specimens of *Clarias batrachus* examined from the local markets of Hyderabad city without any other details.

349. *Myxobolus crucifila* (Qadri, 1962) Landsberg and Lom, 1991
(Figs. 652-653)

1962. *Gyrospora crucifila* Qadri, *Z. Parasitenkd.*, **21** : pp. 513-516.

1991. *Myxobolus crucifila* (Qadri) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165-186.

Diagnosis : Spore pyriform, anterior end broad, posterior end narrow, bluntly curved, 9-10 μm x 8-8.5 μm ; valves thick, symmetrical, single valve; no sutural line seen; polar capsules 2, circular with a distinct neck, convergent; a thread like structure connecting 2 polar capsules; polar filament thick, terminating into a fine undulating process, when extended cross each and measuring 42-43 μm ; sporoplasm hyaline, filling the entire spore cavity.

Host : *Labeo fimbriatus*; site of infection : gills.

Distribution : India : Andhra Pradesh (Fisheries Dept. sales depot, Hyderabad city, Hyderabad district).

Remarks : Landsberg and Lom (1991) treated the genus *Gyrospora* Qadri as a junior synonym of the genus *Myxobolus* Butschli, 1882.

350. *Myxobolus episquammalis* Egusa, Maeno and Sorimachi, 1990
(Figs. 654-656)

1990. *Myxobolus episquammalis*, Egusa *et al.*, *Fish Pathology*, **25** (2) : pp. 87-911.

1990. *Myxosoma ganapatii* Anuradha, Ph.D. thesis (unpublished), Andhra University, India.

1992. *Myxobolus episquammalis* : Kalavati and Anuradha, *Proc. Zool. Soc., Calcutta.*, **45** (suppl. A) : pp. 107-113.

Material examined : Sev. exs., Visakhapatnam harbour, Visakhapatnam, Visakhapatnam district, February to December 1987, I. Anuradha.

Diagnosis : Trophozoite flat, oval or irregularly outlined cyst; spores oval in front view, enclosed in a thick mucus coat, 6.0-7.6 (7.2) μm x 5.16-5.84 (5.6) μm ; valves thin, smooth; sutural line thin, straight; polar capsules unequal, one narrow and the other broad, pyriform, convergent, terminal; inter-capsular appendix present; 3.2-3.6 (3.45) μm x 2.0-2.8 (2.6) μm and 3.2-3.6 (3.45) μm x 1.4-1.6 (1.5) μm ; polar filaments making 4-6 coils while inside the capsule; sporoplasm semicircular, hyaline; iodophilous vacuole absent.

Hosts : *Mugil cephalus*, *Liza macrolepis*; site of infection : gills, visceral peritoneum, and intestine.

Distribution : India : Andhra Pradesh (Coastal waters of Visakhapatnam and Bheemunipatnam, Visakhapatnam district; Kakinada, East Godavari district); Orissa. *Elsewhere* : Gokasho Bay, Japan.

Remarks : Egusa *et al.* (1990) reported this species from the scales of *Mugil cephalus* in the coastal waters of Japan. A comparison of spore morphometrics showed that *M. ganapatii* of Anuradha (1990, unpublished) is similar to *M. episquammalis*. Hence it is proposed to synonymize *M. ganapatii* with *M. episquammalis*.

351. *Myxobolus esomi* (Kalavati and Narasimhamurti, 1984)
Landsberg and Lom, 1991
(Syn. *Rudicapsula esomi*)
(Figs. 657-659)

1984. *Rudicapsula esomi* Kalavati and Narasimhamurti, *Z. Parasitenkd.*, **70** : pp. 21-27.

1991. *Myxobolus esomi* (Kalavati and Narasimhamurti) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165-186.

Material examined : Sev. exs., Kondakarla Lake, Visakhapatnam district, September–December 1982, C. Kalavati.

Diagnosis : Trophozoites in the form of multilobulated tumors, 2.0–3.0 mm in size; spore pear-shaped with truncated anterior end; posterior end rounded; 11.2–12.4 (11.8) μm x 6.8–7.2 (7.0) μm ; valves smooth, refractile, double layered, inner thick and outer thin; sutural line not seen; polar capsules unequal and dissimilar; large capsule pyriform, subterminal; 4.8–5.2 (5.0) μm x 3.0–3.2 (3.16) μm ; polar filament making 9–10 coils while inside the capsule, 48–56 (52.5) μm ; smaller polar capsule rudimentary, terminal, 1.6–2.0 μm x 1.0 μm , nonfunctional; no polar filament seen; a small deeply stained rod-like structure seen inside; sporoplasm semilunar occupying the entire extracapsular space; iodophilous vacuole 3–4 μm in diameter.

Host : *Esomus sp.*; site of infection : caudal fin.

Distribution : India : Andhra Pradesh (Kondakarla Lake, Visakhapatnam district).

352. *Myxobolus hyderabadense* (Lalitha Kumari, 1969), Landsberg and Lom, 1991 (Figs. 660–662)

1969. *Myxosoma hyderabadense* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153–225.

1991. *Myxobolus hyderabadense* (Lalitha Kumari) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165–186.

Diagnosis : Spores pyriform, 9.3–11.5 (10.1) μm x 5.0–8.0 (5.9) μm in size, anterior end narrow, pointed, posterior end rounded; spore valves equal with 4–6 ridges at the posterior end; sutural ridge broad with a clear median sutural line; polar capsules 2, equal, pyriform, 5.0–7.3 (5.8) μm x 1.4–3.0 (2.2) μm , subterminal with small intercapsular space; polar filaments equal, forming 8–9 coils within the capsule, 69 μm when extended; sporoplasm granular, homogenous and small; iodophilous vacuole absent.

Host : *Barbus pinnauratus*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

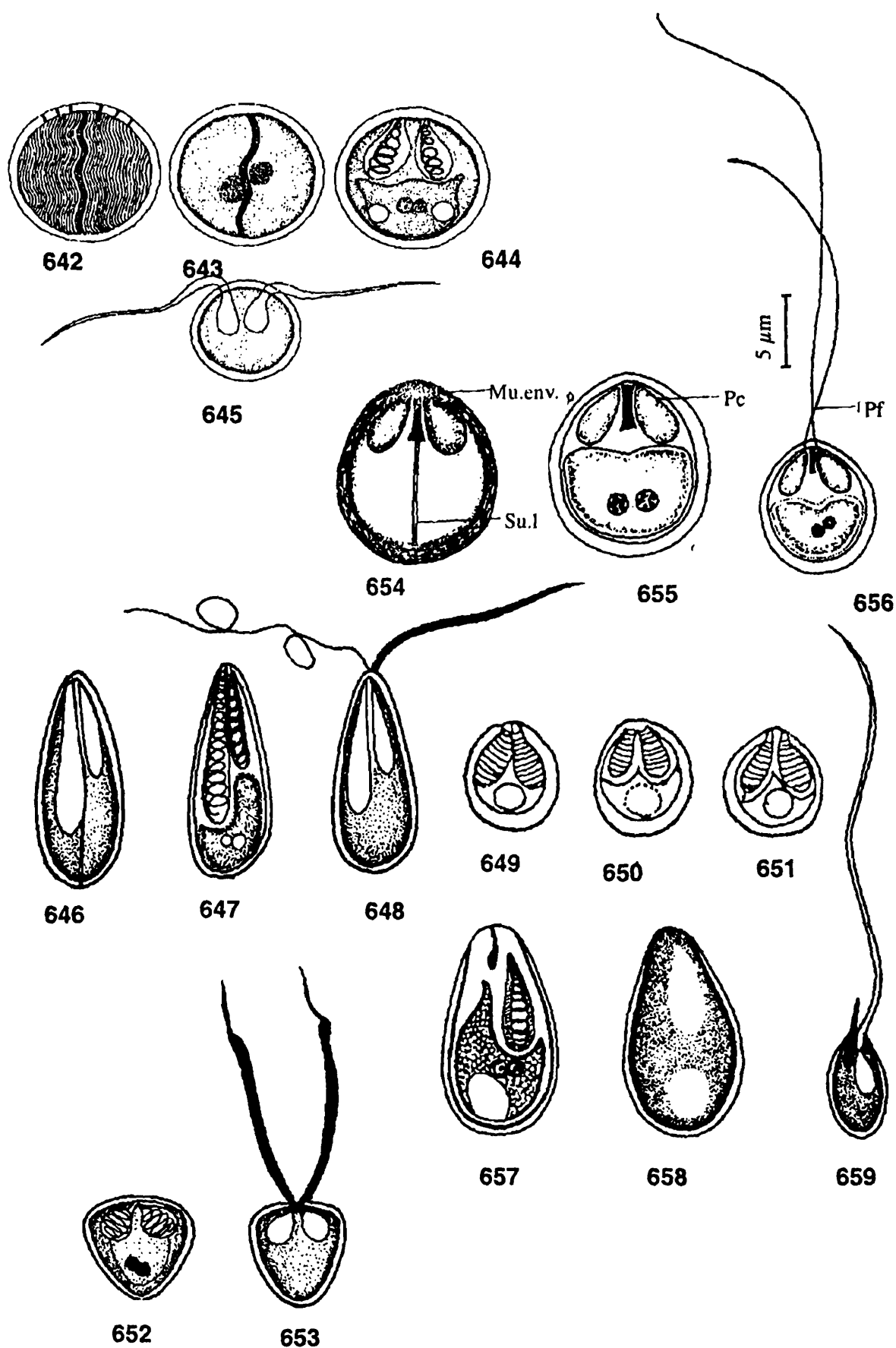
353. *Myxobolus indiae* (Lalitha Kumari, 1969) Landsberg and Lom, 1991 (Figs. 663–666)

1969. *Myxosoma indiae* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153–225.

1991. *Myxobolus indiae* (Lalitha Kumari) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165–186.

Material examined : Sev. exs., Warangal, Warangal district, 29.vi.1988. I. Anuradha.

Diagnosis : Trophozoites 1.0–2.0 mm in diameter; pansporoblasts disporous; spores pyriform or ovoid, 12.4–15.0 (13.7) μm x 6.4–8.6 (7.3) μm in size, anterior end narrow pointed, posterior end rounded; sutural ridge median, visible to the middle of the spore; polar capsules



Figs. 642-659. Myxozoan parasites of Andhra Pradesh : 642-645. *Myxobolus bivaculatus*; 646-648. *M. channai*; 649-651. *M. clarii*; 652-653. *M. crucifila*; 654-656. *M. episquammalis* and 657-659. *M. esomi*.

2–3 in number, unequal, pyriform, 5.7–7.1 (5.9) μm x 1.4–2.5 (2.1) μm and 5.0–6.4 (5.2) μm x 1.4–2.5 (2.1) μm , opening independently; polar filaments unequal, forming 8–10 coils within the capsule, 71.5–107.0 (87.0) μm when extended; sporoplasm clear, homogenous filling the entire spore cavity extending into intracapsular space; iodophilous vacuole absent.

Host : *Barbus sarana*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district and Warangal, Warangal district).

354. *Myxobolus koli* Lalitha Kumari, 1969
(Figs. 667–669)

1969. *Myxobolus koli* Lalitha Kumari, *Riv. Parassitol.*, **30**(3) : pp. 153–225.

Diagnosis : Pansporoblasts disporous; spores oval with broad posterior and truncated anterior ends; 7.1–9.6 (8.4) μm x 5.0–6.4 (6.0) μm in size; spore valves thin, transparent and uniformly thick with 6–8 parietal markings on posterior margin; sutural ridge not prominent; sutural line fine, slightly curved; polar capsules 2, unequal, one very small, pyriform, 3.9–4.6 (4.3) μm x 2.1–3.1 (2.8) μm and 1.4–2.1 (2.0) μm x 0.7–1.4 (1.2) μm in size; polar filaments remarkably unequal, 42–70.5 (51.3) μm and 6–13.5 (8.9) μm in size, forming 5–6 tight coils while inside the capsule; sporoplasm granular, homogenous occupying the place behind the polar capsule; iodophilous vacuole large, oval or spherical.

Host : *Barbus kolus*; site of infection : dorsal and ventral fins.

Distribution : India : Andhra Pradesh (Local market in Hyderabad city, Hyderabad district).

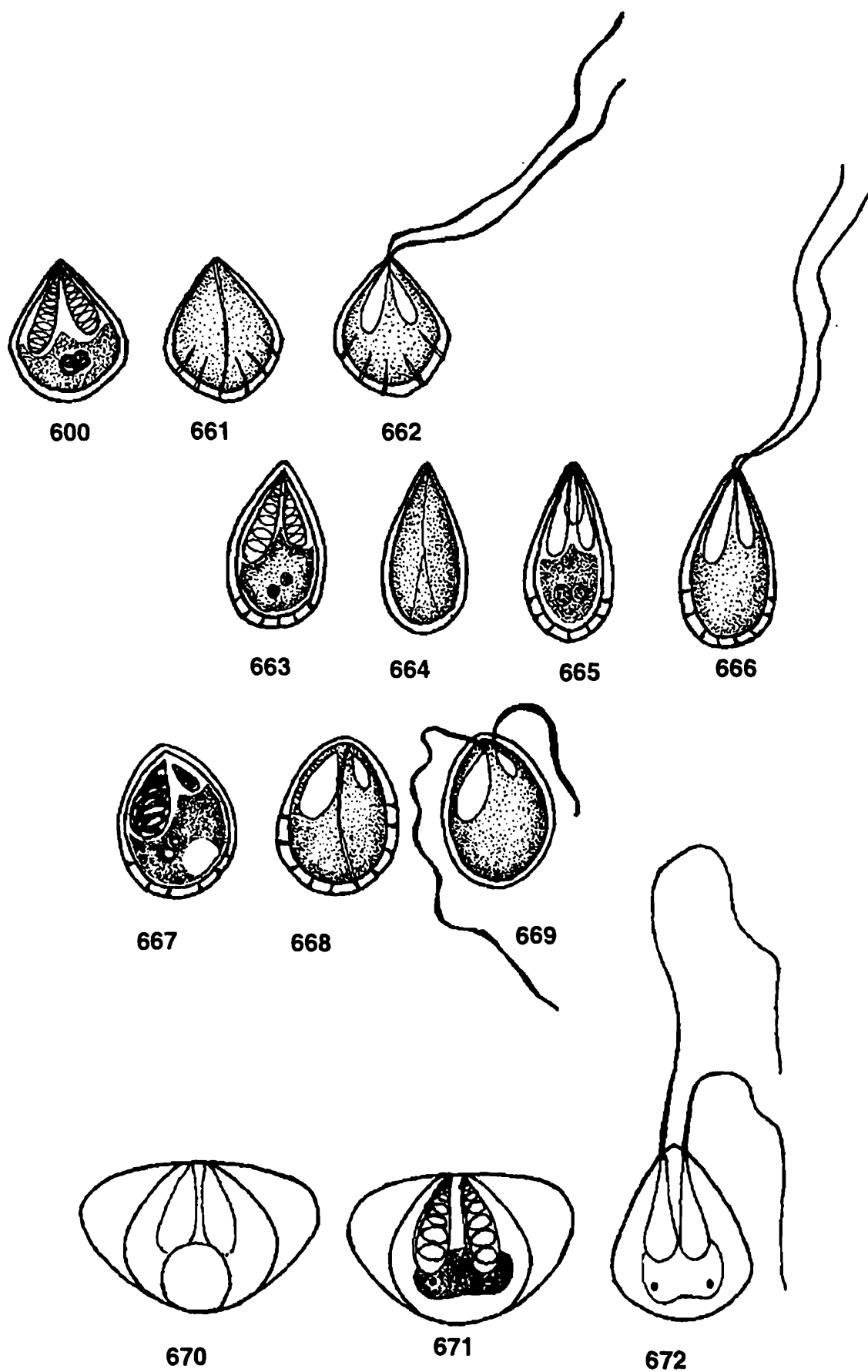
355. *Myxobolus lizae* (Narasimhamurti and Kalavati, 1979) Landsberg and Lom
(Figs. 670–672)

1979. *Myxosoma liardi* Narasimhamurti and Kalavati, *Proc. Indian Acad. Sci.*, **88B** (4) : pp. 269–272.

1991. *Myxobolus lizae*. (Narasimhamurti and Kalavari) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165–186.

Material examined : Sev. exs., Bheemunipatnam, Visakhapatnam district, October–November, 1977, Kakinada, East Godavari district; July 1987, K. Padma Dorothy.

Diagnosis : Trophozoites opaque, white, spherical, 1.5–3.0 mm, attached to the outer wall of the intestine; spores pear-shaped in valvular view; 4.6–5.2 (4.9) μm x 9.0–9.5 (9.3) μm ; outer mucus envelop forming 2 prominent lateral lappets on either side; valves smooth, equal; sutural line faint; polar capsules 2, equal, parallel to each other, pear-shaped with long neck, 3.0–4.6 (3.2) μm x 1.8–3.6 (3.2) μm in size; polar filament forming 5–7 coils while inside the capsule and 50–60 (56.5) μm in length when extended; sporoplasm dumb-bell shaped; iodophilous vacuole not seen.



Figs. 660-672. Myxozoan parasites of Andhra Pradesh : 660-662. *Myxobolus hyderabadensis*; 663-666. *M. indiae*; 667-669. *M. koli* and 670-672. *M. lizae*.

Host : *Liza macrolepis*; site of infection : intestinal wall.

Distribution : India : Andhra Pradesh (Bheemunipatnam and Visakhapatnam, Visakhapatnam district, Kakinada, East Godavari district).

356. *Myxobolus macrolepi* Padma Dorothy and Kalavati, 1992
(Figs. 673-675)

1992. *Myxobolus macrolepi* Padma Dorothy and Kalavati, *Proc. zool. Soc., Calcutta*, **45** (2) : pp. 197-204.

Material examined : Sev. exs., Bheemunipatnam, Visakhapatnam district, February 1987–March 1988, K. Padma Dorothy.

Diagnosis : Trophozoites opaque, white, spherical 188-200 μm ; pansporoblast disporous; spores oval or spherical, 5.2-6.9 (6.28) μm x 4.3-6.9 (5.26) μm ; sutural line bent; shell valves equal, symmetrical, 5 widely spaced diagonal striations extending between lateral walls; polar capsules 2, equal, pyriform, convergent, 1.72-3.44 (2.78) μm x 1.72-2.58 (2.0) μm ; polar filaments forming 3-4 coils while inside the capsule; polar filaments unequal, thin, 14.4-17.6 (15.62) μm and 8.0-11.2 (10.34) μm when fully extended; sporoplasm oval in the posterior part of the spore; iodophilous vacuole absent.

Host : *Liza macrolepis*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Bheemunipatnam, Visakhapatnam district).

357. *Myxobolus mahendrae* Sarkar, 1986
(Figs. 676-678)

1986. *Myxobolus mahendrae* Sarkar, *Acta Protozool*, **25**(2) : pp 235-238.

1988. *Myxobolus mahendrae* : Lakshminarayana, M.Phil dissertation (Unpublished), Andhra University, India.

Material examined : Sev. exs., Vogaruvagu, Chilakaluripet, Guntur district, 20.vii.1987, D. Lakshminarayana.

Diagnosis : Trophozoites 2.0–3.0 mm in size; spores cylindrobiconical, 9.8–12.0 (11.3) μm x 8.0–10.2 (9.2) μm in size; shell valves smooth, refractile, double layered; sutural line slightly curved; polar capsules unequal and dissimilar; large capsule pyriform, subterminal, 5.0–6.0 (5.28) μm x 2.0–2.4 (2.08) μm ; polar filament forming 6-7 coils while inside the capsule, 33.0–43.0 (37.7) μm in size; smaller polar capsule terminal, 3.0–3.4 μm x 0.9–1.0 μm ; polar filament making 4–5 coils while inside the capsule; polar filament small deeply stained, 7.0–11.0 μm ; sporoplasm semilunar, occupying the entire extracapsular spore cavity; iodophilous vacuole spherical, 1.0–1.6 μm .

Host : *Catla catla*; site of infection : gill rachii.

Distribution : India : Andhra Pradesh (Vogaruvagu, Chilakaluripet, Guntur district) and West Bengal.

Remarks : Lakshminarayana (1988) recorded this species from this state.

358. *Myxobolus mugcephalus* (Narasimhamurti, Kalavati and Saratchandra, 1980)
Landsberg and Lom, 1991
(Figs. 679-681)

1980. *Myxosoma microspora* Narasimhamurti *et al.*, *J. Fish. Biol.*, **16** : pp. 345-348.

1991. *Myxobolus mugcephalus* (Narasimhamurti, Kalavari and Saratchandra) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165-186.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district, October to December 1977, C. Kalavati.

Diagnosis : Trophozoites opaque, white, spherical, 0.5-1 mm in diameter; pansporoblast disporous; spores spherical or slightly oval with outer mucus membrane having two protrubences in equatorial axis. 4.8-5.2 (5.1) μm in diameter; valves smooth, equal; sutural line thick, straight; polar capsule 2, pyriform, equal, terminal, 1.6-2.0 (1.8) μm x 1.0-1.2 (1.1) μm ; polar filament 22-28 (26) μm , forming 5-6 loose coils while inside the capsule; sporoplasm homogeneous, bean-shaped, below the capsule; iodophilous vacuole not seen.

Host : *Mughil cephalus*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district) Chilka Lake, Orissa.

Remarks : Since species name *microspora* is preoccupied by *Myxobolus microspora* Li and Nie in Chen 1973, Landsberg and Lom (1991) renamed *Myxosoma microspora* of Narasimhamurti *et al.* (1980) as *Myxobolus mugcephalus*.

359. *Myxobolus narasii* (Narasimhamurti, 1969) Landsberg and Lom, 1991
(Figs. 682-684)

1969. *Myxosoma intestinalis* Narasimhamurti, *Proc. Indian. Acad. Sci.*, **79B** : pp. 19-27.

1991. *Myxobolus narasii* (Narasimhamurti) Landsberg and Lom, *Syst. Parasitology*, **18** : pp. 165-186.

Diagnosis : Trophozoites spherical, about 2.0 mm, attached to intestinal wall; spore oval, longer than wide. 12.5-13.5 (12.8) μm x 8.6-9.5 (9.0) μm ; valves thin, equal, symmetrical; sutural line fine; sutural ridge narrow; polar capsules 2, equal, sub-terminal, pear-shaped, 2.9-3.6 (3.2) μm x 1.6-1.8 (1.7) μm ; polar filament 30-45 (42.5) μm in length, making 4-5 coils while inside the capsule; iodophilous vacuole absent.

Host : *Mugil waigensis*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Fish market at Bheemunipatnam and Visakhapatnam, Visakhapatnam district).

Remarks : Narasimhamurti (1969) described *Myxosoma intestinalis*. The species name was preoccupied by *Myxobolus intestinalis* Kudo, 1929. Landsberg and Lom (1991) while synonymising the genus *Myxosoma* and *Myxobolus* renamed it as *Myxobolus narasii* (an abbreviated form of Narasimhamurti, the author of *Myxosoma intestinalis*).

360. *Myxobolus osmaniae* Lalitha Kumari, 1969
(Figs. 685-687)

1969. *Myxobolus osmaniae* Lalitha Kumari, *Riv. Parssitol.*, 30(3) : pp. 153-225.

Diagnosis : Trophozoites 1-1.5 mm in diameter; spores pyriform, anterior end narrow, bent to one side; posterior end broad and rounded; 12.4-15.0 (13.5) μm x 7.1-10.0 (8.6) μm in size; spore valves uniformly thick with 8-10 parietal folds on posterior margin; sutural line median, faint; polar capsules 2, unequal, pyriform with prominent neck, 5.0-7.1(5.6) μm x 2.0-3.9 (3.2) μm and 2.1-3.6 (2.6) μm x 1.4-2.9 (2.5) μm in size; intercapsular ridge absent; polar filaments unequal, 109-134 (126.0) μm and 18-39 (25.6) μm in size, forming 5-6 tight coils while inside the capsule; sporoplasm granular, homogenous, occupying the entire extra capsular spore cavity; iodophilous vacuole large and centrally placed.

Host : *Barbus punjaubensis*; site of infection : liver and intestine.

Distribution : India : Andhra Pradesh (Local market in Hyderabad city, Hyderabad district).

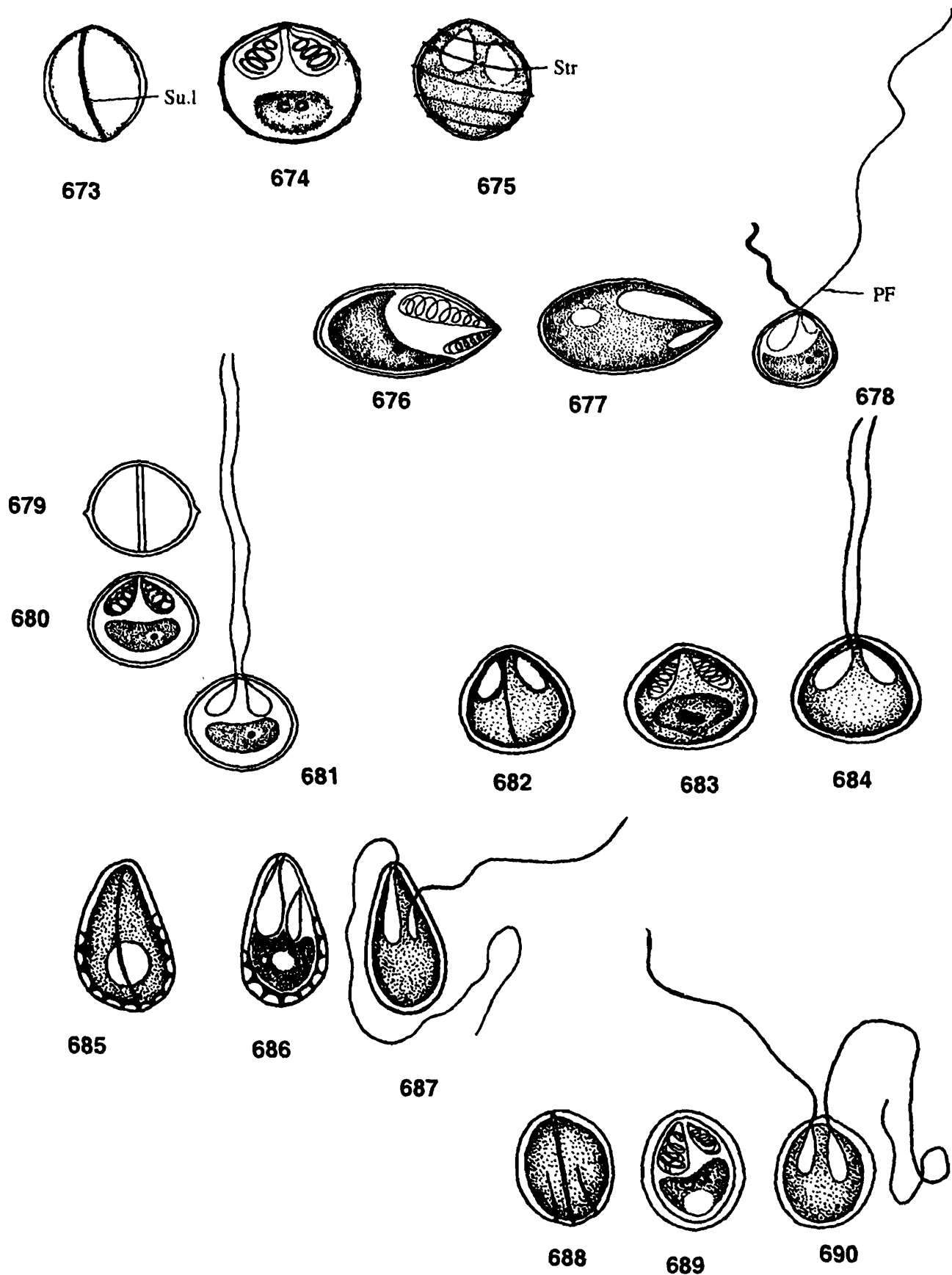
361. *Myxobolus pinnaurati* Lalitha Kumari, 1969
(Figs. 688-690)

1969. *Myxobolus pinnaurati* Lalitha Kumari, *Riv. Parssitol.*, 30(3) : pp. 153-225.

Diagnosis : Spores oblong or oval with rounded ends, 8.0-11.4 (9.6) μm x 6.5-7.9 (7.0) μm in size; spore valves symmetrical, uniform, equal; sutural ridge median, straight with 2 or more parallel ridges on either side; polar capsules 2, unequal, elongated, pyriform, subterminal, 3.6-6.4 (4.4) μm x 1.1-2.1 (1.9) μm and 2.9-5.0 (3.1) μm x 1.1-2.1 (1.6) μm in size; polar filaments unequal, cross each other when extended, measuring 35.0-46.5 (41.6) μm and 21.5-26.0 (23.2) μm ; no intercapsular ridge; sporoplasm finely granular, homogenous and occupying the entire spore cavity; iodophilous vacuole oval, large located in the posterior region.

Host : *Barbus pinnauratus*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Lake near Hyderabad city, Hyderabad district).



Figs. 673-690. Myxozoan parasites of Andhra Pradesh : 673-675. *Myxobolus macrolepi*; 676-678. *M. mahendrae*; 679-681. *M. mugcephalus*; 682-684. *M. narasii*; 685-687. *M. osmaniae* and 688-690. *M. pinnaurati*.

362. *Myxobolus potaili* Lalitha Kumari, 1969
(Figs. 691-693)

1969. *Myxobolus potaili* Lalitha Kumari, *Riv. Parssitol.*, 30(3) : pp. 153-225.

Diagnosis : Spores oval in valvular view with prominent knobs at the anterior end; pyriform in sutural view; posterior end broad and rounded; 6.3-7.9 (7.2) μm x 4.3-6.4 (5.4) μm in size; spore valves equal, symmetrical, with markings on posterior margin; sutural ridge not seen; polar capsules 2, equal and oval with prominent ducts, 2.9-3.6 (3.3) μm x 1.4-2.1 (2.0) μm in size; a small clear intercapsular ridge present; polar filaments 9.0-15.5 μm long, forming 3 fine loose coils while inside the capsule; sporoplasm granular, homogenous, occupying the entire extracapsular spore cavity; iodophilous vacuole large and in the posterior region of the spore

Host : *Labeo potaili*; site of infection : gill content.

Distribution : India : Andhra Pradesh (Local market in Hyderabad city, Hyderabad district).

363. *Myxobolus psilorhynchi* Lalitha Kumari, 1969
(Figs. 694-696)

1969. *Myxobolus psilorhynchi* Lalitha Kumari, *Riv. Parssitol.*, 30(3) : pp. 153-225.

Diagnosis : Trophozoites small, round, 0.5-1.0 mm in diameter; pansporoblasts disporous; spores spherical or slightly oval with rounded ends, 9.3-10.7 (10.0) μm x 8.6-10.0 (9.4) μm in size, small valves asymmetrical, with two striations one on either side of the sutural line and 3-4 parietal folds at the posterior end; sutural line slightly shifted; polar capsules 2, unequal, elongated, pyriform with short neck, 4.3-5.7 (4.8) μm x 2.9-3.9 (3.2) μm and 2.9-4.3 (3.5) μm x 2.1-3.0 (2.5) μm in size; subterminal; intercapsular ridge prominent; polar filaments unequal, forming 6-7 tight coils while inside the capsule, 98-141 (119.8) μm and 31-68.5 (56.0) μm long when extended; sporoplasm finely granular, homogenous, occupying the entire spore cavity; iodophilous vacuole oval, large, either central or shifted to one side.

Host : *Psilorhynchus balitora*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Lake near Hyderabad city, Hyderabad district).

364. *Myxobolus seshadrui* Lalitha Kumari, 1968
(Figs. 697-699)

1968. *Myxobolus seshadrui* Lalitha Kumari, *Riv. Parssitol.*, 29(3) : pp. 161-164.

Diagnosis : Spores oval with narrow blunt anterior end and rounded posterior end, 11.4-12.9 (12.21) μm x 8.6-10.0 (9.04) μm ; valves thin in the anterior half, thick posteriorly; polar capsules large, ovoid, slightly unequal with small ducts; large capsule 5.7 μm x 2.9-4.3 (3.66) μm ; small capsule 4.3-5.0 (4.9) μm x 2.5-3.6 (2.99) μm ; intercapsular ridge prominent; polar

filaments unequal, whip-like, cross each other at the base when extended; a small constriction at the junction of the capsule; sporoplasm homogenous, granular, occupying the entire extracapsular space.

Host : *Labeo fimbriatus*; site of infection : gills.

Distribution : India : Andhra Pradesh (Tungabadhra river, Kurnool, Kurnool district).

365. *Myxobolus sphaeralis* Padma Dorothy and Kalavati, 1992

(Figs. 700-702)

1992. *Myxobolus sphaeralis* Padma Dorothy and Kalavati, *Proc. zool. Soc., Calcutta.*, **45**(2) : pp. 197-204.

Material examined : Sev. exs., Visakhapatnam harbour, Visakhapatnam, Visakhapatnam district, October to December 1987, K. Padma Dorothy.

Diagnosis : Trophozoites oval, opaque white, 96-215 μm x 80-165 μm ; spores spherical, 6.0-7.3 (6.74) μm in diameter; sutural line straight, distinct; polar capsules 2, equal, pyriform, convergent, 3.4-3.9 (3.75) μm x 2.2-3.4 (2.6) μm ; polar filaments forming 4-5 coils while inside the capsule, 19.2-27.2 (21.76) μm when extended; sporoplasm hyaline, cup-shaped with 2 small depressions below the capsules; iodophilous vacuole absent.

Host : *Liza macrolepis*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

366. *Myxobolus spinocurvatura* Maeno, Sorimachi, Ogawa and Egusa, 1990

(Figs. 703-705)

1990. *Myxobolus spinocurvatura* Maeno et al., *Fish Pathology*, **25**(10) : pp. 37-41.

1991. *Myxosoma paedolpavi* : Anuradha, Ph.D thesis (unpublished), Andhra University, India.

1992. *Myxobolus spinocurvatura* : Kalavati and Anuradha, *Proc. Zool. Soc. Calcutta*, **45** : pp. 107-113.

Material examined : Sev. exs., Visakhapatnam harbour, Visakhapatnam, Visakhapatnam district, October to December 1987, I. Anuradha.

Diagnosis : Pansporoblast disporous; spores oval with rounded ends in valvular view, lenticular with two “knob-like” extensions on either side in sutural view, 10.6-13.6 (11.5) μm x 9.6-11.2 (10.5) μm ; shell valves striated; sutural line distinct, narrow, straight or slightly wavy, extending beyond the spore body, like two small knobs at both ends; polar capsules 2, equal, pyriform, subterminal, convergent, 2.58-4.8 (3.8) μm x 1.72-3.2 (3.6) μm ; polar filament forming 4-6 longitudinal coils while inside the capsule, 25.8-30.0 (28.0) μm when extended; sporoplasm cup-shaped occupying the entire extracapsular area; no iodophilous vacuole.

Host : *Mugil cephalus*; site of infection : branchial cartilage.

Distribution : India : Andhra Pradesh (Gosthani Estuary, Bheemunipatnam Visakhapatnam, Visakhapatnam district). **Elsewhere** : Bay of Mie prefecture, Japan.

Remarks : *M. paedolpavi* of Anuradha (1991, unpublished) is identical with *M. spinocurvatura* and hence considered a junior synonym of the latter species by Kalavati and Anuradha (1992).

367. *Myxobolus tripathii* Kalavati, Sandeep and Narasimhamurti, 1981
(Figs. 706-708)

1981. *Myxobolus tripathii* Kalavati *et al.*, *Proc. Indian Acad. Sci.*, **90B** (1) : pp. 61-78.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district, 25.x.1979; sev. exs., Akiveedu, West Godavari district, B. V. Sandeep.

Diagnosis : Trophozoites opaque, white, 0.5-1.0 mm in diameter; spores spherical or oval, 9.8-10.2 (10.1) μm x 12.0-13.5 (13.0) μm ; valves smooth, equal, symmetrical; sutural ridge prominent extending beyond the valve periphery like a knob; polar capsules 2, oval, equal 5.0-6.0 (5.5) μm x 2.5 μm , opening independently; a distinct deeply stained, cushion-like mass at the opening of the polar capsules; polar filaments forming 8 coils while inside the capsule, 45-50 (47.6) μm in length; sporoplasm homogenous, extending like a rim around the large oval iodophilous vacuole.

Host : *Clarias* sp.; site of infection : wall of the gut and visceral organs.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district, Akiveedu, West Godavari district).

368. *Myxobolus* sp.
(Figs. 709-711)

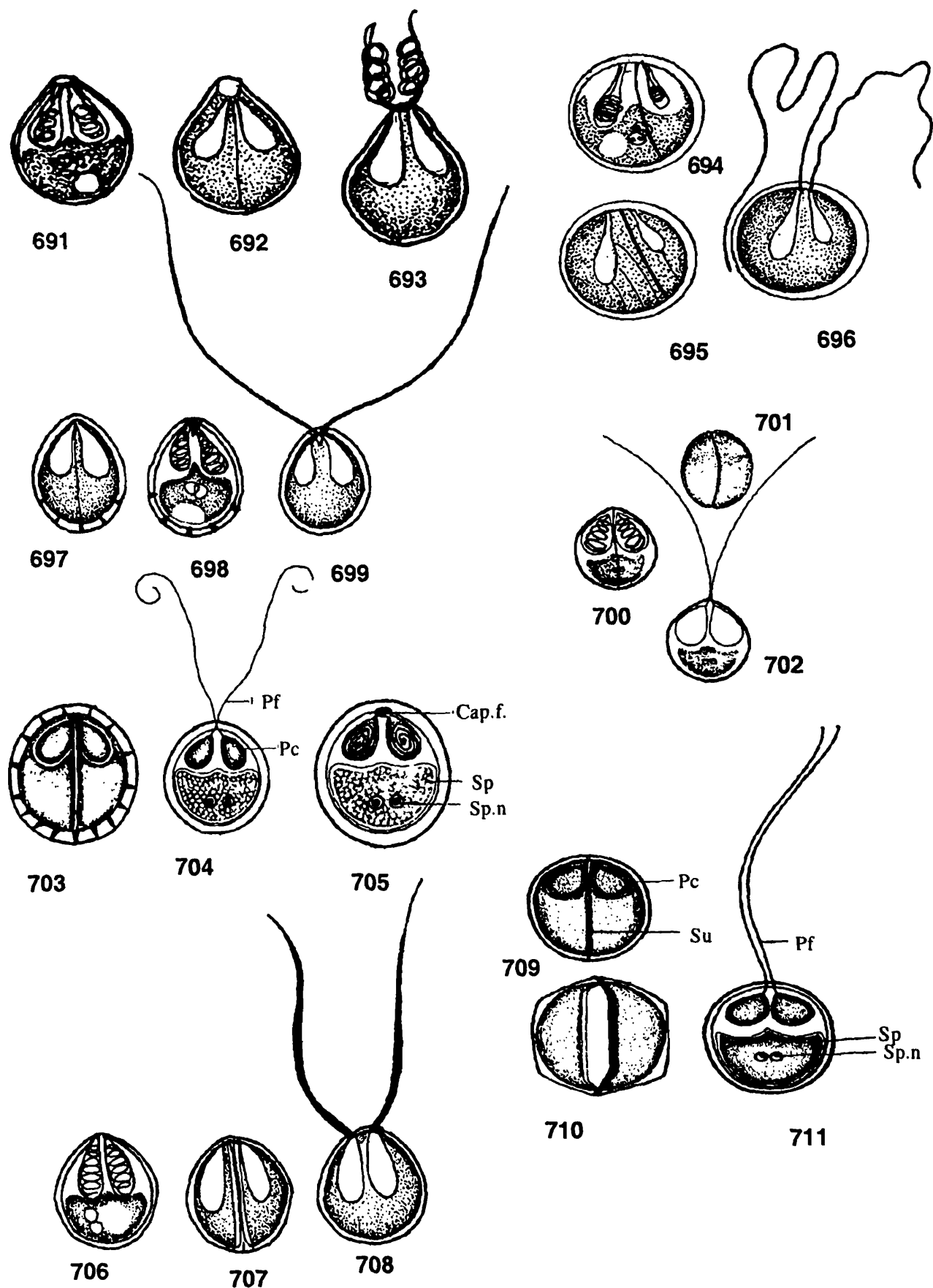
1992. *Myxobolus* sp. Padma Dorothy and Kalavati, *Proc. zool. Soc., Calcutta*, **45** : pp. 197-204.

Material examined : Sev. exs., Visakhapatnam harbour, Visakhapatnam, Visakhapatnam district, October to December, 1987, K. Padma Dorothy.

Diagnosis : Spores broadly oval, enveloped in a thin indistinct mucus sheath forming 5-6 bluntly pointed posterior processes; two peripheral processes thicker than the central ones, 6.9-8.6 (7.74) μm x 5.6-6.5 (6.02) μm ; valves thick, smooth; sutural line broad, straight; polar capsules 2, oval or pyriform, equal, convergent, 2.6-3.5 (3.32) μm x 1.7-2.6 (2.06) μm ; polar filaments forming 5-6 coils while inside the capsule, 25.6-28.8 (26.4) μm when extended; sporoplasm homogenous, granular and occupied the posterior part of the spore.

Host : *Liza macrolepis*, *Mugil cephalus* ; site of infection: intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam harbour, Visakhapatnam district).



Figs. 691-711. Myxozoan parasites of Andhra Pradesh : 691-693. *Myxobolus potaili*; 694-696. *M. psilorhynchi*; 697-699. *M. seshadrii*; 700-702. *M. sphaeralis*; 703-705. *M. spinocurvitura*; 706-708. *M. tripathii* and 709-711. *Myxobolus* sp.

Remarks : This taxon seems to be new species but, it could not be named since additional information concerning the nature of trophozoite and its development were not available (Padma Dorothy and Kalavati, 1992).

Genus *Henneguya* Thelohan, 1892

1892. *Henneguya* Thelohan, *Bull. Soc. Philon.*, **4** : pp. 115-178.

Diagnosis : As in the key.

Remarks : The species, *Henneguya jubili* is not included in the key since its description or diagnosis is not available.

Key to the species

1. Polar capsules equal 3
2. Polar capsules unequal 4
- 3.1 Spores ovoid, 9.29–9.99 μm x 4.0–4.78 μm ; caudal appendages straight; polar capsules pyriform with duct. *H. ganapatiae*
- 3.2 Spores oval, compressed along the sutural line, 14.6–16.5 μm x 2.3–4.0 μm ; polar capsules pyriform; caudal appendage 'U' shaped *H. waltairensis*
- 4.1 Spores ellipsoid or lanceolate, 11.5–13.0 μm x 4.5–5.0 μm ; polar capsules elongate, unequal, one pyriform, other with long duct opening like a golf stick *H. notopteriae*
- 4.2 Spores elongate oval, 11.0–13.6 μm x 3.9–5.7 μm ; polar capsules unequal, pyriform, terminal; large capsule curved. *H. singhi*
- 4.3 Spores elongated and oval, 9.24–12.32 μm x 4.62–5.39 μm , polar capsules pyriform, unequal, converging anteriorly and each opening to the exterior separately by means of a duct *H. qadrii*

369. *Henneguya ganapatiae* Qadri, 1970 (Figs. 712-713)

1970. *Henneguya ganapatiae* Qadri, *Prof. Ganapati. Shas. Comm. vol.*, pp. 1-5.

Diagnosis : Spores ovoid with rounded, narrow anterior extremity and posterior end drawn out into caudal appendages; spore body 9.28-9.99 (9.72) μm x 4.0-4.78 (4.5) μm in size; caudal appendages 22-25 (22.25) μm ; valves smooth, thin symmetrical; polar capsules 2, equal, elongated, pyriform with a duct, 3.21-2.57 (3.32) μm x 1.4-1.78 (1.64) μm ; sporoplasm homogenous, occupying the entire extracapsular spore cavity.

Host : *Notopterus notopterus*; site of infection : gill contents.

Distribution : India : Andhra Pradesh (Lake near Hyderabad city, Hyderabad district).

370. *Henneguya jubili* Qadri, 1969

1969. *Henneguya jubili* Qadri, *Progress in Protozoology*, p. 241.

Diagnosis : Not available.

Host : *Notopterus notopterus*; site of infection : gills.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Qadri (1969) reported this species in the abstract book "Progress in Protozoology" As such this may be a '*nomen nudum*'

**371. *Henneguya notopteriae* Qadri, 1965
(Figs. 714-715)**

1965. *Henneguya notopteriae* Qadri, *Zool. Anz.*, **175** : pp 225-228.

Diagnosis : Spores elongated, ellipsoidal or lanceolate with long divided caudal processes; anterior end fusiform, pointed; posterior end flattened and rounded; 11.5-13.0 μm x 4.5-5.0 μm ; caudal appendage 40.5-42.0 μm ; sutural ridge fine; polar capsules elongate, unequal; one capsule pyriform, other with long duct appearing like a golf stick; 3.5-4.5 μm x 1.0-1.25 μm and 5.0-5.5 μm x 1.0-1.5 μm in size respectively; sporoplasm homogenous; iodophilous vacuole round, located in the posterior half of the spore.

Host : *Notopterus notopterus*; site of infection : gills.

Distribution : India : Andhra Pradesh (Local fish market, Hyderabad city, Hyderabad district).

372. *Henneguya qadrii* Lalitha Kumari, 1965

1965. *Henneguya qadrii* Lalitha Kumari, *Riv. Parassitol.*, **26** : pp. 79-84, figs. 1-10.

Diagnosis : Spores elongated and oval, measuring 9.24-12.32 (11.00) μm x 4.62-5.39 (4.62) μm ; spore wall uniformly thick; spore widest at the middle, anterior end narrow and rounded, posterior end tapering and extending into caudal appendage of 5.39-9.24 (7.28) μm in length, bifurcated into two filaments; two polar capsules pyriform and unequal, 5.39-8.08 (6.17) μm and 4.62-6.16 (5.60) μm , converging anteriorly and each opening to the exterior separately by means of a duct; polar filaments unequal, averaging 45.40 μm and 34.50 μm , with nine coils inside the polar capsule; sporoplasm granular, restricted posterior to polar capsule; capsulogenous nucleus not prominent; two sporoplasmic nuclei large and round and situated above the large iodophilous vacuole; sometimes two valvular or parietal nuclei present at the posterior side of spore; sutural ridge broad with very prominent sutural lines.

Host : *Ophicephalus gachua*; site of infection : cyst on viscera.

Distribution : India : Andhra Pradesh (Hyderabad).

Remarks : Lalitha Kumari (1969) reported this species in 10 out of 20 specimens of *Ophicephalus gachua* from cyst on viscera.

373. *Henneguya singhi* Lalitha Kumari, 1969
(Figs. 716-717)

1969. *Henneguya singhi* Lalitha Kumari, *Riv. Parassitol.*, **30**(3) : pp. 153-225.

Diagnosis : Spore body elongate, oval with narrow anterior end; caudal appendage bifurcated into two processes at a distance from the posterior end; 11.1–13.6 (12.3) μm x 3.9–5.7 (4.4) μm in size; caudal appendage 30.0–48.0 (39.0) μm ; spore valves thin, smooth and uniform; sutural ridge not seen; polar capsules 2, unequal, pyriform, 4.8–6.4 (5.7) μm x 0.8–1.4 (1.1) μm and 3.5–5.5 (4.1) μm x 1.4–2.0 (1.6) μm , terminal and large, capsule often curved; polar filaments unequal, forming 4–5 coils within the capsule; 26.0–38.5 (33.5) μm and 7.0–16.5 (10.1) μm long when fully extended; sporoplasm finely granular and homogenous; iodophilous vacuole small.

Host : *Notopterus osmanii*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

374. *Henneguya waltirensis* Narasimhamurti and Kalavati, 1975
(Figs. 718-719)

1975. *Henneguya waltirensis* Narasimhamurti and Kalavati, *Riv. Parassitol.*, **36**(4) : pp. 255-259.

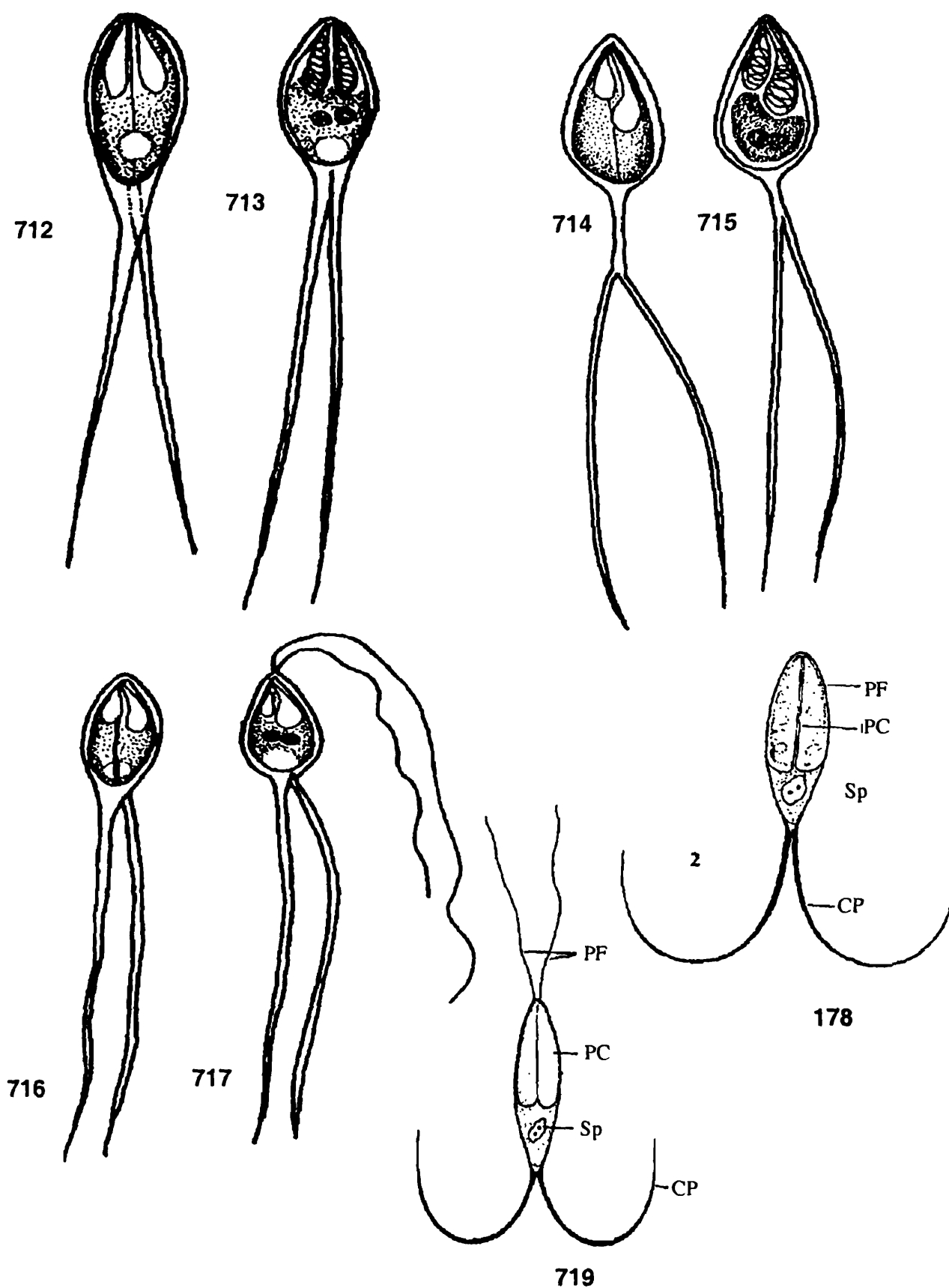
Material examined : Sev. exs., Fish markets of Anakapalle, Visakhapatnam and Vizianagaram, Jan-Feb 1974 and July 1978 to June 1979, C. Kalavati.

Diagnosis : Trophozoites translucent, 50–120 μm in size, variable in shape; spore oval compressed along the sutural line; spore valves prolonged as 2 characteristic 'U' shaped processes; spore body 14.6–16.5 (15.53) μm x 3.2–4.0 (3.82) μm ; caudal appendage 40.0–50.0 (45.5) μm ; polar capsules 2, equal, pyriform, 10.0–12.0 (11.4) μm x 1.6–2.5 (1.82) μm , one on either side of the sutural line and opening independently; polar filament forming 6–7 coils when inside the capsule; polar filaments thin, 15–20 (18.48) μm ; sporoplasm hyaline; iodophilous vacuole seen in fresh material.

Host : *Channa (Ophicephalus) punctatus*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Anakapalli and Visakhapatnam, Visakhapatnam district; Vizianagaram, Vizianagaram district).

Remarks : Narasimhamurti and Kalavati (1984) observed seasonality of infection with this parasite, which was recorded as maximum in winter (22.4%) and minimum in summer months. Subsequently, Kalavati and Narasimhamurti (1985) studied the histopathological changes in the gills of *Channa (Ophicephalus) punctatus* infected with this parasite and



Figs. 712-719. Myxozoan parasites of Andhra Pradesh : 712-713. *Henneguya ganapatiae*; 714-715. *H. nototopteriae*; 716-717. *H. singhi* and 718-719. *H. waltirensis*.

observed hypertrophy of the host tissue, vacuolization of the cell cytoplasm in early infection while degenerative changes associated with accumulation of macrophages and haemorrhage of capillaries was evident at the later stages.

Genus *Thelohaenellus* Kudo, 1933

1933. *Thelohaenellus* Kudo, *Trans. Amer. Micro Soc.*, **52** : pp. 195-216.

Diagnosis : As in the key.

Key to the Species

1. Spores elongate, pyriform, 11.2-14.85 μm x 4.5-5.5 μm ; polar capsule pyriform, large, adherent to lateral valves *T. andhrae*
2. Spores pyriform, 11.4-13.6 (12.3) μm x 4.3-7.9 (6.2) μm ; polar capsule large, pyriform, oblique and shifted to a side *T. batae*
3. Spores egg-shaped; anterior end bluntly pointed, 11.0-12 μm x 6.0-7.5 μm ; polar capsule flask-shaped with distinct neck *T. boggoti*
4. Spores egg-shaped or pyriform. Anterior end flat, 9.3-10.3 (9.8) μm x 4.6-6.0 (5.5) μm ; polar capsule oval or elongated with small neck *T. chelai*
5. Spores pyriform, 10.7-15.0 (12.4) μm x 4.3-7.1 (5.4) μm ; polar capsule pyriform, terminal *T. chrysopomati*
6. Spores elongated, oval, 12.1-16.0 (13.0) μm x 9.9-9.5 (8.2) μm ; sutural ridge prominent, curved, shifted to a side; polar capsule broad, oval with distinct neck *T. potali*
7. Spores large, pyriform in valvular and arched in sutural view, one side flat, other curved, 14.3-17.1 (14.7) μm x 5.0-6.0 (5.4) μm ; polar capsules large, pear-shaped with a constriction in the middle region *T. qadrii*
8. Spores narrow, elongate, oval or pear-shaped; 11.42-12.85 (12.53) μm x 6.42-7.14 (6.91) μm ; sutural ridge slightly curved; polar capsule elongated, oval *T. shortii*

375. *Thelohaenellus andhrae* Qadri, 1962

(Figs. 720-722)

1962. *Thelohaenellus andhrae* Qadri, *Z. Parasitenk.*, **21** : pp. 517-520.

Diagnosis : Spore elongated pyriform; anterior end tapering, extremely blunt; posterior end wide, round, 11.2-14.5 μm x 4.5-5.5 μm ; valves thin, smooth with parietal folds at the posterior end; sutural ridge or line not seen; polar capsule 1, pyriform, large, adherent to lateral valves till 3/4th length, 6.0-8.0 μm x 2.0-2.5 μm ; polar filament making 10-11 coils while inside the capsule; sporoplasm granular forming a mass in the posterior part of the spore; polysaccharide inclusion spherical.

Host : *Labeo fimbriatus*; site of infection : gills.

Distribution : India : Andhra Pradesh (Fisheries Dept. sales depot, Hyderabad city, Hyderabad district).

Remarks : Lalitha Kumari (1969) reported this species in 4 out of 7 specimens of *Labeo fimbriatus* from this state.

376. *Thelohaenellus batae* Lalitha Kumari, 1969
(Figs. 723-725)

1969. *Thelohaenellus batae* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153-225.

Diagnosis : Spores pyriform, anterior end narrow, posterior end rounded, 11.4–13.6 (12.3) μm x 4.3–7.9 (6.2) μm in size; spore valves thin, smooth and symmetrical; sutural ridge not seen; polar capsule 1, large, pyriform, oblique, shifted to a side, 6.4–8.6 (7.7) μm x 2.9–3.6 (3.0) μm , terminal; polar filament long, whip-like, 168–185 (178.3) μm ; sporoplasm finely granular and homogenous occupying the entire extracapsular space; iodophilous vacuole large, located posteriorly.

Host : *Labeo bata*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Hyderabad city, lake near Hyderabad, Hyderabad district).

377. *Thelohaenellus boggoti* Qadri, 1962
(Figs. 726-728)

1962. *Thelohaenellus boggoti* Qadri, *Arch. Protistenk.*, **106** : pp. 218-222.

Diagnosis : Spore egg-shaped; anterior end bluntly pointed; posterior end round; 11.0–12.0 μm x 6.0–7.5 μm ; valves thick, smooth; sutural line curved and wavy in appearance; polar capsule 1, flask-shaped with distinct neck, 5.5–7.0 μm x 3.6–4.0 μm ; polar filament making 10–11 coils while inside the capsule; sporoplasm finely granular; iodophilous vacuole small and variable in position.

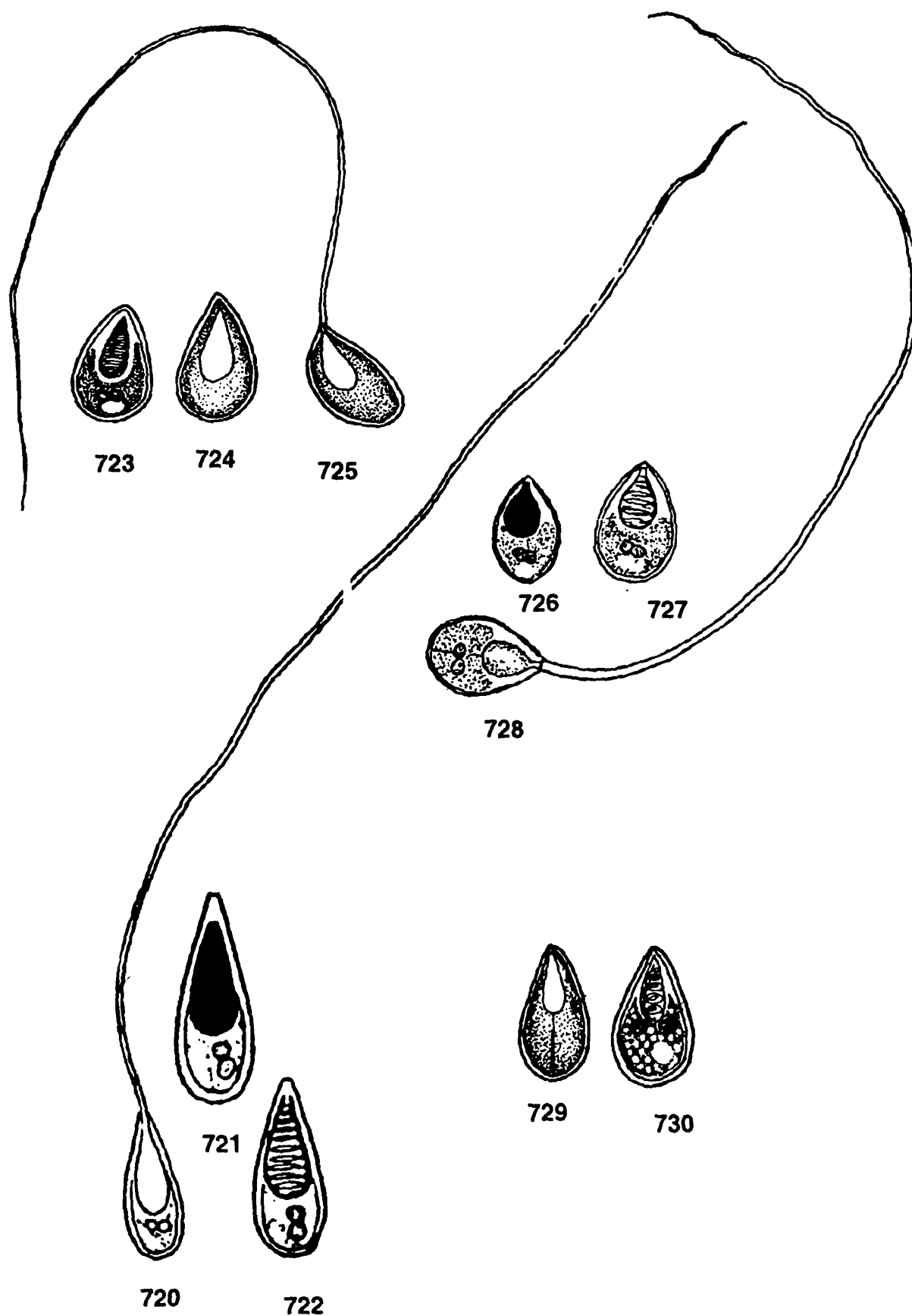
Host : *Labeo boggut*; site of infection : gills.

Distribution : India : Andhra Pradesh (Fish market, Hyderabad city, Hyderabad district).

Remarks : Lalitha Kumari (1969) reported this species in gills of 3 out of 23 specimens of *Labeo boggut* from this state.

378. *Thelohaenellus chelae* Lalitha Kumari, 1969
(Figs. 729-730)

1969. *Thelohaenellus chelae* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153-225.



Figs. 720-730. Myxozoan parasites of Andhra Pradesh : 720-722. *Thelohanellus andhrae*; 723-725. *T. batae*; 726-728. *T. boggoti* and 729-730. *T. chelae*.

Diagnosis : Spores egg-shaped or pyriform; anterior end narrow, flat at the tip; posterior end rounded, $9.3\text{--}10.3$ (9.8) μm $\times$ $4.6\text{--}6.0$ (5.5) μm in size; spore valves thin, uniform, unequal, with 8–10 striations running parallel to sutural line and converging near the ends; sutural ridge and sutural line clear, shifted to a side; polar capsule 1, oval or elongated, terminal with small neck, $4.0\text{--}5.7$ μm $\times$ $2.5\text{--}3.0$ (2.8) μm ; polar filament $40.0\text{--}45.0$ (43.0) μm long; sporoplasm finely granular and homogenous, occupying the space between the capsules; polysaccharide inclusion large, located centrally.

Host : *Chela bacaila*; site of infection : gall bladder.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

379. *Thelohaenellus chrysopomati* Lalitha Kumari, 1969
(Figs. 731-733)

1969. *Thelohaenellus chrysopomati* Lalitha Kumari, *Riv. Parassitol.*, 30(3) : pp. 153-225.

Diagnosis : Spores pyriform; anterior end narrow, posterior end rounded, $10.7\text{--}15.0$ (12.4) μm $\times$ $4.3\text{--}7.1$ (5.4) μm in size; spore valves thick, uniform with 4–6 parietal folds in the posterior region; sutural ridge prominent and extending beyond the valvular periphery; polar capsule 1, pyriform, terminal without a neck, $5.7\text{--}9.0$ (6.5) μm $\times$ $2.1\text{--}3.8$ (2.7) μm in size; polar filament forming 9–10 spring-like coils while inside the capsule; polar filament whip-like, $79\text{--}102$ (104.1) μm long when fully extended; sporoplasm finely granular and homogenous; iodophilous vacuole present.

Host : *Barbus chrysopoma*; site of infection : gill contents.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

380. *Thelohaenellus potaili* Lalitha Kumari, 1969
(Figs. 734-736)

1969. *Thelohaenellus potaili* Lalitha Kumari, *Riv. Parassitol.*, 30 (3) : pp. 153-225.

Diagnosis : Trophozoites creamy white, 1–1.5 mm in diameter; pansporoblasts mono- or disporous; spores elongate, oval in valvular view; ellipsoidal in sutural view; anterior end narrow, flat at the tip; posterior end rounded; $12.1\text{--}16.0$ (13.0) μm $\times$ $7.9\text{--}9.5$ (8.2) μm in size; spore valves thick, uniform with 4–5 parietal folds at the posterior region; sutural ridge prominent slightly curved and shifted to a side; sutural line clear; polar capsule 1, broad, oval, terminal with distinct neck, $5.0\text{--}8.0$ (5.9) μm $\times$ $3.6\text{--}5.7$ (4.3) μm ; polar filament $60\text{--}71$ (65.7) μm long; sporoplasm finely granular and homogenous occupying the entire extracapsular space; iodophilous vacuole large.

Host : *Labeo potail*; site of infection : fins.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

381. *Thelohaenellus qadrii* Lalitha Kumari, 1969
(Figs. 737-739)

1969. *Thelohaenellus qadrii* Lalitha Kumari, *Riv. Parassitol.*, **30** (3) : pp. 153-225.

Diagnosis : Spores large, pyriform in valvular and arched in sutural view; anterior end narrow, posterior end rounded; one side flat and the other curved; 14.3–17.1 (14.7) μm x 5.0–6.0 (5.4) μm in size; spore valves thin, uniform, smooth, slightly asymmetrical; sutural line shifted to a side; polar capsule 1, large, pear-shaped, terminal with broad rounded posterior region and a constriction in the middle region, 7.5–8.6 (8.2) μm x 2.9–3.9 (3.8) μm ; polar filament whip-like, 115–204.5 (184.1) μm long forming 13–18 coils while inside the capsule; sporoplasm finely granular and homogenous, occupying the entire extracapsular space; iodophilous vacuole large, located centrally.

Host : *Labeo potail*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

382. *Thelohaenellus shortii* Qadri, 1967
(Figs. 740-742)

1967. *Thelohaenellus shortii* Qadri, *J. Protozool.*, **2** : pp. 207-218.

Diagnosis : Trophozoites small; pansporoblast mono- or disporous; spores narrow, elongate, oval, pyriform or pear-shaped, tapering anteriorly, broad in the middle and rounded posteriorly; 11.42-12.85 (12.53) μm x 6.42-7.14 (6.91) μm ; valve uniform, smooth; sutural ridge wide slightly curved; polar capsule elongated oval; without duct; 6.42-7.95 (7.07) μm x 3.5-4.28 (4.2) μm ; polar filaments making 3-4 fine loose coils while inside the capsule and 38.42-47.48 (42.95) μm , wavy and thick when extruded; sporoplasm homogeneous, granular, occupying the space behind the polar capsule; polysaccharide inclusion small, posterior.

Host : *Labeo fimbriatus*; site of infection : fins.

Distribution : India : Andhra Pradesh (Hyderabad city, Hyderabad district).

Genus *Unicauda* Davis, 1944

1944. *Unicauda* Davis, *Trans. Amer. Micro.Soc.*, **63** : 311-320.

Diagnosis : As in the key.

383. *Unicauda andhrae* Kalavati and Narasimhamurti, 1981
(Figs. 743-745)

1981. *Unicauda andhrae* Kalavati and Narasimhamurti, *Z. Parasitenk.*, **65** : pp. 89-93.

Material examined : 6 exs., Anantagiri, Viskhapatnam district, July 1978, C. Kalavati.

Diagnosis : Pansporoblast disporoblastic; spore oval or pyriform with a single undivided caudal appendage; 38.4-47.3 (42.5) μm x 4.0-5.4 (4.9) μm ; anterior end of caudal appendage broad and concave with which the posterior part of the spore body fitting into; spore valves smooth, sutural line fine; polar capsules 2, pyriform, equal, terminal, opening independently on either side of sutural line, 5.0-6.4 (5.9) μm x 1.0-1.6 (1.2) μm ; polar filament making 4-6 coils while inside the capsule, 25.4-30.4 (28.2) μm when extended; sporoplasm occupying the entire extracapsular spore cavity; iodophilous vacuole small and spherical.

Host : *Channa (Ophicephalus) gachua*; site of infection : gills.

Distribution : India : Andhra Pradesh (Ananthgiri, Visakhapatnam district).

Genus *Phlogospora* Qadri, 1962

1962. *Phlogospora* Qadri, Arch. Protistenk., 106 : pp. 211-217.

Diagnosis : As in the key.

384. *Phlogospora mysti* Qadri, 1962 (Figs. 746-747)

1962. *Phlogospora mysti* Qadri, Arch. Protistenk., 106 : pp. 211-217.

Diagnosis : Spore bunsen-flame like, anterior end pointed and posterior end enveloped by a thin membrane; valve thin, smooth and single; posterior portion with a tail-like bifurcated appendage; anterior end broad with cup-like depression into which the spore body fitting; spore body 14-18.0 μm x 3.5-5.0 μm ; caudal appendage 21-24.0 μm ; no sutural line; polar capsule 1, bottle-shaped, terminal; 7.0-9.0 μm x 1.7-2.5 μm ; polar filament making 10-11 coils while inside the capsule, 65.0-70.0 μm when extruded enveloped in a sheath; sporoplasm dense, granular, not extending into caudal fold; iodophilous vacuole spherical or oval near the posterior end.

Host : *Mystus bleekeri*; site of infection : gills.

Distribution : India : Andhra Pradesh (Hyderabad city fish market, Hyderabad district).

Order MULTIVALVULIDA Schulman, 1959

Family KUDOIDAE Meglitsch, 1960

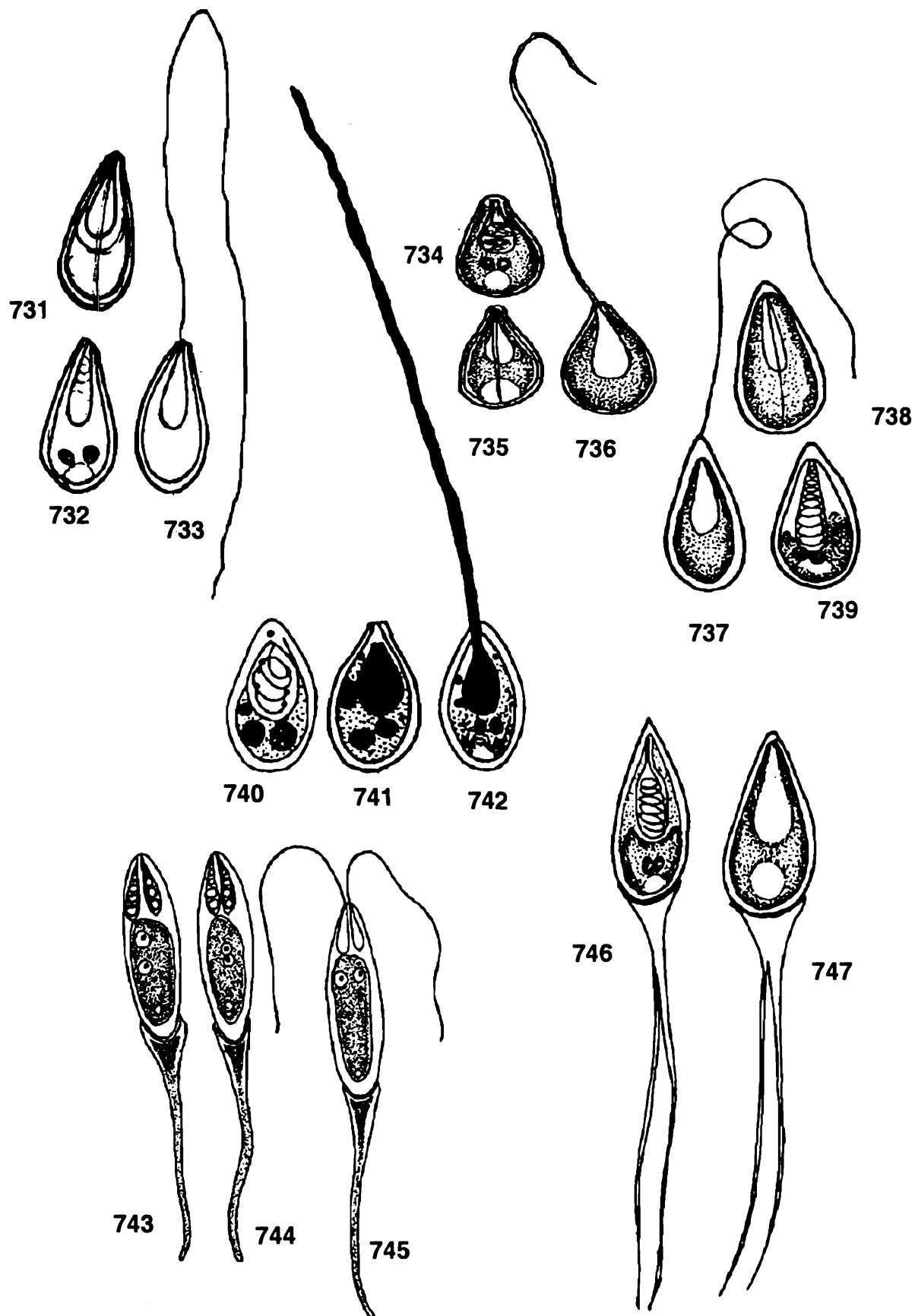
1960. *Kudoidae* Meglitsch, Trans. Roy Soc. N.Z., 88 : pp. 265-356.

Diagnosis : Spores with four shell valves each containing one polar capsule; single genus.

Genus *Kudoa* Meglitsch, 1947

1947. *Kudoa* Meglitsch, J. Parasitology, 33 : pp. 271-277.

Diagnosis : Spores stellate or quadrate in apical view; sutural line indistinct; polar capsules pyriform; two uninucleate sporoplasms one enveloping the other; histozoic in marine fishes.



Figs. 731-747. Myxozoan parasites of Andhra Pradesh : 731-733. *Thelohanellus chrysopomati*; 734-736. *T. potaili*; 737-739. *T. qadrii*; 740-742. *T. shortii*; 743-745. *Unicauda andhrae* and 746-747. *Phlogospora mysti*.

Key to the Species

1. Spores quadrate in polar view, enclosed in mucus envelop, triangular in valvular view; 8.0-11.0 (9.0) μm x 8.0-11.0 (9.0) μm x 8.0-9.5 (9.0) μm ; polar capsules equal, pyriform *K. atropi*
2. Spores quadrate in polar view and triangular in valvular view; 9.0-10.2 (9.4) μm x 9.5-10.5 (9.8) μm x 9.5-10.5 (9.8) μm ; polar capsules club-shaped *K. sphyraeni*
3. Spores quadrate in polar view, club-shaped in valvular view; 8-11.0 (9.0) μm x 8.0-12.0 (9.0) μm ; polar capsules club-shaped, equal *K. tetraspora*
4. Spores quadrate in polar view, club-shaped with deep notches in valvular view; 5.2-6.6 (5.6) μm x 4.3-5.6 (4.7) μm x 5.0-5.4 (5.3) μm ; polar capsules pyriform, unequal; shell valves asymmetrical *K. valamugili*

385. *Kudoa atropi* Sandeep, Kalavati and Narasimhamurti, 1986 (Figs. 748-751)

1986. *Kudoa atropi* Sandeep *et al.*, *Vest. Ces. Spolec. Zool.*, **50** : pp. 132-135.

Material examined : Sev. exs., catches at the Fishing harbour, Visakhapatnam, Visakhapatnam district, September 1984, B.V. Sandeep.

Diagnosis : Trophozoites opaque white, 0.5-1.0 mm in diameter; pansporoblast disporous; spores enclosed in a mucus envelop, quadrate in polar view, with deep notches extending $\frac{1}{4}$ the length of the sutural line; ends rounded, triangular with rounded corners and bluntly pointed anterior end in valvular view; 8.0-11.0 (10.0) μm x 8.0-11.0 (10.0) μm x 8.0-9.5 (9.0) μm ; shell valves smooth, equal; sutural line faint; polar capsules 4, terminal, equal, pyriform, 3.0-3.6 (3.3) μm x 1.6-1.8 (1.7) μm ; polar filament making 6-7 coils while inside the capsule; two uninucleate hyaline sporoplasms, one enclosing the other; sometimes appearing as oval binucleate body.

Host : *Atropus atropus*; site of infection : gill filaments.

Distribution : India : Andhra Pradesh (Catches at the Fishing harbour, Visakhapatnam, Visakhapatnam district).

386. *Kudoa sphyraeni* Narasimhamurti and Kalavati, 1979 (Figs. 752-754)

1979. *Kudoa sphyraeni* Narasimhamurti and Kalavati, *Proc. Indian. Acad. Sci.*, **88B** (4) : pp. 265-268.

Material examined : Bheeminipatnam and Visakhapatnam fish-landing centres, Visakhapatnam district, October-December 1975, C. Kalavati.

Diagnosis : Trophozoites small, spherical, opaque white, pedunculate 0.5-2.0 mm in size; spore quadrate in polar view, triangular in valvular view, broader than long 9.0-10.2 (9.4) μm x 9.5-10.5 (9.8) μm x 9.5-10.5 (10.8) μm ; valves thin, smooth, transparent; sutural line very

faint; polar capsules 4, club-shaped, equal, 3.0-4.2 (3.6) μm x 1.0-1.6 (1.42) μm ; polar filament forming 7 coils while inside the capsule, 20-28.0 (26.8) μm when fully extended. 2 filaments straight and 2 coiled; sporoplasm bean-shaped.

Hosts : *Sphyraena jello*; site of infection : muscles.

Distribution : India : Andhra Pradesh (Bheeminipatnam and Visakhapatnam fish-landing centres, Visakhapatnam district).

387. *Kudoa tetraspora* Kalavati and Narasimhamurti, 1979
(Figs. 755-757)

1979. *Kudoa tetraspora* Kalavati and Narasimhamurti, *Proc. Indian Acad. Sci.*, **88B**. (1) : pp. 85-89.

Material examined : Fish market, Visakhapatnam, Visakhapatnam district, August, 1976, C. Kalavati.

Diagnosis : Trophozoites translucent, white, oval or spherical, 0.3-1.5 mm in size; pansporoblast di- or tetrasporous; spores quadrate in polar view, club-shaped with deep notches in valvular view, triangular with rounded corners and bluntly pointed anterior end in lateral view; 8.0-11.0 (9.0) μm x 8.0-12.0 (9.0) μm ; shell valves delicate, smooth, equal; sutural line faint; polar capsules 4, subterminal, equal, club-shaped, 3.4-4.0 (3.8) μm x 1.5-1.8 (1.68) μm ; polar filament making 3-4 coils while inside the capsule; polar filaments 10.0-12.0 μm and varying in thickness when extruded; two uninucleate sporoplasms located in juxtaposition, oval in shape.

Host : *Mugil cephalus*; site of infection : brain and optic lobes.

Distribution : India : Andhra Pradesh (Fish market, Visakhapatnam, Visakhapatnam district).

388. *Kudoa valamugili* Kalavati and Anuradha, 1993
(Figs. 758-761)

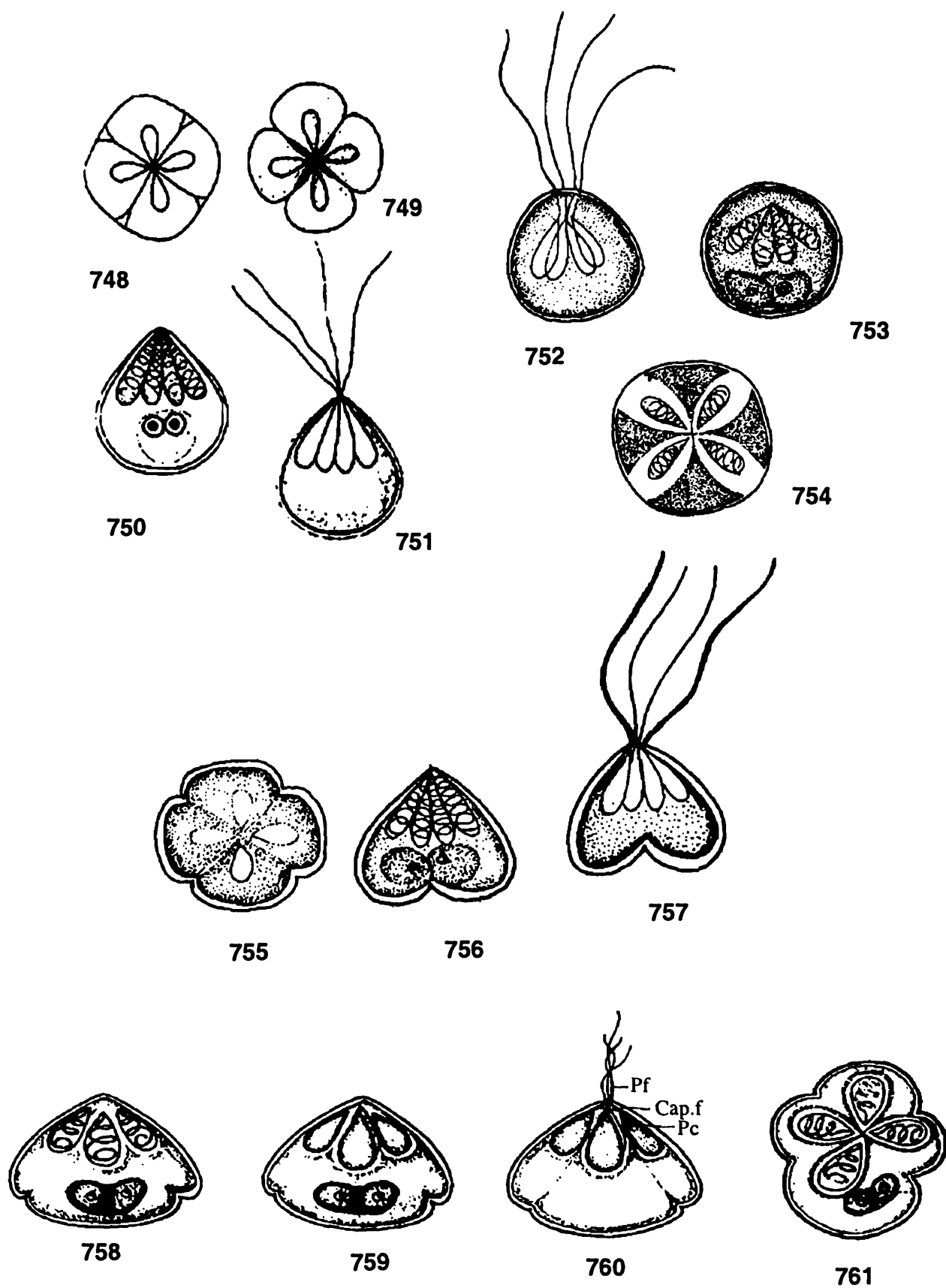
1993. *Kudoa valamugili* Kalavati and Anuradha, *Uttar Pradesh J. Zool.*, **13** (2) : pp. 148-152.

Material examined : Sev. exs., Visakhapatnam harbour, Visakhapatnam district, July-October 1987, I. Anuradha.

Diagnosis : Trophozoites opaque, white, spherical, 0.45-0.65 mm enclosed in a thin connective tissue layer; pansporoblast disporous; spores quadrate, club-shaped with deep notches in valvular view, triangular with broad base and pointed anterior end in lateral view; 5.2-6.6 (5.6) μm x 4.3-5.6 (4.7) μm x 5.0-5.4 (5.3) μm ; valves thick, smooth, unequal; one valve large with rounded ends; sutural line faint and indistinct; polar capsules 4, subterminal, pyriform, unequal, large capsules, in large valves, 3.0-3.8 (3.2) μm x 1.6-2.0 (1.8) μm ; polar filament making 3-4 coils while inside the capsule. 5.0-8.0 μm long; smaller capsules, in small valves, 2.0-3.2 (2.4) μm x 1.2-1.6 (1.4) μm ; two uninucleate sporoplasms, one enveloping the other, in larger valve.

Host : *Valamugil cunnessius*; site of infection : muscles of the intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam harbour, Visakhapatnam district).



Figs. 748-761. Myxozoan parasites of Andhra Pradesh : 748-751. *Kudoa atropi*; 752-754. *K. sphyraeni*; 755-757. *K. tetraspora* and 758-761. *K. valamugili*.

Class ACTINOSPOREA
 Subclass ACTINOMYXEA
 Order ACTINOMYXIDA

Diagnosis : Polycellular spores with more than one sporoplasm.

Family ACTINOMYXIDAE Janiszewska, 1957

1957. *Actinomyxidae* Janiszewska, *Zoolog. Polon.*, 8 : pp. 3-34.

Diagnosis : Spore with 3 distinct processes in the episporium formed by exospore, spores single or connected with nets.

Genus *Triactinomyxon* Stolc, 1899

1899. *Triactinomyxon* Stolc, *Bull. Internat. l'Acad. Sci., de Boheme*, 22 : p. 1.

Diagnosis : Spore anchor-shaped with long narrow protrusions.

389. *Triactinomyxon naidanum* Naidu, 1956
 (Fig. 762)

1956. *Triactinomyxon naidanum* Naidu *J. Protozool.*, 3 : pp. 209-210.

Material examined : 6 cysts, K.V. Naidu, Cuddapah, Cuddapah district.

Diagnosis : Cysts spherical, in the intestinal wall; spores with 3 transparent valves fused distally to form a hollow, vertical central axis that separate proximally, 3 polar capsules apical, 12 uninucleate sporoplasms.

Host : *Nais communis punjabensis* (Oligochaeta, Annelida); site of infection : posterior part of the gut.

Distribution : India : Andhra Pradesh, Cuddapah (Cuddapah district).

390. *Triactinomyxon* sp.
 (Figs. 763-764)

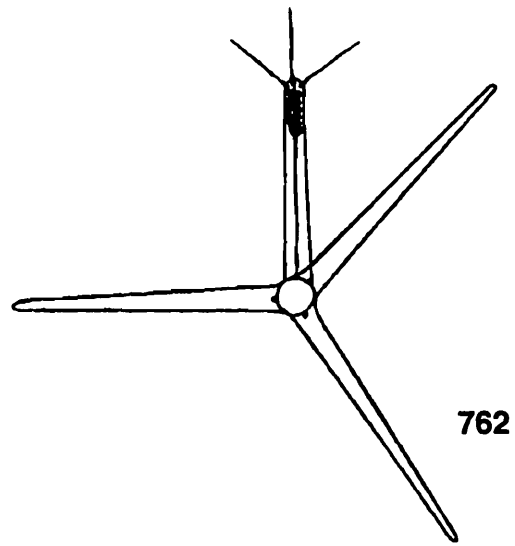
1959. *Triactinomyxon* sp. Naidu, *J. Zool. Soc. India*, 11(1) : pp. 39-42.

Material examined : 6 cysts, K.V. Naidu, July-October 1957, Cuddapah, Cuddapah district.

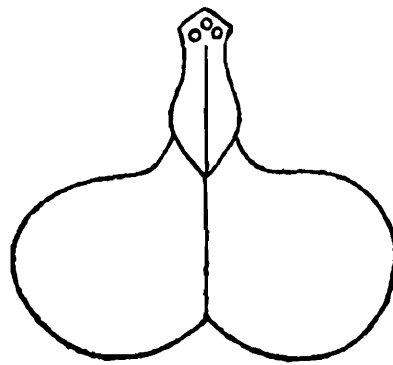
Diagnosis : Spore colour less transparent, rocket-shaped, central axis vertical, barrel-shaped, 15 μ m, 3 polar capsules apical, 3 similar, flap-like vertical valves located equidistantly forming triradiate base, 60-65 μ m, 8 sporoplasms.

Host : *Pristina longiseta* (Oligochaeta, Annelida); site of infection : gut wall.

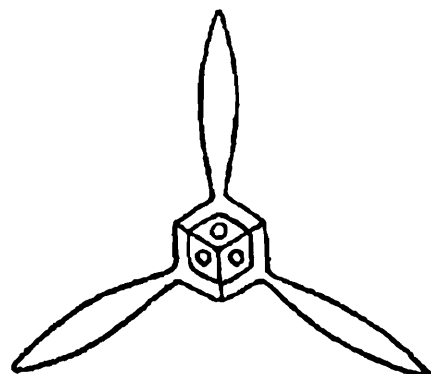
Distribution : India : Andhra Pradesh, Cuddapah (Cuddapah district).



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763



764

Figs. 762-764. Actinosporean (Myxozoa) parasites of Andhra Pradesh : 762. *Triactinomyxon naidanum* and 763-764. *Triactinomyxon* sp.

Phylum	CILIOPHORA
Class	KINETOFRAGMINOPHOREA
Order	TRICHOSTOMATIDA
Family	BALATIDIIDAE

Diagnosis : Vestibulum anteriorly located, cytostome located at the base of the vestibulum, somatic ciliation uniform, parasitic in invertebrate and vertebrate hosts.

Genus *Balantidium* Claparede and Lachmann, 1858

1858-61. *Balantidium* Claparede and Lachmann, *Etudes sur les infusoires et les rhizopodes*, Genève, p. 247.

Diagnosis : Body oval, ellipsoid to subcylindrical, uniformly ciliated, cytostome located at the base of an anteriorly situated vestibulum, cytopharynx not well developed, contractile vacuole and cytopyge terminal; parasitic in the gut of both vertebrates and invertebrates.

Remarks : In all, 9 species of *Balantidium* have been reported from Andhra Pradesh, all of which have been recovered from vertebrate hosts.

Key to the species

1. Commensal in the gut of amphibians 2
- Commensal in the gut of mammals 6
2. Vestibulum reaching the middle of the body; body oval, macronucleus kidney-shaped *B. duodeni*
- Vestibulum not reaching the middle of the body 3
3. Vestibulum slit-like 4
- Vestibulum funnel-shaped or triangular 5
4. Body egg-shaped, macronucleus kidney-shaped, contractile vacuole usually one, sometimes two in number *B. helenae*
- Body cylindrical, macronucleus oval, contractile vacuoles 2 to 3 in number *B. elongatum*
5. Body elongate, anterior end broad, macronuclei two in number, spherical or oval and equal in size, contractile vacuoles two *B. rhacophori*
- Body flask-shaped, anterior end narrow, posterior end broad and rounded, macronucleus one, oval, contractile vacuole one *B. waltirensis*
- 6.1 Larger in dimension, 95-154 μm x 50-100 μm , anterior end rounded, tapering posteriorly

- to a blunt point, greatest width at anterior part of the body, macronucleus elliptical, located at the anterior region of the body *B. indicum*
- 6.2 Comparatively small in dimension, 59-84 μm x 27-48 μm , anterior end of the body rounded, greatest width of the body near posterior third, macronucleus oval, located near the anterior region of the body, commensal in the gut of goat *B. caprae*
- 5.3 Small in dimension, 43.0–97.9 μm x 36.8–77 μm , both ends blunt, posterior end broader than the anterior, macronucleus oval or rod-like with both ends rounded, generally located near the posterior third of the body; commensal in the gut of the Bonnet Monkey
..... *B. osmaniae*
- 6.4 Body dimension highly variable, 30-200 μm x 20-70 μm , anterior end somewhat narrowed and pointed, greatest width of the body near the middle, macronucleus sausage or bean-shaped, lying transversely at the middle of the body *B. coli*

391. *Balantidium caprae* Abraham, 1962

(Fig. 765)

1962. *Balantidium caprae* Abraham, *Arch. Protistenkd.*, 106 : p. 47.

Diagnosis : Body more or less oval, anterior end of the body rounded, its greatest width near posterior third from where the body tapering to a blunt end; its length 69.6 (59-84) μm , breadth 34.6 (27-48) μm ; macronucleus oval with pointed anterior end and blunt posterior end, located at anterior region of the body; a single contractile vacuole present adjacent to cytostome, commensal in the gut of goat.

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

Distribution : Andhra Pradesh (Hyderabad district).

Remarks : Abraham (1962) described this species from the stomach contents of goats, *Capra hircus* from Andhra Pradesh.

392. *Balantidium coli* (Malmsten, 1857)

(Fig. 766)

1857. *Paramaecium coli* Malmsten, *Virchows Arch. Berlin*, 12 : p. 302.

1928. *Balantidium coli* : Chatterjee, *Indian Med. Gaz.*, 63 : p. 79.

Diagnosis : Body egg-shaped, measuring 30-200 μm x 20-70 μm , with posterior end slightly broader and anterior end somewhat narrowed and pointed; cilia arranged in longitudinal rows with slightly spiral course; peristome ventral, at the anterior end, somewhat obliquely placed, with adoral zone of cilia passing through the subterminal cytostome into the short cytopharynx; cytophyge near the posterior end; many food vacuoles containing starch grains, cell fragments,

bacteria, erythrocytes, *etc.*; macronucleus sausage or bean-shaped, lying transversely at the middle of the body, with a small micronucleus close to it; contractile vacuules two, one at the posterior and the other near the middle of the body; cyst spherical to ovoid, 40-60 μm in length.

Host : *Bubalus bubalis*; site of infection : colon.

Distribution : India : Andhra Pradesh (Cuddapah district), West Bengal.

Elsewhere : a cosmopolitan species of worldwide distribution.

Remarks : Rao and Anjanyulu (1974) reported this species as an outbreak of balantidiosis in all the 19 buffaloes of a herd in Cuddapah Taluk belonging to three farmers of the same family with the history of diarrhoea and impaired digestion on 15th May, 1974. However, this species is extremely common in swine. It is pathogenic in man and other primates causing diarrhoea or balantidial dysentery in man (Levine, 1967). Khan and Rao (1981) found balantidiul infection in primates maintained at Zoological Park, Hyderabad. Dr. Md. Hafeez (personal communication, 6.11.2002) informed that Ravi Kumar (1994) observed *B. coli* in 200 animals (primates) in Andhra Pradesh.

393. *Balantidium duodeni* Stein, 1867

1867. *Balantidium duodeni* Stein, *Der organismum der Infusionsthier, etc.*, p. 325.

Material examined : Sev. exs., Vizianagaram, Vizianagaram district.

Diagnosis : Body oval or slightly bean-shaped, 60-80 μm x 35-68 μm in dimension; vestibulum narrow, cleft-like and extending up to the middle of the body; macronucleus oval or kidney-shaped, measuring 10-16 μm x 5-10 μm ; micronucleus small and spherical located close to the macronucleus; cytopyge small cleft-like; contractile vacuule single.

Host : *Rana tigrina*; site of infection : duodenum, small intestine and rectum.

Distribution : India : Andhra Pradesh (Vizianagaram district).

Elsewhere : Pakistan and Sri Lanka.

Remarks : Kalavati *et al.* (1991) reported this species from the above locality.

394. *Balantidium elongatum* Stein, 1867

1867. *Balantidium elongatum* Stein, *Der. Organismus der infusionsthier, etc.*, p. 319.

Material examined : Sev. exs., Nellore, Nellore district.

Diagnosis : Body elongated, anterior end bluntly rounded and posterior end pointed, dimensions 8-120 μm x 25-56 μm ; vestibulum more or less triangular, extending about one-third the length of the body; macronucleus oval, measuring 10-15 μm x 8-12 μm , situated generally in the posterior half of the body; micronucleus adjacent to macronucleus; contractile vacuules 2-3 in number.

Host : *Rana breviceps*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Nellore district).

Elsewhere : Pakistan.

Remarks : Bhatia (1936) recorded this species from the intestine of *Rana tigrina* in Lahore, Pakistan. Subsequently, Kalavati *et al.* (1991) recovered this species from *Rana breviceps* in Andhra Pradesh.

395. *Balantidium helenae* Bezzenberger, 1904

1904. *Balantidium helenae* Bezzenberger, *Arch. Protistenkd.*, 4 : p. 151.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district.

Diagnosis : Body oval, both the ends broadly rounded, 110-140 μm x 60-70 μm in dimension; vestibulum broad, extending about one-fifth the length of the body; macronucleus kidney-shaped, measuring 18-20 μm x 10-16 μm ; micronucleus lying in the notch of macronucleus; contractile vacuole single or variable in number irregularly distributed in the body.

Host : *Rana limnocharis*; site of infection : colon.

Other hosts : *Rana cyanophlyctis*, *Rana hexadactyla*, *Rana limnocharis* and *Rana tigrina*; site of infection : intestine and rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district), Goa and West Bengal.

Elsewhere : Pakistan, Sri Lanka.

Remarks : Bezzenberger (1904) described this species from the rectum of *Rana tigrina*. The type locality of this species was mentioned as Asia (without citing exact locality). Kalavati *et al.* (1991) reported this species from *Rana limnocharis* from Andhra Pradesh.

396. *Balantidium indicum* Abraham, 1962

(Fig. 767)

1962. *Balantidium indicum* Abraham, *Arch. Protistenkd.*, 106 : p. 49.

Diagnosis : Body elongate oval, anterior end rounded, tapering posteriorly to a slight blunt point, greatest width at anterior region of the body, dimensions 129.5 (95-154) μm x 78.7 (50-100) μm ; vestibulum extending one-sixth the length of the body; macronucleus elliptical with either one or both ends pointed and located at the anterior region of the body, measuring 48.6 (30-65) μm x 19.7 (11-24) μm , micronucleus usually lying in the anterior region of the macronucleus; contractile vacuole single.

Host : *Bos indicus*; site of infection; stomach.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : Abraham (1962) described this species from the stomach contents of *Bos indicus* from Andhra Pradesh. This is the only report of this species.

397. *Balantidium osmaniae* Qadri and Navarathman, 1966
(Figs. 768-769)

1966. *Balantidium osmaniae* Qadri and Navarathnam, *Riv. Parassitol.*, 27 : pp. 89-96.

Diagnosis : Body generally oval and vesicular, sometimes round, (43.0-97.9) 81.4 μm x (36.8-77.0) 57.2 μm ; both ends blunt, posterior end broader than the anterior end; cytostome situated at the anterior end of the body with a wide cytostomal groove; cytopharynx tube-like, 32 μm x 10 μm , but bulged in the middle and continued as a narrow pipette; cytopyge small tube-like, situated laterally at the posterior end of the body; macronucleus oval or rod-like with both ends rounded, (18.9-33.5) 25.3 μm x (6.7-21.0) 12.7 μm , usually transversely placed, generally situated at the posterior third of the body, sometimes in the centre and rarely at the anterior third, micronucleus very small and compact; body wall thin, covered with longitudinal rows of cilia, equal in length except the longer cilia of cytostomal region; contractile vacuoles two in number, one located at each end of the body.

Host : Indian Bonnet Monkey, *Macaca radiata*; site of infection : intestine (faeces).

Distribution : India : Andhra Pradesh (exact locality not mentioned).

398. *Balantidium rhacophori* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 770)

1991. *Balantidium rhacophori* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper* No. 141, p. 10.

Material examined : Sev. exs., Araku Valley, Visakhapatnam district.

Diagnosis : Body elongated with broad anterior and narrow posterior ends, dimension 150-300 μm x 30-70 μm ; vestibulum funnel-shaped, appearing as a depression in fresh preparations and opening into a small tubular cytopharynx through a narrow cytostome; macronucleus spherical or oval, rarely one and more often two of equal diameter, located in the anterior half of the body and measuring 10-15 μm x 10-12 μm ; micronucleus not seen; contractile vacuoles two, one each lying in anterior and posterior halves of the body.

Host : *Rhacophorus maculatus*; site of infection : colon and rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

399. *Balantidium waltirensis* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 771)

1991. *Balantidium waltirensis* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper* No. 141 : p. 11.

Material examined : Sev. exs., Vishakhapatnam, Visakhapatnam district.

Diagnosis : Body typically flask-shaped, anterior end narrow and pointed, posterior end broad and rounded, dimensions 110-140 μm x 90-105 μm ; vestibulum broad, triangular with slight curvature; cytopharynx tubular, extending up to one-third length of the body; macronucleus oval, measuring 25-35 μm x 15-20 μm ; micronucleus spherical lying in close proximity to macronucleus; contractile vacuole single.

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

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Order RHYNCHODIDA

Family ANCISTROCOMIDAE

Diagnosis : Somatic ciliature present but concentrated over anterior half of the body; body shape ovoid to pyriform with sucking tube sometimes clearly protruding from anterior end, parasitic in both freshwater and marine invertebrates.

Key to the genera

1. Number of kineties more than 10 and unequal in length 2
- Number of kineties 8-10, equal in length, body elongated, banana-shaped, with flat thigmotactic area *Enerthecoma*
2. Body pear-shaped, elongated, with moderately flattened thigmotactic area, thigmotactic ciliature comprising of two complexes, on the right side two arc-like bent present, kineties 12-13, unequal in length *Raabella*
- Body cylindrical, kineties 19-23, unequal in length *Holocoma*

Genus *Enerthecoma* Jarocki, 1935

1935. *Enerthecoma* Jarocki : Corliss, 1979 : *The Ciliated Protozoa*, Pergamon Press, p. 233.

Diagnosis : As in the key to the genus.

Key to the species

1. Body elongated, symmetrical, banana-shaped, 27-49 μm x 9-19 μm ; ventral ciliary kineties 8 in number; macronucleus sausage-shaped, 9-19 μm x 2-28 μm *E. dissimilis*
- Body elongated, symmetrical, laterally curved, 60-85 μm x 12-30 μm ; 8-10 ciliary rows at the base of suctorial tentacle; macronucleus oval, 10.5-12.2 μm x 4.0-5.7 μm *E. melanoidii*

400. *Enerthecoma dissimilis* Mahmood and Khan, 1980

1980. *Enerthecoma dissimilis* Mahmood and Khan, *Acta Protozool.*, **19** : pp. 269-276.

Diagnosis : Body elongated, symmetrical, banana-shaped, anterior end tapering sharply, curved in an arc when viewed laterally while posterior end rounded, dimensions 37.6 (27-49) μm x 13.5 (9-19) μm , anterior end provided with a suckorial tentacle with an internal tubular canal; ciliary system disposed on flat area occupying anterior two-third of the ventral surface; kineties 8 in number, equal in length; macronucleus typically sausage-shaped, situated in the middle and placed obliquely to longitudinal axis of the body, measuring 9-19 μm x 2-28 μm ; contractile vacuole single and lying in the middle slightly towards left side of the body.

Host : Freshwater snail, *Viviparus dissimilis*; site of infection : mantle cavity.

Distribution : India : Andhra Pradesh (Hyderabad district).

Remarks : This species was described by Mahmood and Khan (1980). It was collected from the mantle cavity of snails, *Viviparus dissimilis* from the freshwater ponds and lakes of Hyderabad, Andhra Pradesh.

401. *Enerthecoma melanoidii* Kalavati, Ramakumari and Narasimhamurti, 1987
(Figs. 772-773)

1987. *Enerthecoma melanoidii* Kalavati, Ramakumari and Narasimhamurti, *Indian J. Parasitol.*, **11** (2) : pp. 195-197.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district, August-November 1984, B. Ramakumari.

Diagnosis : Body elongated, symmetrical, laterally curved, posterior end curved, 60-85 μm x 12-30 μm ; pellicle thin, smooth, suckorial tentacle small, 35-55 μm anterior, continuing into a dorsally directed internal tubular canal taking a sharp bend ventrally and running obliquely towards the right side of the body, 8-10 ciliary rows arising at the base of the suckorial tentacle and extending up to the middle of the body; macronucleus oval centrally placed, 10.5-12.2 μm x 4.0-5.7 μm , micronucleus small spherical adherent to macronucleus.

Host : *Melanoides tuberculatus*; site of infection : mantle cavity and gills.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

Genus *Holocoma* Chatton and Lwoff, 1950

1950. *Holocoma* Chatton and Lwoff, *Arch. zool. exp. gen.*, **86** : p. 393.

Diagnosis : Cylindrical; ventral surface convex; tentacle at anterior end; 19-23 ciliary rows; 6-10 median rows long; on the gills of molluscs.

402. *Holocoma singhii* Kalavati, Ramakumari and Narasimhamurti
(Fig. 774)

1987a. *Holocoma singhii* Kalavati, Ramakumari and Narasimhamurti, *Indian J. Parasitol*, **11** (2) : pp. 195-197.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district, August-November 1984, B. Ramakumari.

Diagnosis : Body oval, ends rounded, 28-42 μm x 20-30 μm , pellicle thin, smooth, a small hyaline knob seen at the anterior end leading into a small internal tubular canal; macronucleus 'U'-shaped with two broad arms, 17.0-23.0 μm x 4.0-5.0 μm , somatic ciliation restricted to anteroventral thigmotactic field, kineties 19-23, cytoplasm hyaline without any inclusions, 2 or 3 contractile vacuoles.

Host : *Melanoides tuberculatus*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Visakhapatnam, Visakhapatnam district).

Genus *Raabella* Chatton and Lwoff

1950. *Raabella* Chatton and Lwoff, *Archs. zool. exp. gen.*, **86** : p. 393.

Diagnosis : As in the key to the genus.

403. *Raabella helensis* Chatton and Lwoff, 1950

1950. *Raabella helensis*, *Archs. zool. exp. gen.*, **86** : p. 393.

Diagnosis : Body pyriform, pointed anteriorly and rounded posteriorly, dimensions 25.5-35.7 μm x 13.6-18.7 μm ; anterior end with suckorial tentacles; macronucleus ovoid or spherical, situated near the centre, measuring 6.8-11.05 μm x 5.1-7.65 μm ; micronucleus spherical, located anterior to macronucleus; contractile vacuole single lying close to macronucleus; thigmotactic zone formed of three ciliary rows, central complex of 5 kineties running meridionally, left complex of 5-6 kineties and right system with two long, arcly buckled, parallelly running kineties.

Hosts : Marine bivalve, *Modiolus (Modiolus) striatulus*; site of infection : gills.

Other hosts : *Mytilus edulis*, *M. galloprovincialis* and *M. minimus*.

Distribution : India : Andhra Pradesh (Kakinada Bay, East Godavari district) and West Bengal.

Elsewhere : Colynia.

Remarks : Jamadar and Choudhury (1988) recorded this species from the marine bivalve *Modiolus striatulus* collected from Kakinada Bay of Andhra Pradesh.

Family PARAISOTRICHIDAE

Diagnosis : Cytostome at or near apical pole, body ovoid to pyriform; uniform somatic ciliation, often plus anterior tuft of longer cilia; concrement vacuoles present; common endocommensals in horses, but also in capybaras, guinea pigs and elephants.

Genus *Paraisotricha* Fiorentini, 1890

1979. *Paraisotricha* Fiorentini, 1890; Corliss, *The Ciliated Protozoa*, Pergamon Press, p. 220.

Diagnosis : Uniformly ciliated in more or less spiral longitudinal rows; longer cilia at anterior end; cytostome near anterior tip; contractile vacuole posterior; in the caecum and colon of horse.

404. *Paraisotricha equi* Abraham, 1961

1961. *Paraisotricha equi* Abraham, *Ann. Mag. Nat. Hist.*, 13 ser, 4 : pp. 445-448.

Diagnosis : Body elongated-oval, (43-71) 55 μm x (28.5-43.5) 33.5 μm , body ratio 1.6, greatest width a little above the middle; body covered by a tough membrane, the pellicle, two layered in appearance; body ciliation uniform, excepting a tuft of longer and larger number of cilia at the anterior extremity; cytostome conspicuous, 27 μm in average length, extending from one-half to two-thirds the body-length, well ciliated, opening into a long tubular oesophagus, lips widely separated in some and one showing a heavier ciliation than the other; peristome situated in a slight depression on one side of the body, leading into a curved cytostome; a large concretion vacuole containing eight refractive granules, six large and two small; contractile vacuole single and small; cytopyge V-shaped; ciliary striations varying from eight to ten in number.

Host : Horse, *Equus caballus*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Family FOETTINGERIIDAE

Remarks : Apostomatid ciliates, commonly marine, occasionally freshwater, usually in crustacean and other invertebrate hosts belonging to the suborder Apostomatina.

Incertae Sedis

Genus *Koifoidella* Cepede, 1910

1910. *Koifoidella* Cepede, *Arch. Zool. Exp. Gen.* (ser. 5), 3 : pp. 341-609.

Remarks : Corliss (1979) placed this genus as *incertae sedis* to the family Foettingeriidae.

405. *Koifoidella aplocheilusi* Rao, 1979

1979. *Koifoidella aplocheilusi* Rao, *Proc. Indian Sci. Congr.*, **66** : pp. 3-4.

Diagnosis : Not available.

Host : Fish, *Aplocheilus melastigma*; site of infection : gills.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Remarks : Rao (1979) reported this species in the Proceedings of the Indian Science Congress Association as abstract. So, the species is treated as *nomen nudum*.

Order SUCTORIDA

Family CYATHODINIIDAE

Diagnosis : Body ovoid, stalkless, adult stage fleeting, typically producing two ciliated buds simultaneously, endocommensals in digestive tracts of domestic and wild guinea pigs.

Genus *Cyathodinum* da Cunha, 1914

1914. *Cyathodinum* da Cunha, *Mem. Inst. Oswaldo Cruz*, **6**, pp. 58-68.

Diagnosis : As in the diagnosis to the family.

406. *Cyathodinum indiae* Bhaskar Rao and Bhaskar Rao, 1969
(Fig. 775)

1969. *Cyathodinum indiae* Bhaskar Rao and Bhaskar Rao, *Curr. Sci.*, **45**(8) : pp. 299-300.

Diagnosis : Body ovoid, rarely with nipple-like tip, dimensions 55 μm x 20 μm ; pseudostome with two conspicuous lips, left one overlapping the right, extending from anterior part to half or more than half of the body-length; cytostome present at the terminal end of pseudostome; cilia restricted to anterior part only and arranged in 3-4 rows; macronucleus oval, its location variable; micronucleus spherical and lying close to macronucleus.

Host : Laboratory bred *Cavia cutleri*; site of infection; gut.

Distribution : India : Andhra Pradesh (Hyderabad district).

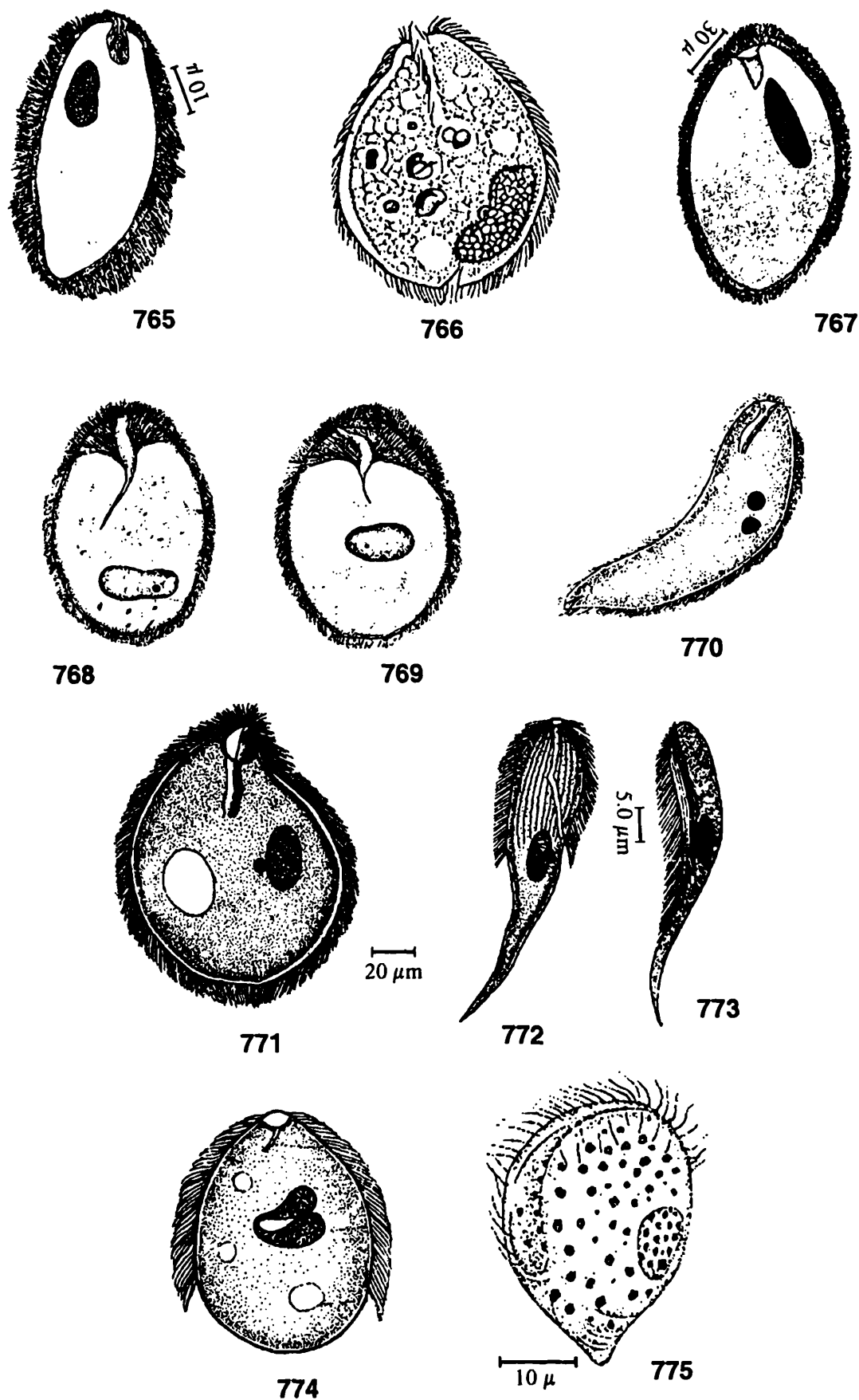
Remarks : Bhaskar Rao and Bhaskar Rao (1969) described this species from the laboratory bred guinea pigs in Hyderabad, Andhra Pradesh.

Class OLIGOHYMENOPHOREA

Order SCUTICOCILIATIDA

Family ANCISTRIDAE

Diagnosis : Body occasionally elongate, not laterally flattened, anterior thigmotactic ciliature present but not any thigmotactic sucker, buccal ciliature conspicuous, winding in arc of $>360^\circ$ around antapical pole in some species.



Figs. 765-775. Ciliophoran parasites of Andhra Pradesh : 765. *Balantidium caprae*; 766. *B. coli*; 768-769. *B. osmaniae*; 770. *B. rhacophori*; 771. *B. waltirensis*; 772-773. *Entherocoma melanoidi*; 774. *Holocoma singhi* and 775. *Cyathodinium indiae*.

Key to the genera

1. General ciliature dense and abundant, number of kineties 40 or above 2
- General ciliature not so dense, number of kineties 20-35 3
2. Body oval, slightly flattened, number of kineties 40-60; two adoral kineties running from apical suture nearly till the posterior pole, forming a large loop at the end *Ancistrum*
- Body oval, strongly flattened, ciliature dense, number of kineties about 65 in number, two adoral kineties starting from about one-third the body-length from the apical pole forming a small arc near the hind part of the body *Protophrya*
3. Body elongated, slightly flattened, with cone-shaped prolongation at posterior end, number of kineties about 26 in number, starting from about one-third of the body length from the apical end, two adoral kineties forming a big loop near the hind part of the body *Fenchelia*

Genus *Ancistrum* Maupas, 1883

1883. *Ancistrum* Maupas, *Arch. Zool. Exp. Gen.* (ser. 2), 6 : pp. 427-664.

Diagnosis : As in the key.

407. *Ancistrum ganapatii* Kalavati, Ramakumari and Narasimhamurti (Figs. 776-778)

1987b. *Ancistrum ganapatii* Kalavati, Ramakumari and Narasimhamurti, *Indian J. Parasitol.* 11 (2) : pp. 233-234.

Material examined : Sev. exs., Tadepallegudem and Tanuku West Godavari district, January 1985, B. Ramakumari.

Diagnosis : Body oval or pear-shaped, dorsoventrally compressed with slightly flattened right side, 20.0-40.0 μm x 16.0-21.0 μm , pellicle thick, peristomeal groove 15.0-25.0 μm , starting at the extreme right side in the anterior region extending posteriorly, widening and terminating near the cytostome; macronucleus horse-shoe shaped with two equal arms, 14.0 x 5.0 μm , micronucleus 1.0-2.0 μm , spherical, kineties starting at the anterior end near a small suture extending to the posterior end close to the pellicle; fibrillar network seen on the left margin; thigmotactic zone with long cilia; a tuft of cilia at the posterior end arising from a depression in the right margin, cytoplasm granular, contractile vacuole single.

Host : *Pila globosa*; site of infection : intestine.

Distribution : India : Andhra Pradesh (Tadepallegudem and Tanuku, West Godavari district).

Genus *Fenchelia* Raabe, 1970

1970. *Fenchelia* Raabe, *Acta Protozool.*, 7 : p.153.

Diagnosis : As in the key.

Key to the species

1. Body ovoid or pear-shaped with a short distinct prolongation on posterior body pole, 39.1-51.0 μm x 22.1-37.4 μm in dimensions *F. sagarica*
- Body ovoid with a conspicuous cone-shaped prolongation on the posterior body pole, 25.5-40.8 μm x 13.6-30.6 μm in dimensions *E. kapili*

408. *Fenchelia kapili* Jamadar and Choudhury, 1988
(Figs. 779-780)

1988. *Fenchelia kapili* Jamadar and Choudhury, *Tech. Manograph. zool. Surv. India*, 12 : p. 32.

Diagnosis : Body ovoid, dimensions 25.5-40.8 μm x 13.6-30.6 μm , dorso-ventrally flattened with a cone-shaped prolongation at the posterior end; kineties 20-25 in number; anterior thigmotactic cilia longer; peristome starting behind the anterior one-third of the body; undulating number forming a big loop posteriorly; macronucleus ovoid or oblong, measuring 8.5-15.3 μm x 5.1-10.2 μm ; micronucleus spherical, lying anterior to macronucleus; contractile vacuole single, large, located posteriorly near cytostome.

Host : *Cerithidea obtusa*; site of infection : ctenidium and mantle cavity.

Distribution : India : Andhra Pradesh (Kakinada Bay, East Godavari district) and West Bengal.

Remarks : Jamadar and Choudhury (1988) described this species from Andhra Pradesh from the host as mentioned above.

409. *Fenchelia sagarica* Jamadar and Choudhury, 1988
(Fig. 781)

1988. *Fenchelia sagarica* Jamadar and Choudhury, *Tech. Manograph. zool. Surv. India*, 12 : p. 30.

Diagnosis : Body dorso-ventrally flattened, 39.1-51.0 μm x 22.1-37.4 μm , ovoid or pear-shaped with a small protrusion at the posterior end; kineties 30-32 in number; peristome starting considerably posteriorly from the anterior pole of the body; macronucleus variable in shape, 8.5-17.0 μm x 6.8-17.0 μm , located at the anterior half of the body; micronucleus spherical or oval, shadowed by macronucleus and not readily visible; contractile vacuole single, large and located posteriorly.

Host : *Cerithidea obtusa*; site of infection : mantle cavity.

Distribution : India : Andhra Pradesh (Kakinada Bay, East Godavari district) and West Bengal.

Remarks : This species was recorded by Jamadar and Choudhury (1988) from Andhra Pradesh from the host as mentioned above.

Genus *Protophrya* Kofoid, 1903

1903. *Protophrya* Kofoid, *Mark Anniv. Vol. Harvard Univ.*, p. 3.

1949. *Protophrya* : Chatton and Lwoff, *Arch. Zool. exp. gen.*, **86** : p. 169.

Diagnosis : As in the key to the genus.

**410. *Protophrya indica* Jamadar and Choudhury, 1988
(Figs. 782-785)**

1988. *Protophrya indica* Jamadar and Choudhury, *Tech. Monograph. zool. Surv. India*, **12** : p. 36.

Diagnosis : Body pyriform, laterally flattened, 59.5-89.9 μm x 35.7-59.5 μm ; kineties 60-77 in number, peristome naked and narrow starting from the mid-region of the body; cytostome situated close to posterior end; undulating membrane formed of adoral cilia and a long caudal cilium of 11.9-17.0 μm in length; macronucleus oval or round, located at the anterior part of the body; micronucleus spherical, lying above the macronucleus; contractile vacuole single, located adjacent to the cytostome.

Hosts : *Littorina melanostoma* and *Littorina scabra scabra*; site of infection : mantle cavity and buccal mass.

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district), Goa and West Bengal.

Remarks : Jamadar and Choudhury (1988) described this species from Andhra Pradesh from the marine snails *Littorina (Littorinopsis) scabra scabra* as mentioned above.

Order ASTOMATIDA

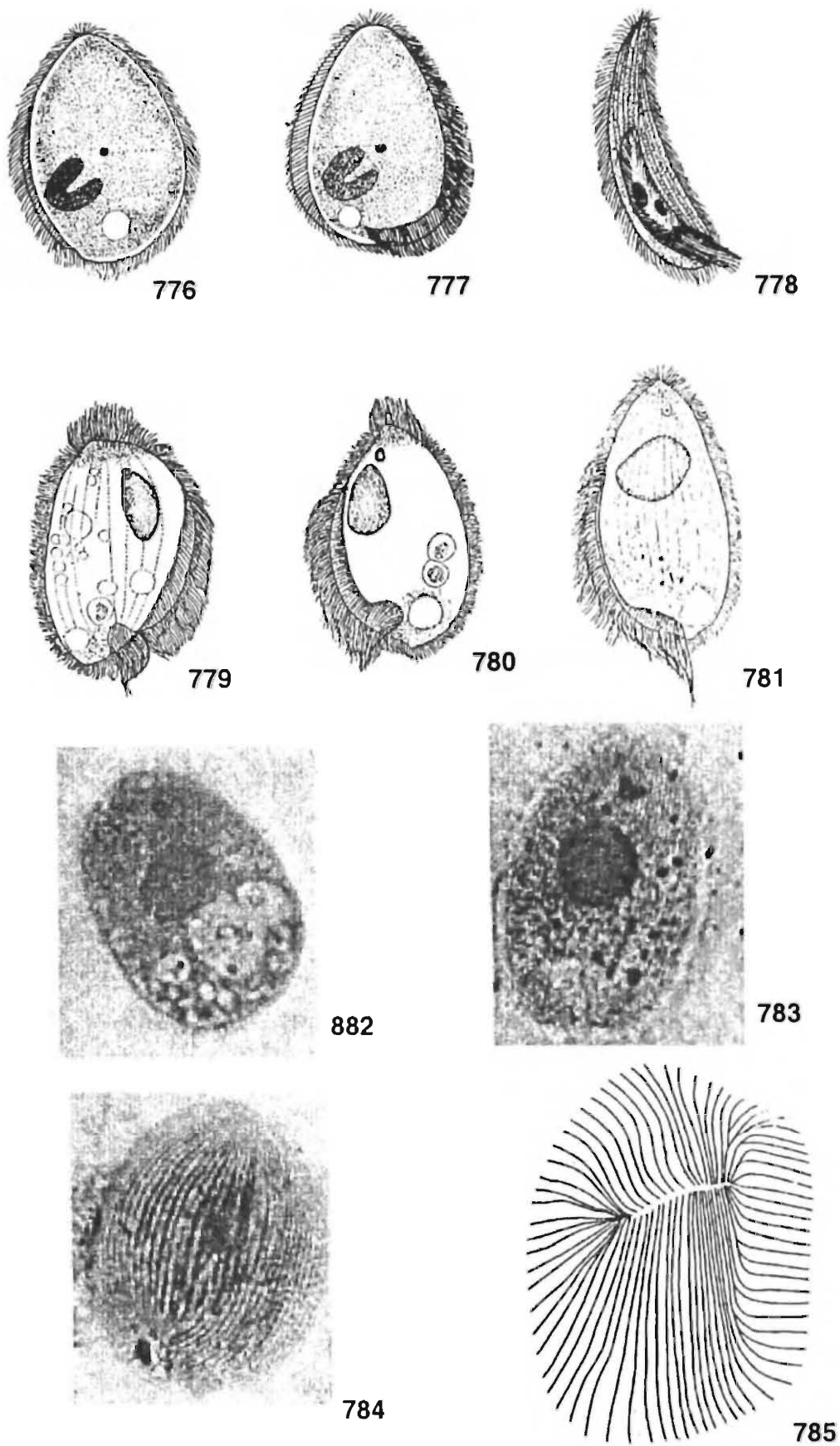
Family HOPLITOPHRYIDAE

Diagnosis : Body elongate, cylindrical, tapered posteriorly, cytoplasm thickened at apical end with insertion of some cytoskeletal fibres, commensal on freshwater oligochaetes.

Genus *Radiophryoides* Lom, 1956

1956. *Radiophryoides* Lom, *Arch. Protistenkd.*, **101** : pp. 277-288.

Diagnosis : As for the family.



Figs. 776-785. Ciliophoran parasites of Andhra Pradesh : 776-778. *Ancistrum ganapatii*; 779-780. *Fenchelia kapili*; 781. *F. sagarica* and 782-785. *Protophrya indica*.

Key to the species

1. Body spindle-shaped, dimensions 160-180 μm x 70-78 μm , 28-30 longitudinal ciliary rows covering the body surface, separated satellite 70-75 μm x 30-40 μm *R. puytoraci*
- Body shape more or less as above, dimensions 80-105 μm x 30-35 μm , 35-40 longitudinal ciliary rows covering the body surface, separated satellite 30-33 μm x 25 μm
..... *R. visakhapatnamensis*

411. *Radiophryoides puytoraci* Naidu, 1961

1961. *Radiophryoides puytoraci* Naidu, *J. Protozool.*, 8 : p. 248.

Diagnosis : Body spindle-shaped with either end bluntly pointed, dimensions 160-170 μm x 70-78 μm ; 28-30 longitudinal ciliary rows covering the body surface, cytostome and contractile vacuole absent; macronucleus straight, rod-shaped, axially placed and extending from end to end, micronucleus minute lying close to macronucleus at about the middle of the body, separated satellite 70-75 μm x 30-40 μm .

Host : Oligochaete, *Aeolosoma travancorensis*; site of infection : gut.

Distribution : India : Andhra Pradesh (Cuddapah district) and Kerala.

15. *Radiophryoides visakhapatnamensis* Joseph and Hanumantha Rao, 1980

1980. *Radiophryoides visakhapatnamensis* Joseph and Hanumantha Rao, *Indian J. Parasitol.*, 4 : p. 31.

Diagnosis : Body colourless and transparent, dimensions 80-105 μm x 30-35 μm , anterior half of the body slightly broader; body covered with 35-40 longitudinal ciliary rows; cytostome and contractile vacuole absent; macronucleus straight, rod-shaped, placed longitudinally, extending almost from anterior to posterior end; shape and location of micronucleus similar to those of the preceding species; separated satellite 30-33 μm x 25 μm .

Host : *Aeolosoma hyalinum*; site of infection : gut.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

Order PERITRICHIDA

Family TRICHODINIDAE

Diagnosis : Mobile, body cylindrical, adoral spiral ranging from the turn of 180° to two or three nearly full circles, always with wide radius.

Genus *Trichodina* Ehrenberg, 1838

1838. *Trichodina* Ehrenberg, *Die Infusionsthierchen als Vollkommene Organismen*.

Diagnosis : Body barrel-shaped with well developed adhesive basal disc, a skeletal ring with radially arranged denticles composed of distally projecting blades and medially extending spines; adoral ciliary row spiralling one to three times; commensal or parasite of aquatic animals.

Key to the species

1. Adoral zone with an angle of 360°-420°, performing one complete turn, skeletal ring with 28-42 denticles, macronucleus bean-shaped, contractile vacuole single, velum incipient *T. cyanophlycti*
- Adoral zone with an angle of 390°-450°, performing one and a half turn, skeletal ring with 48-52 denticles, macronucleus bent with one short and one long arm, contractile vacuole absent, velum distinct with marginal cilia *T. waltirensis*

413. *Trichodina cyanophlycti* Kalavati, Narasimhamurti and Usharani, 1991 (Fig. 786)

1991. *Trichodina cyanophlycti* Kalavati, Narasimhamurti and Usharani, *Rec. Zool. Surv. India, Occ. Paper No. 141* : p. 14.

Material examined : Sev. exs., Eluru, West Godavari district.

Diagnosis : Body oval or rectangular, measuring 60-186 µm x 28-128 µm; adoral zone with an angle of 360°-420°, performing one complete turn at anterior end of the body, parallel to adhesive disc; skeletal ring with 20-42 denticles; macromucleus bean-shaped, measuring 35-48 µm x 15-20 µm, velum incipient, contractile vacuole single.

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

Distribution : India : Andhra Pradesh (West Godavari district).

414. *Trichodina waltirensis* Kalavati, Narasimhamurti and Usharani, 1991 (Fig. 787)

1991. *Trichodina waltirensis* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 16.

Material examined : Sev. exs., Vizianagaram, Vizianagaram district.

Diagnosis : Body cylindrical, measuring 90-150 µm x 40-45 µm; adoral zone with an angle of 390°-450°, performing one and a half turns at the anterior end of the body; skeletal ring with 48-52 denticles, macronucleus bent with one short and one long arm, measuring 40-50 µm x 4-5 µm; velum distinct with marginal cilia, contractile vacuole absent.

Hosts : *Rana breviceps* and *Rana cyanophlyctis*; site of infection : urinary bladder.

Distribution : India : Andhra Pradesh (Vizianagaram district).

Class POLYHYMENOPHOREA

Order HETEROTRICHIDA

Key to the families

1. Body plump-ovoid to ellipsoidal, occasionally tailed, sucker typically present on concave side of the body, uniquely reinforced with polysaccharide skeletal elements SICUOPHORIDAE
- Body ovoid to slightly reniform, plump, sucker on ventral side lacking NYCTOTHERIDAE

Family NYCTOTHERIDAE

Diagnosis : As in the key.

Key to the genera

1. Body, ovoid, pyriform or reniform, left margin convex, right margin more or less flat, micronucleus always below macronucleus, commensal of anurans *Nyctotheroides*
- Body generally less flat, micronucleus most often located above macronucleus, commensal of both invertebrates and vertebrates *Nyctotherus*

Genus *Nyctotherus* Leidy, 1849

1849. *Nyctotherus* Leidy, *Proc. Acad. Nat. Sci. Philad.*, 4 : p. 233.

Diagnosis : As in the key to the genera.

415. *Nyctotherus indica* Bhaskar Rao, 1969

1969. *Nyctotherus indica* Baskar Rao, *Zool. Anz.*, 182, pp. 435-439.

Diagnosis : Body oval, 44.5-64.0 (51.08) μm x 24.5-53.0 (37.12) μm , with blunt anterior end and almost rounded posterior end; peristomal groove situated at one side of the anterior end, becoming wider towards the cytostome; cytopharynx extended obliquely up to the posterior part of the body and curved posteriorly; cytoproct situated at the posterior end, from it a short canal leading into contractile vacuole; macronucleus usually oval or spindle-like, surrounded by a membrane and extending laterally towards the periphery of the body wall as a karyophore; micronucleus small, situated just below the macronucleus; body covered with cilia running obliquely from anterior to the posterior end; with a crescent-shaped flap-like organelle 25-50 μm in length, extending from 1/3 of the anterior end to the cytoproct, consisting of a number of small platelets ranging from 10.5-20.5 μm in width, bearing cilia of variable length.

Host : *Corydia petiveriana* (Insecta : Blattidae); site of inection : intestine.

Distribution : India : Andhra Pradesh (Hyderabad district).

Genus *Nyctotheroides* Grasse, 1928

1928. *Nyctotheroides* Grasse, *Ann. Protistal*, 1, pp. 55-68.

Diagnosis : As in the key to the genera.

Key to the species

1. Body reniform in shape 2
 - Body oval or pyramidal in shape 4
2. Cytopharynx shorter than transverse diameter of the body 3
 - Cytopharynx nearly equal to the transverse diameter of the body and extending obliquely backwards beyond the middle of the body, macronucleus large ovoid *N. reniformis*
3. Body large, 80-120 μm x 50-85 μm in dimensions, macronucleus kidney-shaped *N. cordiformis*
 - Body small, 50-68 μm x 30-35 μm in dimension, macronucleus sausage-shaped *N. hexadactyli*
4. Body pyramidal, anterior end pointed, posterior end broadly rounded, 50-65 μm x 40-45 μm in dimensions, macronucleus triangular, buccal apparatus 'S'-shaped *N. bhatiae*
 - Body oval, large, above 80 μm in length, buccal apparatus of different shape 5
5. Macronucleus cylindrical; body oval, 100-200 μm x 65-90 μm in dimensions *N. waltirensis*
 - Macronucleus triangular or conical 6
6. Macronucleus triangular, body oval, 80-90 μm x 40-50 μm in dimensions, infundibulum narrow, J-shaped, cytopharynx narrow, hyaline *N. rhacophori*
 - Macronucleus conical, body broadly oval, flat with rounded ends, 90-100 μm x 60-80 μm in dimensions, infundibulum narrow, cytopharynx making two spiral coils in the middle of the body *N. foliatus*

416. *Nyctotheroides bhatiae* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 788)

1991. *Nyctotheroides bhatiae* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper* No. 141 : p. 53.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district.

Diagnosis : Body usually pyramidal or conical, anterior end pointed, posterior end broadly rounded, 50-60 μm x 40-45 μm in dimensions; buccal apparatus forming a characteristic S-shaped structure; peristome starting from the middle of anterior apex and joining infundibulum; distal end of infundibulum globular; macronucleus triangular, lying almost adherent to infundibulum, cytopyege absent.

Host : *Rana limnocharis*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

417. *Nyctotheroides cordiformis* (Ehrenberg, 1838)

1838. *Bursaria cordiformis* Ehrenberg, *Die Infusionsthierchen als Vollkommene Organismen*, Leipzig, p. 328.

1867. *Nyctotheroides cordiformis* Stein, *Der organismus der Infusionsthier* etc, Leipzig, p. 338.

1928. *Nyctotheroides cordiformis* Grasse, *Ann. Protistol. Paris*, 1 : pp. 55-68.

Material examined : Sev. exs., Vizianagaram, Vizianagaram district.

Diagnosis : Body reniform, 80-120 μm x 50-85 μm in dimensions; peristome short, cytopharynx reaching beyond the middle of the body and broadly curved, macronucleus kidney-shaped, micronucleus located below macronucleus and centrally attached to it; contractile vacuole single, postero-terminal with anal aperture close to it.

Host : *Rana cyanophlyctis*, *Bufo melanostictus* and *Rana tigrina*; site of infection; intestine and rectum.

Distribution : India : Andhra Pradesh (Vizianagaram district), Goa, Meghalaya, Karnataka, Rajasthan, Tripura and West Bengal.

Remarks : Kalavati *et al.* (1991) reported this species from Andhra Pradesh from the host *Rana cyanophlyctis*.

418. *Nyctotheroides foliatus* Kalavati, Narasimhamurti and Usharani, 1991 (Fig. 789)

1991. *Nyctotheroides foliatus* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper* No. 141 : p. 54.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district.

Diagnosis : Body broadly oval, flat with rounded ends, 90-100 μm x 60-80 μm in dimensions, peristome originating well beyond anterior apex, running parallel to ventral body surface to meet narrow infundibulum; cytopharynx making two spiral coils in the middle of the body, macronucleus conical, micronucleus small, oval, adherent to macronucleus; cytopyege opening into a big contractile vacuole.

Host : *Rana breviceps*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

**419. *Nyctotheroides hexadactyli* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 790)**

1991. *Nyctotheroides hexadactyli* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 56.

Material examined : Sev. exs., Vizianagaram, Vizianagram district.

Diagnosis : Body reniform, 50-68 μm x 30-35 μm in dimensions; peristome small, infundibulum 'C'-shaped; macronucleus sausage-shaped, following the course of infundibulum; cytophyge cleft-like, contractile vacuole absent.

Host : *Rana hexadactyla*; site of infection : colon and rectum.

Distribution : India : Andhra Pradesh (Vizianagaram district).

420. *Nyctotheroides reniformis* (Bhatia and Gulati, 1927)

1927. *Nyctotherus reniformis* Bhatia and Gulati, *Arch. Protistenk.*, **53** : p. 85.

Material examined : Sev. exs., Repalle, Guntur district.

Diagnosis : Body reniform, 80-100 μm x 40-60 μm in dimensions, peristome starting at anterior apex and extending upto the middle of the body; infundibulum oblique and curved; macronucleus large and ovoidal, micronucleus small and spherical and close to its pointed end.

Hosts : *Rana hexadactyla*, *Bufo macrotis*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Guntur district). Elsewhere : Pakistan.

Remarks : Bhatia and Gulati (1927) described this species under the name *Nyctotherus reniformis* and recovered this species from the host *Bufo macrotis* collected from Sialkot in the then Punjab which is now in Pakistan. After a long gap, Kalavati *et al.* (1991) recorded this species from Andhra Pradesh from the host *Rana hexadactyla*.

**421. *Nyctotheroides rhacophori* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 791)**

1991. *Nyctotheroides rhacophori* Kalavati, Narasimhamurti and Usharani, *Rec. Zool. Surv. India, Occ. Paper No. 141* : p. 51.

Material examined : Sev. exs., Aruku Valley, Visakhapatnam district.

Diagnosis : Body oval, anterior end pointed and posterior end rounded, 80-90 μm x 40-

50 μm in dimensions; peristome starting below anterior apex, infundibulum narrow and J-shaped, cytopharynx narrow; macronucleus triangular, situated above infundibulum; micronucleus embedded in macronucleus; cytopyge present and opening into the contractile vacuole.

Host : *Rhacophorus maculatus*; site of infection : colon.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

422. *Nyctotheroides waltirensis* Usharani and Narasimhamurti, 1981

(Fig. 792)

1981. *Nyctotheroides waltirensis* Usharani and Narasimhamurti, *Proc. Indian Acad. Parasitol.*, 2(1) : pp. 13-15.

Diagnosis : Body oval, 100-200 μm x 65-90 μm , with bluntly rounded anterior end and rounded posterior end; body cilia arranged in fine parallel rows, gradually converging at the poles; adoral zone of membranes running halfway through the length of the body after originating at the anterior end and continued into the buccal overture at an angle of about 95° ; cytostome 8 μm in length, leading into a curved peristome; peristome 24 μm long, running dorsally till the middle of the body, then bending posteroventrally and finally ending about 20-22 μm from the posterior end; cytoplasm clearly distinguishable into outer clear ectoplasm and inner granular endoplasm; macronucleus cylindrical, 50 μm long, located at the anterior part of the body and following the curvature of the buccal overture; micronucleus distinct, closely adherent to the macronucleus at the posterior surface near the peristome; cytopyge situated posteriorly like an invaginated tube; contractile vacuole spherical, 16 μm in diameter, at the posterior end close to cytopyge.

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

Distribution : India : Andhra Pradesh (Waltair, Visakhapatnam district).

Remarks : It needs mention here that the present species, *Nyctotheroides waltirensis* was described inadvertently under the title "*Nyctotherus waltirensis*" (vide. Usharani and Narasimhamurti, 1981).

Family SICUOPHORIDAE

Distribution : As in the key.

Key to the genera

1. Adhesive organellae occupying anterior region of ventral surface, reinforced with armature; ventral surface depressed to form a cup-like sucker anteriorly
..... *Prosicuophora*

- Adhesive organellae not restricted to anterior region of ventral surface as above 2
- 2. Adhesive organellae occupying entire ventral surface, with characteristic terminal enlargements for marginal plaques, skeletal elements well developed *Metasicuophora*
- Adhesive organellae on concave side reinforced with polysaccharide skeletal elements *Sicuophora*

Genus *Metasicuophora* Alberet, 1973

1973. *Metasicuophora* Alberet, *J. Protozool.*, **20** : pp. 51-57.

Diagnosis : As in the key to the genera.

Key to the species

- 1. Body small, 75-95 μm x 45-65 μm in dimension, peristome short, infundibulum with two spires, macronucleus club-shaped *M. cyanophlycti*
- Body large, 125-168 μm x 100-125 μm in dimension, peristome long, infundibulum with one spire, macronucleus trapezium-shaped *M. melanosticti*

423. *Metasicuophora cyanophlycti* Kalavati,
Narasimhamurti and Usharani, 1991
(Fig. 793)

1991. *Metasicuophora cyanophlycti* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 38.

Material examined : Sev. exs., Repalle, Guntur district.

Diagnosis : Body small, oval, flattened, 75-95 μm x 45-65 μm in dimensions; peristome long, infundibulum forming two spires in equatorial region in posterior half of the body leading to non-ciliated cytopharynx, macronucleus club-shaped, measuring 15-30 μm x 10-20 μm and placed above infundibulum; micronucleus small, spherical, situated near macronucleus.

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

Distribution : India : Andhra Pradesh (Guntur district).

424. *Metasicuophora melanosticti* Kalavati,
Narasimhamurti and Usharani, 1991
(Fig. 794)

1991. *Metasicuophora melanosticti* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 40.

Material examined : Sev. exs., Machilipatnam, Krishna district.

Diagnosis : Body more or less oval, flat, measuring 125-168 μm x 100-125 μm ; peristome long, extending towards median line; infundibulum forming a single spire; macronucleus trapezium-shaped, measuring 35-42 μm x 20-30 μm with drawn out corners, micronucleus not observed.

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

Distribution : India : Andhra Pradesh (Krishna district).

Genus *Prosicuophora* de Puytorac and Oktem, 1967

1967. *Prosicuophora* de Puytorac and Oktem, *Biol. Gabon*, 3, pp. 223-243.

Diagnosis : As in the key to the genera.

Key to the species

1. Body oval, peristome oblique, infundibulum with single spire, macronucleus bifurcated *P. andhrae*
- Body pear-shaped, peristome straight, infundibulum with single spire, macronucleus 'V'-shaped *P. hexadactyli*

425. *Prosicuophora andhrae* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 795)

1991. *Prosicuophora andhrae* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 42.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district.

Diagnosis : Oval, anterior end pointed, posterior end rounded, 280-350 μm x 180-300 μm in dimensions; peristome oblique, originating from anterior region and joining funnel-shaped infundibulum in the middle region of the body, infundibulum with single spire; macronucleus with two bifurcating arms, measuring 40-50 μm x 20-30 μm ; micronucleus small, spherical and adherent to upper surface of macronucleus; cytopyge cleft-like near posterior end; adhesive organellae egg-shaped, located in the lower surface of anterior end appearing depressed with raised margins.

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

Distribution : India : Andhra Pradesh (Visakhapatnam district).

426. *Prosicuophora hexadactyli* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 796)

1991. *Prosicuophora hexadactyli* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 44.

Material examined : Sev. exs., Visakhapatnam and Chirala, Visakhapatnam district.

Diagnosis : Body egg-shaped with narrow pointed end, dimensions 300-380 μm x 180-250 μm ; peristome originating from the anterior region and adherent to the margin of adhesive organellae, joining funnel-shaped infundibulum in the middle region of the body; infundibulum with two spires; macronucleus 'V'-shaped, measuring 40-60 μm x 35-50 μm with two equal arms; adhesive organelle pear-shaped with central cup-like depression and raised margins located adjacent to peristome; cytopyge cleft-like as in the preceding species.

Host : *Rana hexadactyla*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

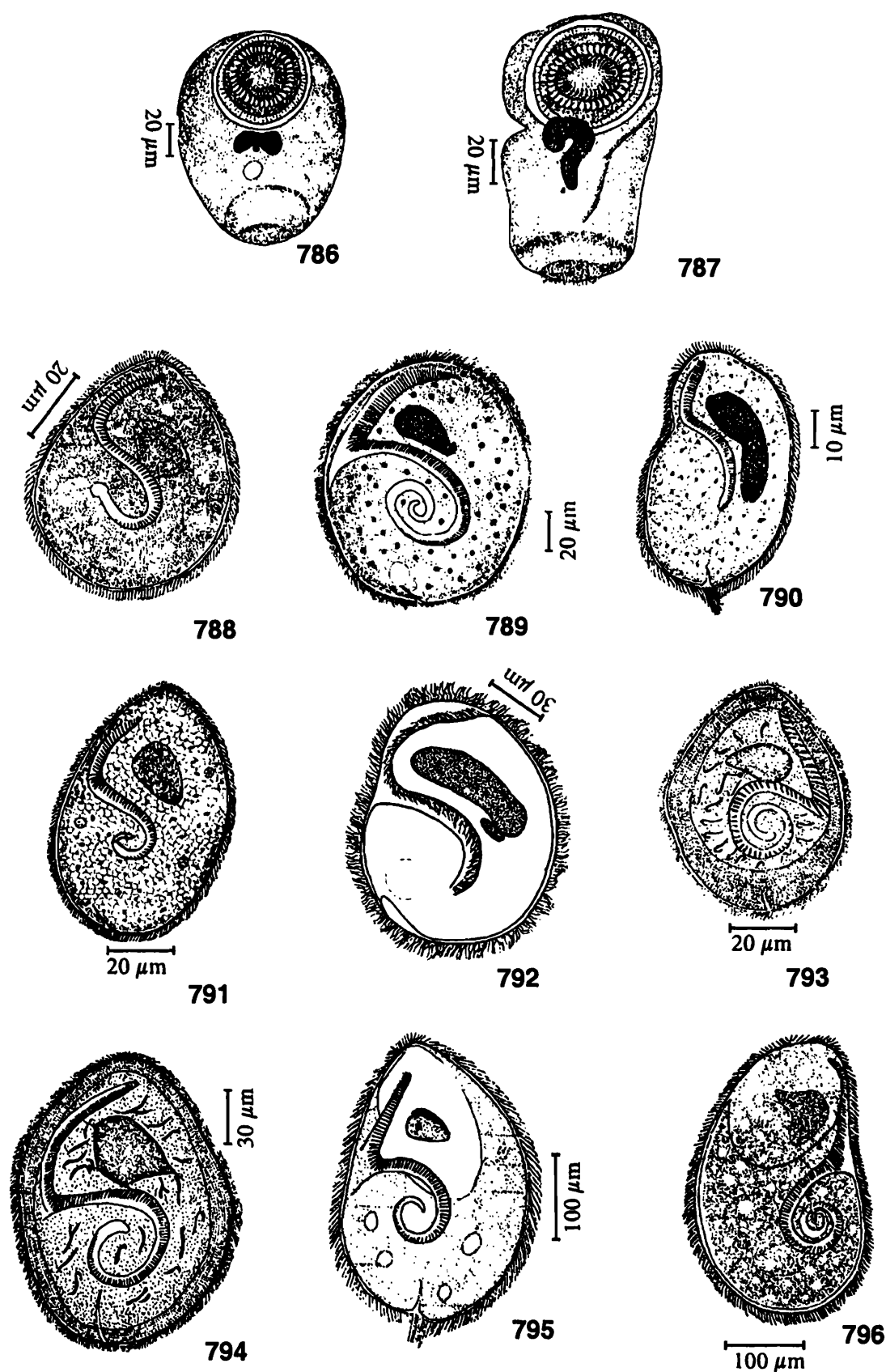
Genus *Sicuophora* de Puytorac and Grain, 1969

1969. *Sicuophora* de Puytorac and Grain, *Protozoologica*, 4, 1968, pp. 405-414.

Diagnosis : As in the key to the genus.

Key to the species

1. Infundibulum with one or two full spiral turns 2
 - Infundibulum without such turn 6
2. Infundibulum with two spires 3
 - Infundibulum forming one full spire, adhesive organelle partly covering the lower surface of the body, macronucleus club-shaped *S. limnochari*
3. Adhesive organelle covering entire lower surface 4
 - Adhesive organelle partly covering the lower surface 5
4. Body oval or kidney-shaped, infundibulum with two and a half spiral turns, macronucleus of diverse shape—oval, cone-shaped or even pentagonal *S. macropharyngea*
 - Body oval, anterior end bluntly pointed and posterior end rounded, infundibulum with two widely-spaced spires, macronucleus triangular with drawn out corners *S. puytoraci*
5. Body flat oval, adhesive organelle broad and located at anterior half, macronucleus bifurcated with two arms *S. ranae*
 - Body oval, dorso-ventrally flattened, apex rounded, adhesive organelle extending posteriorly beyond infundibulum, macronucleus triangular drawn out as a branch on ventral side *S. waltirensis*
6. Body broadly oval, anterior end slightly pointed, posterior end broadly round, adhesive



Figs. 786-796. Ciliophoran parasites of Andhra Pradesh : 786. *Trichodina cyanophlycti*; 787. *T. waltirensis*; 788. *Nyctotheroides bhatiae*; 789. *N. foliatus*; 791. *N. hexadactyli*; 792. *N. waltirensis*; 793. *Metasicuophora cyanophlycti*; 794. *M. melanosticti*; 795. *Prosicuophora andhrae* and 796. *P. hexadactyli*.

organelle large, occupying most of concave surface, infundibulum forming a small arc in middle region of the body, macronucleus bifurcated at the tip *S. fragilis*

- Body flat oval, posterior end pointed, adhesive organelle oval, lying in concave surface in the posterior half of the body, infundibulum funnel-shaped, making a prominent 'C'-shaped curve in the middle of the body, macronucleus irregular, sometimes with drawn out ends *S. levinei*

427. *Sicuophora fragilis* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 797)

1991. *Sicuophora fragilis* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 28.

Material examined : Sev. exs., Nellore, Nellore district.

Diagnosis : Body broadly oval, anterior end slightly pointed and posterior end broadly rounded, 180-220 μm x 132-144 μm in dimension, infundibulum forming a small arc in the middle region of the body without forming any full spiral turn; adhesive organelle large, occupying most of concave surface, macronucleus large, bifurcated at the tip and measuring 50-80 μm in length, cytopygeal tube long with a bulbous tip.

Host : *Rana cyanophlyctis*, *Rana hexadactyla*; site of infection : colon.

Distribution : India : Andhra Pradesh (Nellore district).

428. *Sicuophora levinei* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 798)

1991. *Sicuophora levinei* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 34.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district.

Diagnosis : Body flat, posterior end pointed, 90-108 μm x 64-78 μm in size, infundibulum funnel-shaped, making a prominent 'C'-shaped curve in the middle of the body, adhesive organ oval, lying in posterior half of the body; macronucleus irregular, sometimes with drawn out ends, measuring 18-26 μm x 12-20 μm , cytopyge and cytopygeal tube incipient, faintly seen at posterior end.

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

Distribution : India : Andhra Pradesh (Visakhapatnam district).

429. *Sicuophora limnochari* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 799)

1991. *Sicuophora limnochari* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 23.

Material examined : Sev. exs., Vizianagaram, Vizianagaram district.

Diagnosis : Body flat, oval, both the ends rounded, 290-310 μm x 170-200 μm in dimensions; infundibulum originating in the middle region of the body, running obliquely downwards to the right, forming a single spire; adhesive organelle large, partly covering the ventral surface of the body; macronucleus club-shaped, measuring 55-68 μm x 40-45 μm ; cytophygeal tube with a vacuole at distal end.

Host : *Rana limnocharis*, *Rana cyanophlyctis*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Vizianagaram district).

430. *Sicuophora macropharyngea* (Bezenberger, 1904)

1904. *Nyctotherus macropharyngea* Bezenberger, *Arch. Protistenkd.*, **3** : p. 138.

1973. *Sicuophora macropharyngea* : Albert, *J. Protozool.*, **20** : pp. 51-57.

Material examined : Sev. exs., Visakhapatnam, Visakhapatnam district.

Diagnosis : Body oval, anterior part of the the distinctly thicker than the anterior part, 225 μm x 134 μm in dimension; infundibulum forming a coil in two to two and a half spiral turns; adhesive organelle extending over entire body surface with distinct fibrillar structures, macronucleus of diverse shape (oval, cone-shaped or pentagonal), cytophygeal canal narrow and cleft-like.

Host : *Rana cyanophlyctis*, *Rana breviceps*; site of infection : colon.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

431. *Sicuophora puytoraci* Kalavati, Narasimhamurti and Usharani, 1991 (Fig. 800)

1991. *Sicuophora puytoraci* Kalavati, Narasimhamurti and Usharani, *Rec. Zool. Surv. India, Occ. Paper* No. **141** : p. 32.

Material examined : Sev. exs., Machilipatnam, Krishna district.

Diagnosis : Oval, anterior end bluntly pointed, posterior end rounded, 180-250 μm x 124-160 μm in dimension; infundibulum with two widely spaced spiral turns; macronucleus triangular with drawn out corners, measuring 36-50 μm in length; cytophygeal tube running obliquely opening into a vacuole near infundibular spiral.

Host : *Rana breviceps*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Krishna district).

432. *Sicuophora ranae* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 801)

1991. *Sicuophora ranae* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 35.

Material examined : Sev. exs., Eluru, West Godavari district.

Diagnosis : Body flat, oval, 130-184 μm x 112-136 μm in dimensions; infundibulum with two close spiral turns; adhesive organelle broadly oval, flat, occupying anterior half of the body; macronucleus bifurcated with two arms; cytophygeal tube extending as a fine capillary into contractile vacuole.

Host : *Rana limnocharis*, *Rana hexadactyla*, *Rana cyanophlyctis*; site of infection : rectum.

Distribution : India : Andhra Pradesh (West Godavari district).

433. *Sicuophora waltirensis* Kalavati, Narasimhamurti and Usharani, 1991
(Fig. 802)

1991. *Sicuophora waltirensis* Kalavati, Narasimhamurti and Usharani, *Rec. zool. Surv. India, Occ. Paper No. 141* : p. 21.

Material examined : Sev. exs., Waltair, Visakhapatnam district.

Diagnosis : Body oval, dorso-ventrally flattened; 250-290 μm x 140-175 μm in dimensions; peristome long, extending up to anterior apex; infundibulum making two spiral turns; adhesive organelle extending posteriorly below infundibulum; macronucleus triangular, drawn out as a branch on ventral side, measuring 32-64 μm ; cytophygeal canal with a bulbous base.

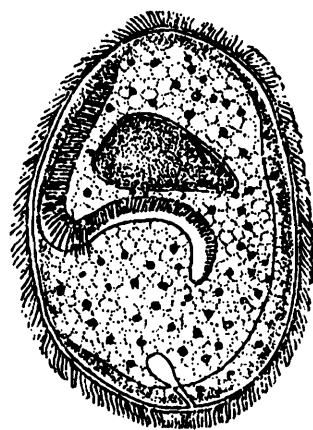
Host : *Rana cyanophlyctis*, *Rana breviceps* and *Rana limnocharis*; site of infection : rectum.

Distribution : India : Andhra Pradesh (Visakhapatnam district).

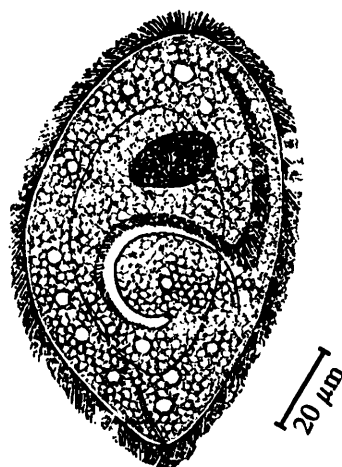
GENERAL REMARKS ON DISTRIBUTION

Distribution of parasitic protozoa in India has intrigued protozoologists since Lewis (1870) first observed the cyst of *Entamoeba coli* from the faecal sample of man while working on cholera evacuation programme in Calcutta. Interest on protozoan parasites, however, has been heightened following Ross's (1898) discovery of the exflagellation of a *Plasmodium* sp. in Secunderabad, Andhra Pradesh heralding in the study of parasites and diseases of domestic and wild animals.

Though the distribution of parasites is associated with the distribution of hosts and even though the host may be infected far away from the site of actual collection of hosts it is worthwhile to depict district-wise distribution of parasitic species recorded so far from the country. The species-wise distribution at the district level has already been shown under their



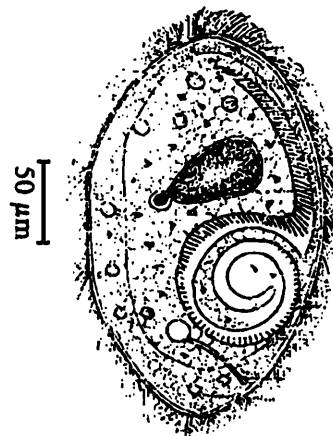
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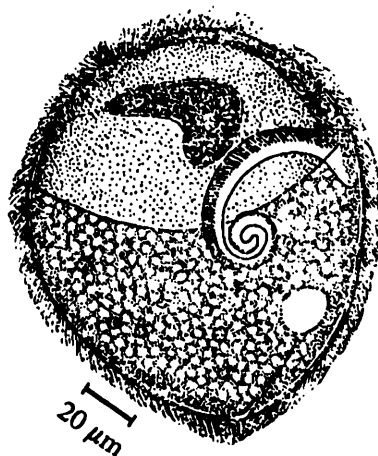
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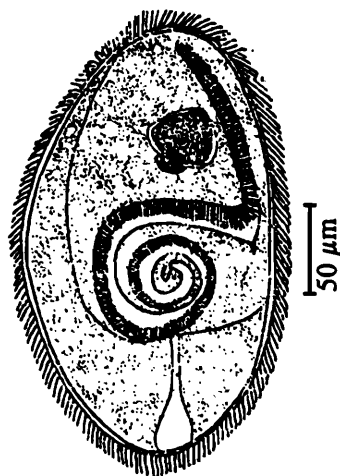
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Figs. 797-802. Ciliophoran parasites of Andhra Pradesh : 797. *Sicuophora fragilis*; 798. *S. levinei*; 799. *S. limnochari*; 800. *S. puyotaraci*; 801. *S. ranæ* and 802. *S. waltirensis*.

respective systematic account of the parasitic species. The district-wise species richness of these parasitic protozoa is presented below, mentioning only the serial number of the species as specified in the parasite-host list of this paper to avoid repetition of species names.

1. **Adilabad district** : SA : 76, 153 = 2; AP : 248-250, 252, 257, 260-264 = 10; Total = 12.
2. **Anantapur district** : SA : 76, 153 = 2; AP : 248-250 = 3; Total = 5.
3. **Chittoor district** : SA : 76, 153 = 2; AP : 221, 224, 248-250, 265 = 6; Total = 8.
4. **Cuddapah district** : SA : 76, 153 = 2; AP : 248-250 = 3; MI : 292 = 1; MY : 389, 390 = 2; CI : 392, 411 = 2; Total = 10.
5. **East Godavari district** : SA : 6, 14, 76, 153 = 4; AP : 160-162, 181, 206, 225, 226, 248-250 = 10; MY : 336, 339, 350, 355 = 4; CI : 403, 408, 409 = 3; Total = 21.
6. **Guntur district** : SA : 14, 17, 76, 153 = 4; AP : 166, 248-250 = 4; MY : 345, 357 = 2; CI : 420, 423 = 2; Total = 12.
7. **Hyderabad district** : SA : 1-3, 5, 8, 13, 15, 16, 18, 28, 31, 38, 39, 41-47, 50-64, 66, 68-74, 76, 77, 84-90, 92, 96, 97, 99, 100, 105, 107, 108, 112-114, 118-123, 125, 127, 129-139, 141-151, 153 = 96; AP : 212, 215-218, 220, 222, 239, 244-251, 253, 266, 272, 273 = 19; MY : 315, 318-320, 328, 335, 342, 343, 348, 349, 352-354, 360-363, 369-373, 375-382, 384 = 32; CI : 391, 396, 400, 404, 406, 415 = 6; Total = 153.
8. **Karimnagar district** : SA : 76, 153 = 2; AP : 248-250 = 3; Total = 5.
9. **Khammam district** : SA : 76, 153 = 2; AP : 214-220, 222, 248-250 = 11; Total = 13.
10. **Krishna district** : SA : 2, 14, 76, 153, 155 = 5; AP : 165, 203, 248-250 = 5; MI : 297-299 = 3; MY : 321, 323, 327, 331 = 4; CI : 424, 431 = 2; Total = 19.
11. **Kurnool district** : SA : 76, 153 = 2; AP : 248-250 = 3; MY : 364 = 1; Total = 6.
12. **Mahbubnagar district** : SA : 76, 153 = 2; AP : 248-250 = 3; Total = 5.
13. **Medak district** : SA : 76, 152, 153 = 3; AP : 248-250 = 3; Total = 6.
14. **Nalgonda district** : SA : 76, 153 = 2; AP : 210, 213, 215-218, 222, 248-250 = 10; Total = 12.
15. **Nellore district** : SA : 76, 153 = 2; AP : 248-250 = 3; CI : 394, 427 = 2; Total = 7.
16. **Nizamabad district** : SA : 76, 153 = 2; AP : 248-250 = 3; Total = 5.
17. **Prakasam district** : SA : 76, 153 = 2; AP : 248-250; Total = 5.
18. **Rangareddy district** : SA : 76, 153 = 2; AP : 248-250, 277 = 4; Total = 6.
19. **Srikakulam district** : SA : 4, 7, 30, 76, 104, 153 = 6; AP : 248-250 = 3; MY : 329, 339 = 2; Total = 11.
20. **Visakhapatnam district** : SA : 4, 7, 9, 26, 27, 29, 33, 35, 36, 40, 49, 75, 76, 79, 95, 98, 102, 103, 106, 111, 128, 153, 154, 156 = 24; AP : 157-161, 163-202, 204, 207-

209, 222, 248-250 = 53; **MI** : 279-291, 293-296, 300-311 = 29; **AS** : 312-314 = 3; **MY** : 316, 317, 319, 321, 322, 324-326, 330, 332-334, 339-341, 344, 347, 350, 351, 355, 356, 358, 359, 365-368, 365-368, 374, 385-388 = 84; **CI** : 395, 398, 399, 401, 402, 405, 410, 412, 416, 418, 421, 422, 425, 426, 428, 430, 433 = 17; Total = 160.

21. **Vizianagaram district** : **SA** : 76, 153 = 2; **AP** : 160, 181, 248-250 = 5; **MY** : 321, 374 = 2; **CI** : 393, 414, 417, 419, 429 = 5; Total = 14.
22. **Warangal district** : **SA** : 10, 32, 37, 48, 67, 76, 101, 124, 126, 153 = 10; **AP** : 211, 215, 216, 218, 222, 248-250, 254-259 = 14; **MY** : 311, 333, 349 = 3; Total = 27.
23. **West Godavari district** : **SA** : 2, 76, 153 = 3; **AP** : 248-250 = 3; **MY** : 346, 367 = 2; **CI** : 407, 413, 432 = 3 Total = 11.
24. **Andhra Pradesh (Unspecified)** : **SA** : 11, 12, 19-25, 65, 77, 81-83, 91, 93, 94, 109, 110, 115-117, 140 = 23; **AP** : 205, 223, 228-238, 240-243, 267-271, 274-276, 278 = 26; **CI** : 397 = 1; Total 50.

District-wise distribution

The district-wise distribution of protozoan parasites from Andhra Pradesh in number of species is presented in Table 3 and in 5 maps (Figs. 803-807), and a graph (Fig. 809) as well as in percentage (Figs. 808, 810). It is to be mentioned that 4 out of 23 districts have been presently surveyed for coccidian parasites. Infections with protozoan parasites were, however, recorded from all the districts as some of human inhabiting malarial and intestinal parasites are known to be common in occurrence throughout the state. Of the 23 districts, Visakhapatnam represents the maximum number of species of protozoan parasites comprising of 160 species embracing 6 phyla followed by Hyderabad (153 species belonging to 4 phyla). The remaining districts represent less than 50 protozoan species (often less than 10 species) of 2-4 phyla indicating under exploration of these areas/districts.

Group-wise distribution

Phyla-wise distribution of protozoan parasites in each district of Andhra Pradesh in terms of number of species is presented in Table 3. It clearly reveals the representation of two phyla viz., Sarcomastigophora and Apicomplexa in all districts. This is primarily due to infection of two human intestinal parasites (*Entamoeba histolytica* and *Giardia intestinalis*) and three malarial parasites (*Plasmodium falciparum*, *P. malariae* and *P. vivax*). Like-wise, the group-wise distribution of protozoan species, genera and families belonging to higher taxa (phyla and subphyla) as well as the number of species of hosts are depicted in Table 4, while the host group-wise distribution of host species infected with protozoan parasites along with districts is presented in Table 5.

Table 4 includes 433 species of protozoan parasites belonging to 128 genera and 74 families under 25 orders, 12 classes and 6 phyla occurring in a total of 208 species of both vertebrate and invertebrate hosts from this state. It is worth mentioning that Andhra Pradesh

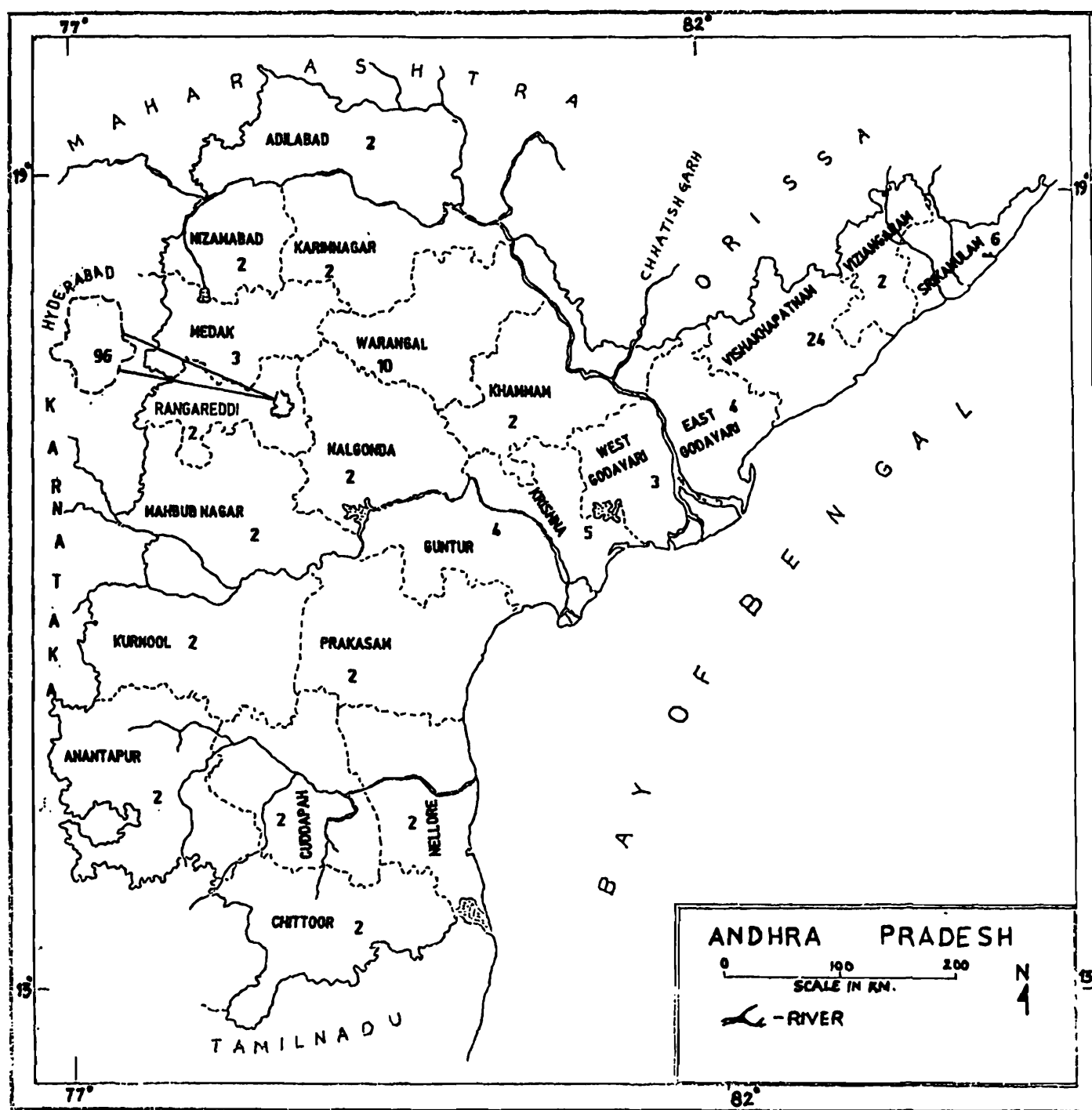


Fig. 803. Map showing district-wise distribution of Sarcomastigophoran parasites (Figure indicates the number of species occurring in the district).

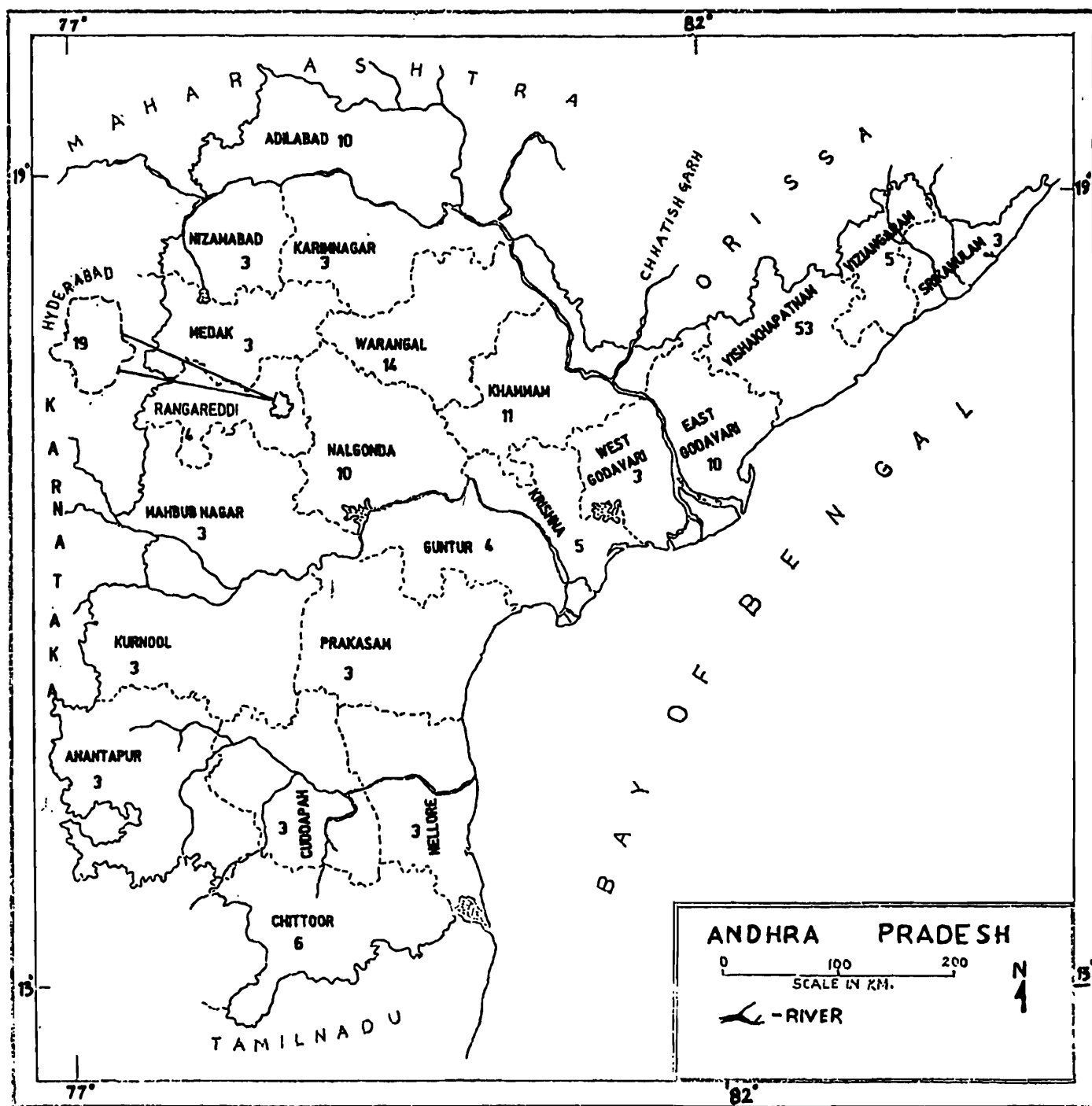


Fig. 804. Map showing district-wise distribution of Apicomplexan parasites (Figure indicates the number of species occurring in the district).

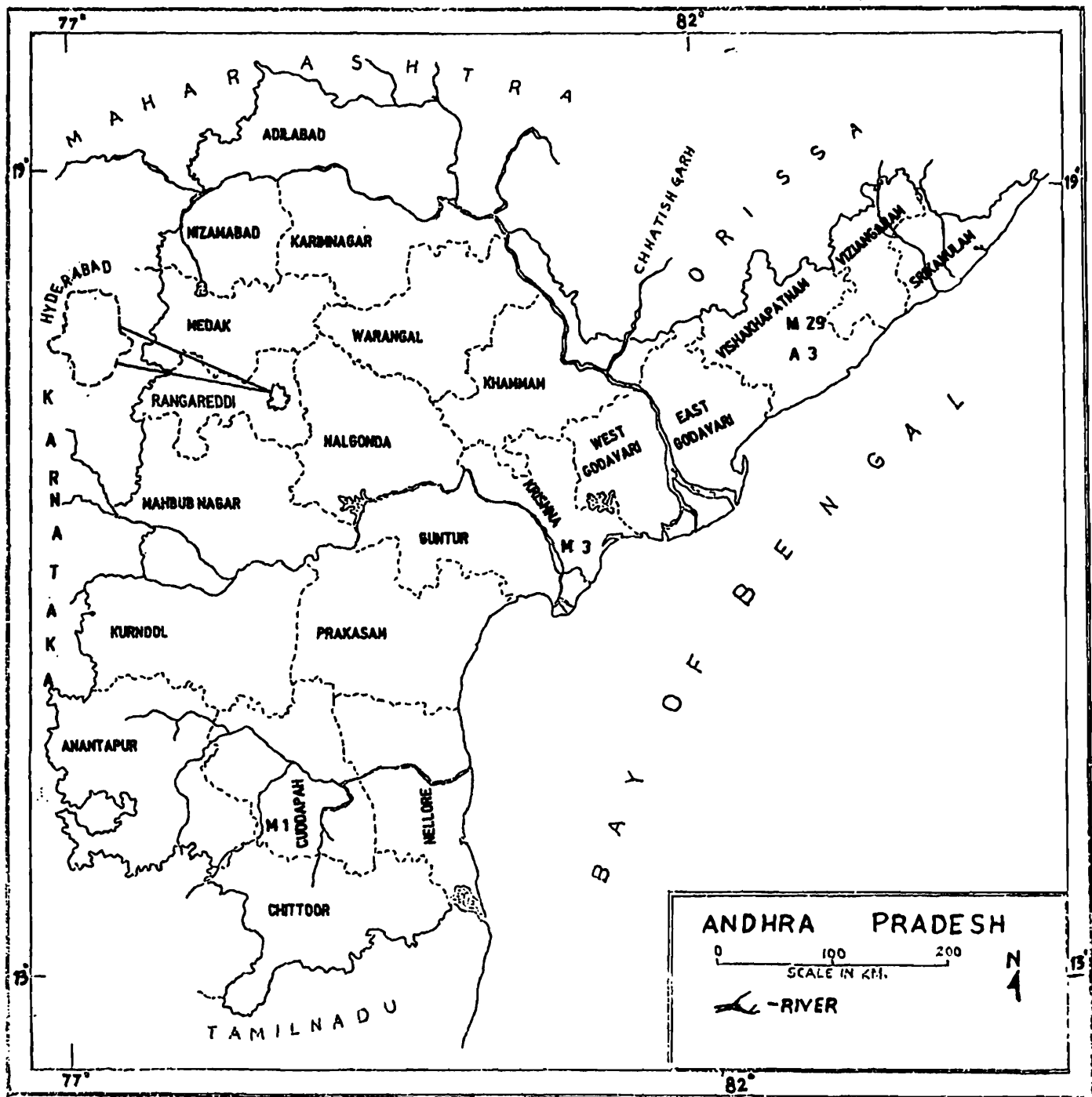


Fig. 805. Map showing district-wise distribution of Microsporan (M) and Ascetosporan (A) parasites (Figure indicates the number of species occurring in the district).

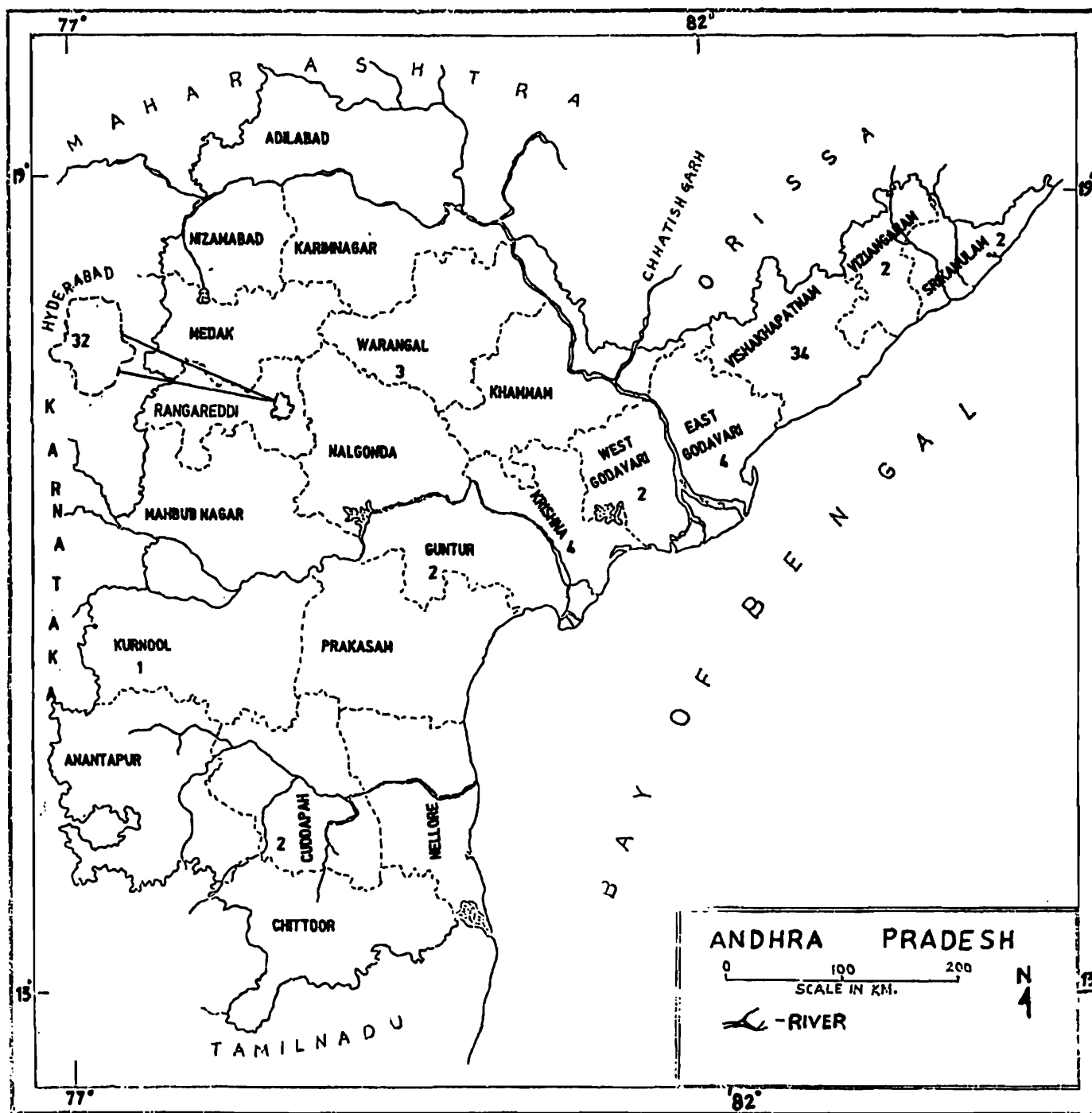


Fig. 806. Map showing district-wise distribution of Myxozoan parasites (Figure indicates the number of species occurring in the district).

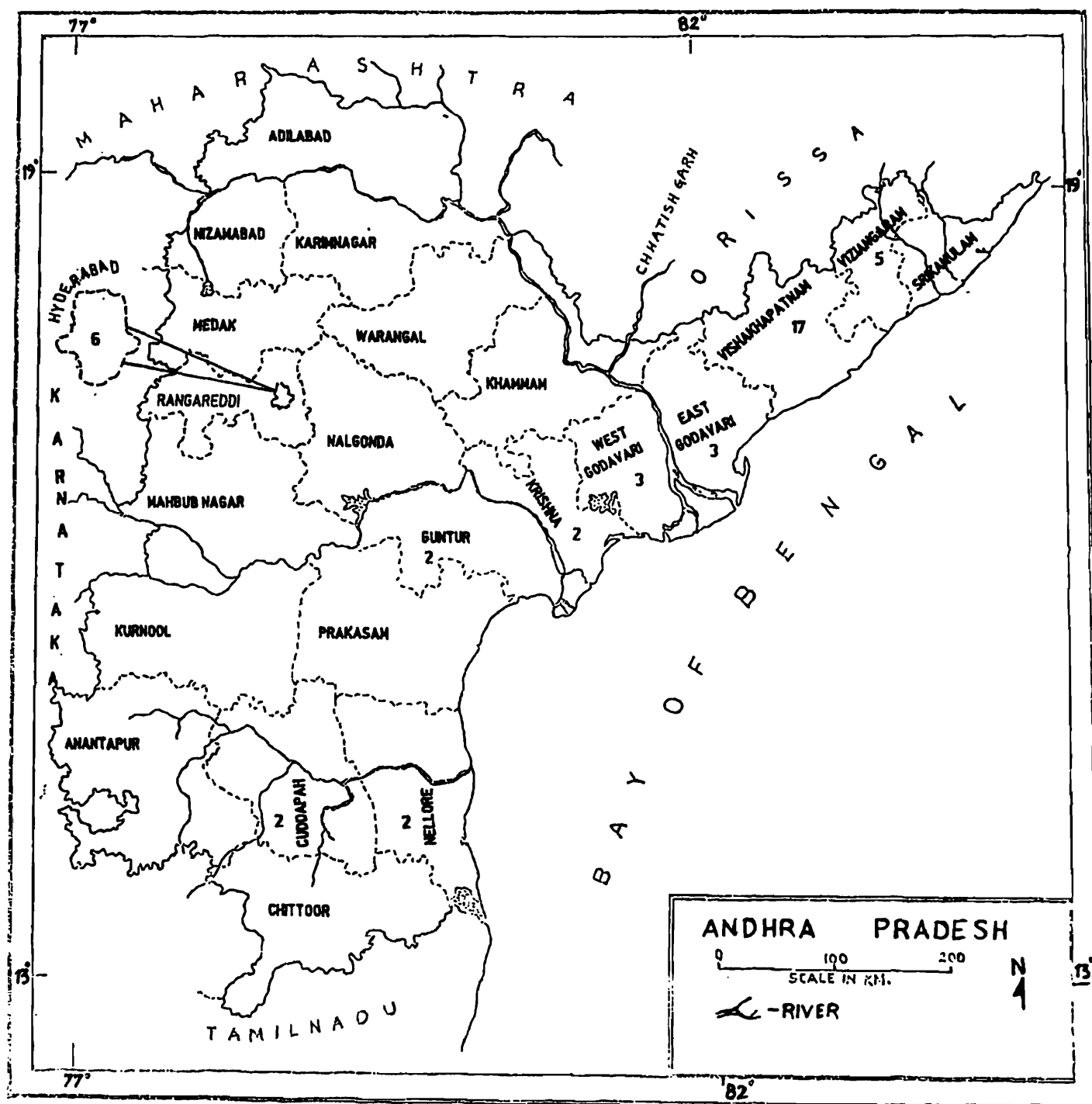


Fig. 807. Map showing district-wise distribution of Ciliophoran parasites (Figure indicates the number of species occurring in the district).

DISTRIBUTION OF PARASITIC PROTOZOAN FAMILY, GENERA, SPECIES AND HOST SPECIES UNDER SIX DIFFERENT PHYLA FROM ANDHRA PRADESH

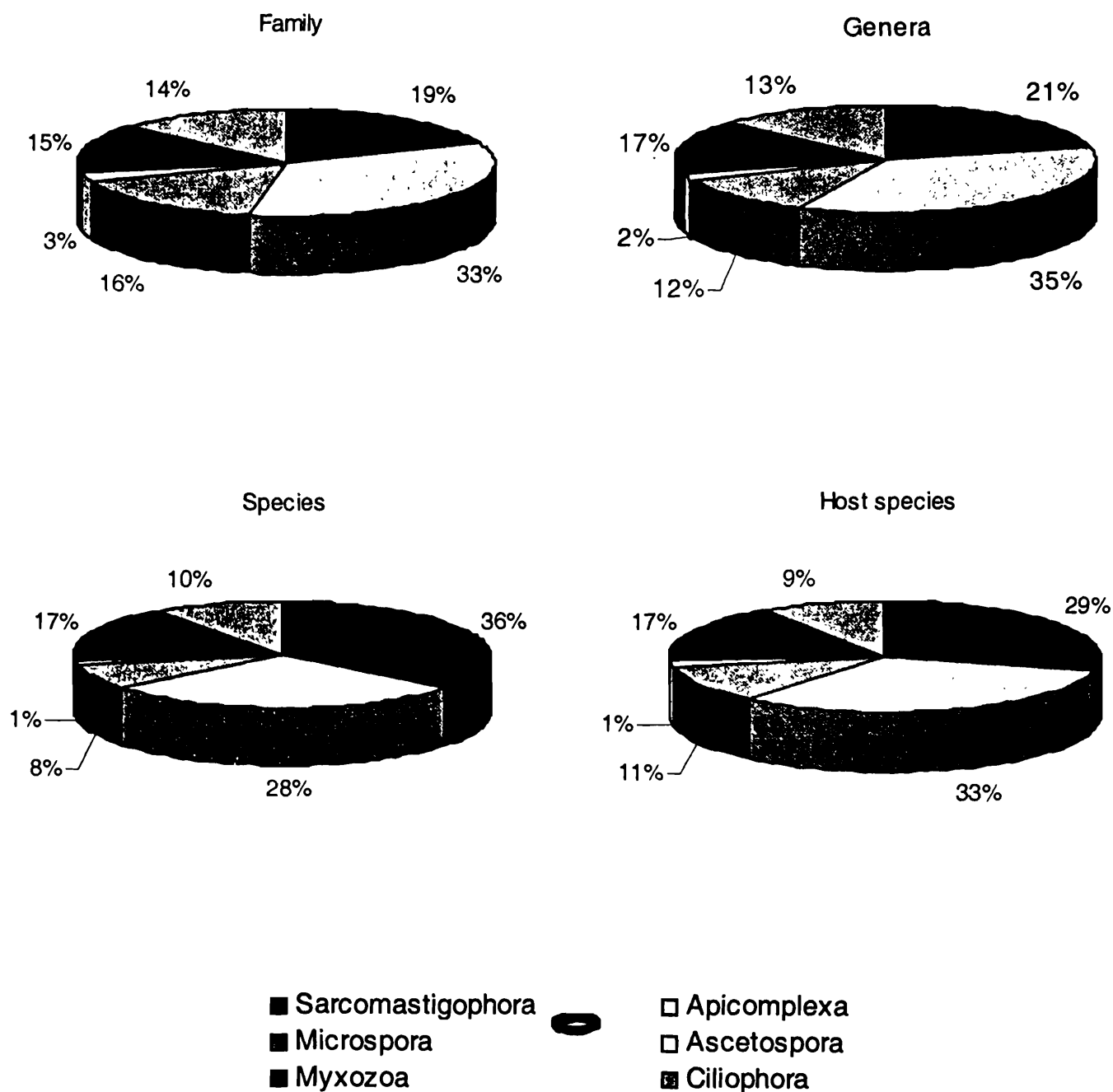


Fig. 808

GROUP-WISE DISTRIBUTION OF HOST SPECIES HARBOURING PARASITIC PROTOZOA FROM ANDHRA PRADESH

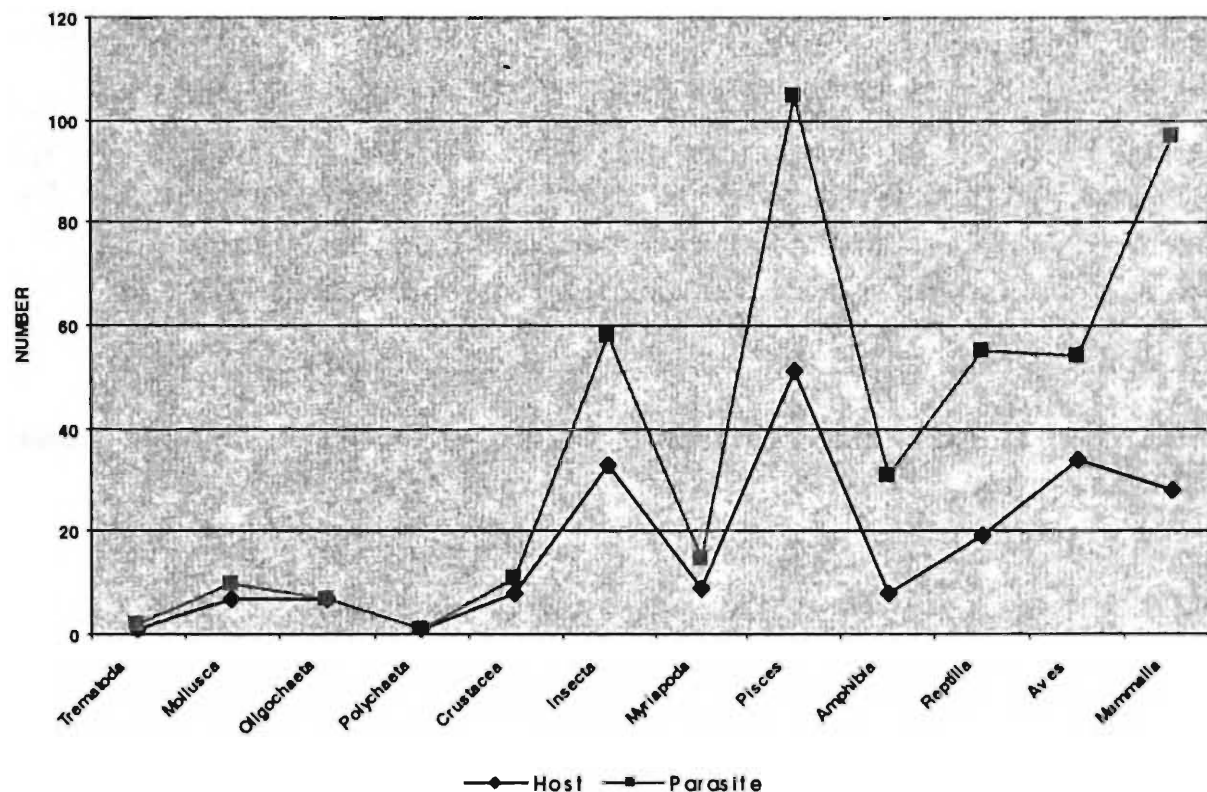


Fig. 809

COMPARATIVE DISTRIBUTION OF FAMILY (F), GENERA (G) AND SPECIES (S) AS WELL AS HOST SPECIES (H) OF PROTOZOAN PARASITE RECORDED FROM ANDHRA PRADESH (A) AND WEST BENGAL (W)

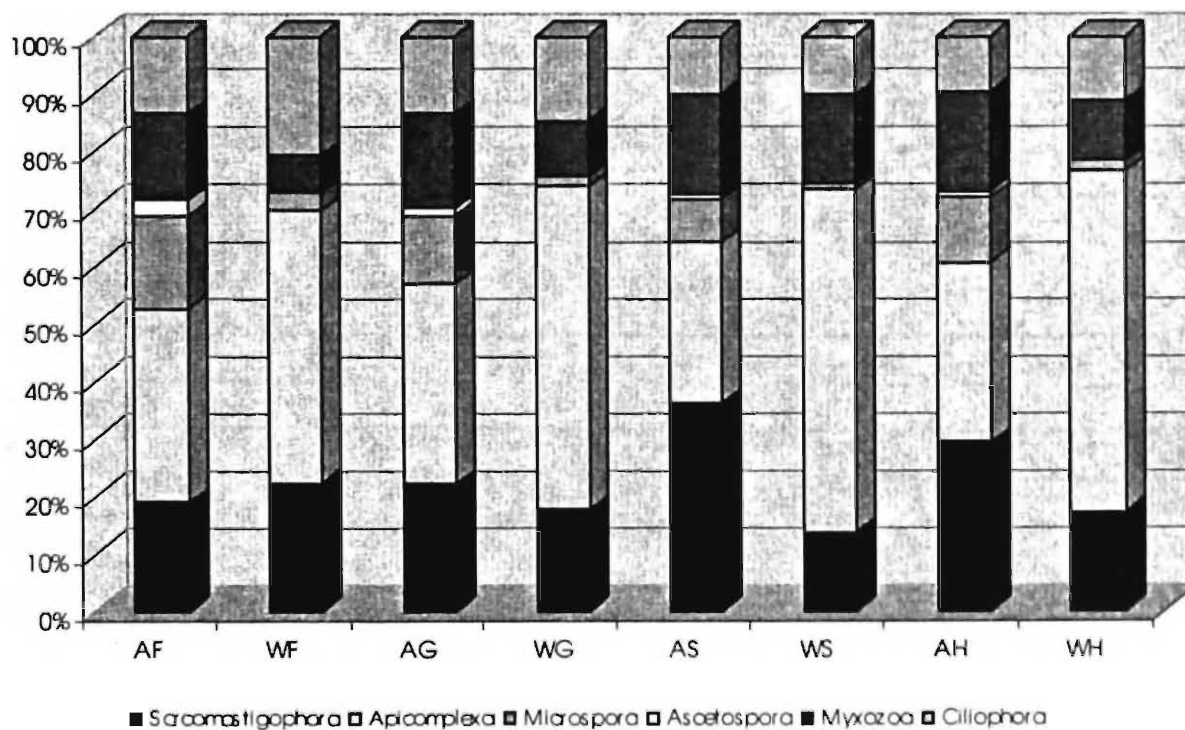


Fig. 810

is the only state in India, which represents 6 parasitic protozoan phyla including the phylum Asctospora. Out of these six phyla the highest representation of 156 species belong to the phylum Sarcomastigophora, followed by Apicomplexa (122 species) and Myxozoa (76 species).

So far, 68 species of invertebrates and 140 species of vertebrates (see host parasite list) comprising of 5 phyla and 12 classes or groups (Table 5) are found to harbour 433 species of protozoan parasites from this state. From Table 5 it is evident that more than 50 fish species have been found to harbour protozoan parasites, followed by insects (35 species), birds (34 species) and mammals (28 species) indicating poor exploration of hosts for protozoan parasites.

Table 3. District-wise distribution of parasitic protozoan species (in number) under to different phyla

Districts	Number of species occurring in the phyla						Total
	Sarcomas-tigophora	Apicom-plexa	Micro-spora	Asceto-spora	Myxozoa	Cilio-phora	
Adilabad	2	10	—	—	—	—	12
Anantapur	2	3	—	—	—	—	5
Chittoor	2	6	—	—	—	—	8
Cuddapah	2	3	1	—	2	2	10
East Godavari	4	10	—	—	4	3	21
Guntur	4	4	—	—	2	2	12
Hyderabad	96	19	—	—	32	6	153
Karimnagar	2	3	—	—	—	—	5
Khammam	2	11	—	—	—	—	13
Krishna	5	5	3	—	4	2	19
Kurnool	2	3	—	—	1	—	6
Mahbubnagar	2	3	—	—	—	—	5
Medak	3	3	—	—	—	—	6
Nalgonda	2	10	—	—	—	—	12
Nellore	2	3	—	—	—	2	7
Nizamabad	2	3	—	—	—	—	5
Prakasam	2	3	—	—	—	—	5
Rangareddy	2	4	—	—	—	—	6
Srikakulam	6	3	—	—	2	—	11
Visakhaptnam	24	53	29	3	34	17	160
Vizianagaram	2	5	—	—	2	5	14
Warangal	10	14	—	—	3	—	27
West Godavari	3	3	—	—	2	3	11
Andhra Pradesh	23	26	—	—	—	1	50

Table 4. Group-wise details of parasitic protozoa (in number) from Andhra Pradesh and number of host species

Group	Number of parasitic protozoan taxa			Number of host species
	Family	Genera	Species	
Phylum Sarcomastigophora	14	28	156	71
Subphylum Mastigophora	11	24	151	67
Subphylum Opalinata	1	1	1	1
Subphylum Sarcodina	2	3	4	4
Phylum Apicomplexa	25	45	122	77
Phylum Microspora	12	15	33	27
Phylum Ascetosporea	2	2	3	3
Phylum Myxozoa	11	21	76	42
Phylum Ciliophora	10	17	43	23
Total	74	128	433	208*

Note : * Total number of host species indicates less than actual total since several hosts harbour parasites of different groups.

Table 5. Group-wise distribution of host species and their parasitic protozoan species (in number) from Andhra Pradesh

Host group	Host species	Parasite species	Districts
Trematoda	1	2	1 (Visakhapatnam)
Mollusca	7	10	4 (East Godavari, Hyderabad, Visakhapatnam and Warangal)
Oligochaeta	7	7	2 (Cuddapah and Visakhapatnam)
Polychaeta	1	1	1 (Visakhapatnam)
Crustacea	8	11	2 (East Godavari and Visakhapatnam)
Insecta	35	58	6 (East Godavari, Guntur, Hyderabad, Krishna, Visakhapatnam and Vizianagaram)
Myriapoda	9	15	1 (Visakhapatnam)
Pisces	51	104	10 (East Godavari, Guntur, Hyderabad, Krishna, Kurnool, Srikakulam, Visakhapatnam, Vizianagaram, Warangal and West Godavari)
Amphibia	8	31	7 (Guntur, Krishna, Medak, Nellore, Visakhapatnam, Vizianagaram and West Godavari)
Reptilia	19	55	5 (Hyderabad, Krishna, Srikakulam, Visakhapatnam and Warangal)
Aves	34	52	7 (Adilabad, Chittoor, Hyderabad, Khammam, Nalgonda, Visakhapatnam and Warangal)
Mammalia	28	96	All districts
Total	208	433	All districts

Table 6. Comparative distribution of parasitic protozoa from Andhra Pradesh/West Bengal

Group	Number of parasitic protozoan taxa			Number of host species
	Family	Genera	Species	
Phylum Sarcomastigophora	14 / 14	28 / 23	156 / 81	71 / 75
Subphylum Mastigophora	11 / 12	24 / 17	151 / 65	67 / 69
Subphylum Opalinata	1 / 1	1 / 3	1 / 6	1 / 4
Subphylum Sarcodina	2 / 1	3 / 3	4 / 10	4 / 8
Phylum Apicomplexa	25 / 30	45 / 74	122 / 357	77 / 257
Phylum Microspora	12 / 2	15 / 2	36 / 5	27 / 8
Phylum Ascetosporea	2 / 0	2 / 0	3 / 0	2 / 0
Phylum Myxozoa	11 / 4	21 / 13	76 / 93	42 / 46
Phylum Ciliophora	10 / 13	17 / 19	43 / 60	20 / 48
Total	74	128 / 131	433 / 596	208 / 351

A comparative account of the distribution of protozoan parasites of Andhra Pradesh and West Bengal (Table 6) also indicates less exploration of hosts in Andhra Pradesh (208 species) than in West Bengal (351 species). Table 6 suggests that greater efforts were made in investigating intestinal flagellates (Subphylum Mastigophora) from Andhra Pradesh (151 species) than West Bengal (65 species).

In overall, 208 species of invertebrate and vertebrate hosts belonging to 5 phyla and 12 classes harbour 433 species of protozoan parasite, indicating on an average more than 2 protozoan parasites per host from this state. Out of these, 101 species are recorded as host for single protozoan parasite, while the rest 107 species are with two or more parasites and only two species viz., a fish, *Liza macrolepis* and a frog *Rana cyanophlyctis* harbour more than 10 protozoan parasites, indicating uneven emphasis/specialization in investigating animal parasites like other parts/states of the country.

SUMMARY

1. A systematic account of 433 species of parasitic protozoa belonging to 128 genera and 74 families under 25 orders, 12 classes and 6 phyla occurring in a total of 208 species of vertebrate and invertebrate hosts from Andhra Pradesh is given in this State Fauna Series.
2. Of these, 156 species belong to the phylum Sarcomastigophora, 122 species comprising of the phylum Apicomplexa and 33 species, 3 species, 76 and 43 species belonging to the phyla Microspora, Ascetosporea, Myxozoa and Ciliophora respectively.

3. Among 122 species of the phylum Apicomplexa, five species of gregarines viz., *Anisolobus triboli* n. sp. from *Tribolium ferruginum*, *Retractocephalus corcyrae* n. sp. from *Corcyra cephalanica*, *Cystocephalus gonocephali* n. sp. from *Gonocephalus arenarium*, *Xiphocephalus rhytinotus* n. sp. from *Rhytinota* sp. and *Harendraia murtii* n. sp. from *Gallerucida bicolor* are new to science.
4. Besides, one species of gregarine, *Chakravartiella krishnamurthyi* Sailaja, 1995 is redescribed with illustration; there are 2 new host-parasite records of gregarines and 9 first records of coccidian parasites from this state.
5. A systematic list of parasitic protozoa along with their host and locality is incorporated.
6. Similarly, a host-parasite list along with references is also communicated for ready reference to the parasites.
7. The district-wise and host-group-wise distributions of parasitic protozoa from Andhra Pradesh are discussed.
8. A comparative distribution of parasitic protozoa from Andhra Pradesh and West Bengal is also provided.
9. In the introductory part, the present state of transition in classification of parasitic protozoa has been briefly reviewed.
10. The study reveals that Andhra Pradesh represents maximum number of Protozoan phyla (six) amongst Indian states.

Postscript : While checking the proof it has been found that the blood film No. 37133 of *Haemoproteus thereicercis* de Mello, 1935 from *Megalaima zeylanica* was collected by H. E. McClure from Andhra Pradesh (exact locality not known) on 13 April 1971 and deposited at the International Reference Centre for Avian Haematozoa (IRCAH), Canada, presently located at the Queensland Museum, Australia. This blood film was designated as neotype of *H. thereicercis* by Bennett and Nandi (1981). Thus, the total number of parasitic protozoan from Andhra Pradesh becomes 434 species (not 433 species as stated above).

Reference : Bennett, G. F. and Nandi, N. C. 1981. Avian Haemoproteidae. 16. The haemoproteids of the avian family Capitonidae (the barbets). *Can. J. zool.* **59**(11) : 2064-2071.

ACKNOWLEDGEMENT

We are thankful to Dr. J. R. B. Alfred, Director, Zoological Survey of India, Kolkata, as well as authorities of Andhra University for facilities provided for this work. We are indebted to several institutes and individuals for consultation of library and sending reprints / xerox copies of papers on parasitic protozoa of Andhra Pradesh. The institutes and organizations visited for library work / supplied information are School of Tropical Medicine, Kolkata; All India Institute of Hygiene and Public Health, Kolkata; Bengal Veterinary College, Kolkata; Central Library, Andhra Pradesh Agricultural University, Hyderabad; Osmania University Library, Hyderabad; Andhra University, Visakhapatnam; National Institute of Cholera and Enteric Diseases, Kolkata and the Zoological Society, Kolkata. The senior author wishes to record his deep sense of gratitude to the following University Professors and researchers who have immensely helped in getting reprints / xerox copies of papers / information in connection with the present work.

1. Prof. A. B. Kulkarni, Professor & Head, Department of Zoology, Marathwada University, Aurangabad-431 004, for sending large number of reprints / xerox copies of Prof. R. Krishnamurthy that infuse hope to undertake this study. As such, this paper is dedicated in honour of him.
2. Prof. Graziella Mento, Istituto di Parassitologia, Policlinico Universitario-Torre Biologica-98124, Messina, Italia, for sending xerox copies of several papers.
3. Prof. D. P. Haldar, Department of Zoology, Kalyani University, Kalyani-741 235, West Bengal, for allowing me to consult his collection of reprints.
4. Prof. Dr. Md. Hafeez, Professor & Head, Department of Parasitology, College of Veterinary Sciences, Tirupati-517 502, Andhra Pradesh.
5. Dr. M. Masood Hussain, Department of Zoology, P. G. College of Science, Osmania University, Saifabad, Hyderabad-500 004.
6. Dr. C. Sampurnannad, Veterinary Biologicals and Research Institute, Shantinagar, Hyderabad-500 028.
7. Prof. K. P. Janardanan, Department of Zoology, University of Calicut, Kerala-673 635.
8. Dr. C. A. N. Rao, Zoological Survey of India, Freshwater Biological Station, Hyderabad-500 020, Andhra Pradesh.
9. Dr. Sumit Nandi, Department of Surgery, Bengal Veterinary College, Belgachia, Kolkata.

Thanks are also due to Sri N. C. Sarkar, Sri S. K. Das, Ms. Mousumi Roy, Sri R. Saktivel and Sri Haradhan Das of this department (ZSI) and to Mr. B. V. V. N. Rao and Mr. N Satish, Department of Zoology, Andhra University, Visakhapatnam for various help in library work, typing, and preparing the manuscript.

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FREELIVING AND SYMBIOTIC PROTOZOA

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INTRODUCTION

The present paper is based on freeliving and symbiotic protozoan species which were collected by the scientists of the Zoological Survey of India (ZSI) from Andhra Pradesh in recent years. As per annual programme of work of ZSI, 9 coastal districts of the state, namely, Srikakulam, Vizianagram, Vishakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore were surveyed for the collection of Protozoa during the first phase. A total of 54 species comprising of 33 species of freeliving protozoa and 21 species of symbiotic flagellates of wood-eating termites were collected from those districts. A manuscript dealing with taxonomic account and district-wise distribution of those species was also submitted for publication. Subsequently, during the second phase ZSI scientists collected 29 species of freeliving protozoa from 8 noncoastal districts of the state. These districts are : Warangal, Nizamabad, Rangareddi, Nalgonda, Karimnagar, Adilabad, Medak and Khammam.

Since taxonomic account of the earlier collections was submitted for publication under the title coastal districts of Andhra Pradesh, taxonomic diversity of the present protozoa collections have been appended in the present State Fauna Series under the subhead non-coastal districts. This will project a holistic picture of all the freeliving and symbiotic protozoan species recently collected by ZSI from the state, without least alteration of the first part of the manuscript.

In this connection it is needed to mention here that all these freeliving protozoa belong to testacid rhizopods under the classes Lobosea and Filosea. On the other hand, symbiotic protozoa were collected from the gut of two species of termite hosts, namely, *Cryptotermes dudleyi* and *Coptotermes heimi*, belonging to the families Kalotermitidae and Rhinotermitidae respectively.

Perusal of available literature reveals that no symbiotic protozoa has been reported so far from Andhra Pradesh. On the other hand, 27 species of testacid rhizopods (freeliving protozoa)

were reported by Naidu (1966) from this state. Out of these, only one species, *Arcella conica* was collected from the coastal district of Andhra Pradesh. The remaining 26 species were recorded from two non-coastal districts of the state, namely, Cuddapah and Chittoor as shown in Table 1. Amongst these 18 species (marked by asterisks (*) in Table 1 are not collected or reported so far from the coastal districts of the state. Therefore, those species are not taxonomically dealt with in this paper.

MATERIAL AND METHODS

Freeliving protozoa were collected from freshwater ponds, puddles and water bodies as well as from mosses grown on soil, rocks and trees of different localities in nine districts mentioned earlier. Freshwater samples were collected along with little algal mass, water weeds, bottom ooze and flocculent matter arising out of washing of aquatic vegetation of the sampling sites. Samples were kept in wide mouthed glass jars. These jars were brought to the laboratory, kept for few days with their lids open for considerable increase in protozoan population. The samples were then thoroughly examined under the light microscope from time to time.

For preparing permanent slides of testacid rhizopods empty tests were isolated from the bottom ooze of the samples. Testacids were also collected by squeezing different parts of aquatic vegetation including their roots and submerged portion of leaves. The testacids were placed in microslides, air dried after two or three washings in absolute alcohol and then mounted in DPX.

For collecting moss inhabiting protozoa moss samples were brought to the laboratory. A portion of each sample was kept in petri dish and sprinkled regularly with sufficient distilled water. After one or two days aqueous drops drawn from the moss by micropipette were kept on microslides and examined thoroughly under the light microscope. Any testacid observed in those drops were fixed and mounted in the same manner as stated earlier for freshwater testacids. For more details Das *et al.* (1993, 1995) and, Chattopadhyay and Das (2003) may be consulted.

For the collection of flagellate symbiotes of termites, the entire gut of the worker caste of termites was removed and gut contents were emptied on clean slides, containing a drop of 0.5 per cent saline. For studying the internal structures of termite flagellates under *in situ* condition 67 per cent Locke's solution was used in which these protozoans remain active in living condition for a longer period with their natural shape and size. For preparing permanent slides these flagellates were fixed in Schaudinn's fluid, stained with Heidenhain's iron haematoxylin and mounted in DPX.

A. TESTACIDS AND SYMBIOTIC FLAGELLATES OF COASTAL DISTRICTS

As mentioned earlier, 54 species of testacid rhizopods and symbiotic flagellates have been collected from 9 coastal districts of Andhra Pradesh. A systematic list of these species are presented below to reveal their taxonomic diversity.

SYSTEMATIC LIST OF TESTACIDS AND SYMBIOTIC PROTOZOA HITHERTO KNOWN FROM COASTAL DISTRICTS OF ANDHRA PRADESH (Classification after Levine *et. al.*, 1980)

A. Freelifving Protozoa

Phylum SARCOMASTIGOPHORA

Subphylum	SARCODINA
Class	LOBOSEA
Order	ARCELLINIDA
Family	ARCELLIDAE
Genus	<i>Arcella</i> Ehrenberg

1. *Arcella conica* (Playfair)
2. *Arcella discoides* Ehrenberg
3. *Arcella vulgaris* Ehrenberg

Family	CENTROPYXIDAE
Genus	<i>Centropyxis</i> Stein

4. *Centropyxis aculeata* (Ehrenberg)
5. *Centropyxis aerophila* Deflandre
6. *Centropyxis aerophila* var. *sphagnicola* Deflandre
7. *Centropyxis constricta* (Ehrenberg)
8. *Centropyxis ecornis* (Ehrenberg)
9. *Centropyxis minuta* Deflandre
10. *Centropyxis orbicularis* Deflandre
11. *Centropyxis platystoma* (Penard)
12. *Centropyxis spinosa* (Cash and Hopkinson)

Genus	<i>Cyclopyxis</i> (Deflandre)

13. *Cyclopyxis arcelloides* (Penard)

Genus	<i>Plagiopyxis</i> Penard

14. *Plagiopyxis callida* Penard
15. *Plagiopyxis minuta* Bonnet

Family DIFFLUGIIDAE

Genus *Difflugia* Leclerc

16. *Difflugia acuminata* Ehrenberg

17. *Difflugia corona* Wallich

18. *Difflugia lithophila* (Penard)

19. *Difflugia lobostoma* Leidy

20. *Difflugia pyriformis* Perty

Family NEBELIDAE

Genus *Heleopera* Leidy

21. *Heleopera sphagni* (Leidy)

Family ?

Genus *Phryganella* Penard

22. *Phryganella acropodia* (Hertwig and Lesser)

Class FILOSEA

Order GROMIIDA

Family EUGLYPHIDAE

Genus *Assulina* Ehrenberg

23. *Assulina seminulum* (Ehrenberg)

Genus *Corythion* Taranek

24. *Corythion dubium* Taranek

Genus *Euglypha* Dujardin

25. *Euglypha acanthophora* (Ehrenberg)

26. *Euglypha ciliata* (Ehrenberg)

27. *Euglypha laevis* (Ehrenberg)

28. *Euglypha rotunda* Wailes and Penard

29. *Euglypha tuberculata* Dujardin

Genus *Tracheleuglypha* Deflandre

30. *Tracheleuglypha dentata* (Vejdowsky)

Genus *Trinema* Dujardin

31. *Trinema complanatum* Penard

32. *Trinema enchelys* (Ehrenberg)

33. *Trinema lineare* Penard

B. Symbiotic Protozoa

Phylum	SARCOMASTIGOPHORA
Subphylum	MASTIGOPHOREA
Class	MASTIGOPHORA
Order	OXYMONADIDA
Family	OXYMONADIDAE
Genus	<i>Oxymonas</i> Janicki

*Symbiotes**Hosts*

34. <i>Oxymonas bosei</i> Das	<i>Cryptotermes dudleyi</i>
35. <i>Oxymonas grandis</i> Cleveland	<i>Cryptotermes dudleyi</i>

Order	TRICHOMONADIDA
Family	DEVESCOVINIDAE
Genus	<i>Devescovina</i> Foa

36. <i>Devescovina glabra</i> Grassi	<i>Cryptotermes dudleyi</i>
37. <i>Devescovina lemniscata</i> Kirby	<i>Cryptotermes dudleyi</i>

Genus *Foina* Janicki

38. <i>Foina reflexa</i> Janicki	<i>Cryptotermes dudleyi</i>
39. <i>Foina solita</i> Kirby	<i>Cryptotermes dudleyi</i>

Family	CALONYMPHIDAE
Genus	<i>Stephanonympha</i> Janicki

40. <i>Stephanonympha minuta</i> Das and Choudhury	<i>Cryptotermes dudleyi</i>
41. <i>Stephanonympha pyriformis</i> Das and Choudhury	<i>Cryptotermes dudleyi</i>
42. <i>Stephanonympha sylvestri</i> Janicki	<i>Cryptotermes dudleyi</i>

Order	HYPERMASTIGIDA
Family	HOLOMASTIGOTIDAE
Genus	<i>Holomastigotoides</i> Grassi and Foa

43. <i>Holomastigotoides bengalensis</i> Chakraborty and Banerjee	<i>Coptotermes heimi</i>
44. <i>Holomastigotoides campanula</i> (De Mello)	<i>Coptotermes heimi</i>
45. <i>Holomastigotoides emersoni</i> Das	<i>Coptotermes heimi</i>
46. <i>Holomastigotoides magnus</i> Uttangi	<i>Coptotermes heimi</i>
47. <i>Holomastigotoides ovalis</i> Uttangi	<i>Coptotermes heimi</i>
48. <i>Holomastigotoides rayi</i> Karandikar and Vittal	<i>Coptotermes heimi</i>
49. <i>Holomastigotoides reniformis</i> de Mello	<i>Coptotermes heimi</i>
50. <i>Holomastigotoides spheroidalis</i> de Mello	<i>Coptotermes heimi</i>

Family SPIROTRICHONYMPHIDAE

Genus *Spirotrichonympha* Grassi and Foa

51. *Spirotrichonympha froilanoi* Karandikar and Vittal *Coptotermes heimi*

Family EUCOMONYMPHIDAE

Genus *Pseudotrichonympha* Grassi and Foa

52. *Pseudotrichonympha cardiformis* Karandikar and Vittal *Coptotermes heimi*

53. *Pseudotrichonympha indica* Chakraborty and Banerjee *Coptotermes heimi*

54. *Pseudotrichonympha subapicalis* Karandikar and Vittal *Coptotermes heimi*

SYSTEMATIC ACCOUNT

A. Freelifving Protozoa

Phylum SARCOMASTIGOPHORA

Class LOBOSEA

Order ARCELLINIDA

Key to the families

1. Test membranous and rigid, having a distinct oral aperture Family ARCELLINIDAE
 - Test with minerals and organic particles and with a oral aperture 2
2. Test with plates or scales, secreted by cytoplasm sometimes with foreign particles ...
 - Family NEBELIDAE
 - Test with foreign particles and without any plate or scale as above 3
3. Symmetry of test dorso-ventral, oral aperture at one side of test (eccentric) or ventral
 - Family CENTROPYXIDAE
 - Test having axial symmetry, oral aperture at extremity of the test (terminal)
 - Family DIFFLUGIIDAE

Family ARCELLIDAE

Genus *Arcella* Ehrenberg

1832. *Arcella* Ehrenberg, *Abh. preuss. Acad. Wiss. Berlin*, p. 40.

Diagnosis : Test membranous, rigid with hexagonal markings, brown or yellow in colour, encrusted with chitinous particles; aperture central, circular and inverted like a funnel.

Key to the species

1. Test hemispherical, evenly convex, height of the dome about half of its diameter *A. vulgaris*
- Test spherical or pyramidal 2
2. Test spherical, circular in front view, height of dome about one-third to one-fourth of its diameter *A. discoides*
- Test pyramidal, sometimes angular in front view, with holes of 4-8 faces ... *A. conica*

1. *Arcella conica* (Playfair)

1918. *Arcella costata* var. *conica* Playfair, *Proc Linn. Soc. New South Wales*, p. 34.

Material examined : 5 exs.

Diagnosis : Test pyramidal, sometimes angular in front view, with holes of 4-8 faces; mouth circular, proportionately small and without buccal tube.

Distribution : India : Andhra Pradesh and West Bengal, amongst bottom ooze.

Remarks : Naidu (1966) was the first to report this species from India, that too, from "a rain water puddle at Machavaram in Vijyawada" in Krishna district, Andhra Pradesh. During the present investigation this species was collected by ZSI Scientists from freshwater tanks of Krishna district.

2. *Arcella discoides* Ehrenberg

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

Material examined : 12 exs.

Diagnosis : Test smooth, flattened, plano-convex in lateral view and circular in front view; height of dome about one-third to one-fourth of the diameter of the test; aperture large and circular.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Himachal Pradesh, Sikkim, Tripura, Uttaranchal and West Bengal; in freshwater ponds and tanks in bottom ooze, also in moss.

Remarks : This species is reported for the first time from Andhra Pradesh. It has been collected from the bottom ooze of freshwater bodies and also from wet mosses of Srikakulam, Krishna, Vishakhapatnam Vizianagram and West Godavari districts of this state during the present investigation.

3. *Arcella vulgaris* Ehrenberg

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

Material examined : 15 exs.

Diagnosis : Test hemispherical, evenly convex, height of the dome about half of its diameter; surface with large 'areoles'; mouth circular and central and, often without buccal tube.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh Manipur, Nagaland, Sikkim and West Bengal; in freshwater amongst bottom ooze and submerged vegetation; also in moss.

Remarks : This species has been collected from the bottom ooze of freshwater bodies and from wet mosses of East Godavari, Guntur, Nellore, Srikakulam and Vishakhapatnam districts of Andhra Pradesh during the present investigation. It constitutes first record for this state.

Family CENTROPYXIDAE

Genus *Centropyxis* Stein

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

1929 *Centropyxis* Stein : Deflandre, *Arch. Protistenkd.*, **67**, p. 322.

Diagnosis : Test dorso-ventrally flattened, spheroidal at posterior portion and tapering towards apertural region; oral aperture eccentric and ventral, typically invaginated without a raised rim.

Key to the species

1. Test beset with spines 2
 - Test without any spine 3
2. Test furnished with a few divergent spines arranged in a single row, usually resembling scrap, oral aperture circular or oval *C. aculeata*
 - Test beset with variable number of spines frequently curved and distributed irregularly on dorsal side, aperture lobate or circular with irregular border *C. spinosa*
3. Test prolonged at anterior end resembling a flat lens covering the mouth, a constriction present between oral part and post-oral part of the test *C. platystoma*
 - Test not prolonged as above, constriction between oral and post-oral part of the test lacking 4

4. Test circular or nearly circular in ventral view 5
 - Test more or less ovoidal, elliptical and discoidal in ventral view 6
5. Test small, usually below 50 μm in diameter, encrusted with siliceous particles, oral aperture circular *C. minuta*
 - Test comparatively large, usually above 70 μm in diameter, encrusted with large stony particles on its dorsal border, oral aperture nearly semi-circular *C. orbicularis*
6. Posterior part of the test strongly arched, in ventral view flanks of the post-oral part of the test convex, one or a few stony particles often attached to its posterior border ...
..... *C. constricta*
 - Posterior part of the test slightly orched, post-oral part of the test not so convex in ventral view as above, also no stony particles as above attached to posterior border
..... 7
7. Test small (usually 50-80 μm), fundus spheroidal with dorsal face strongly flattened towards oral aperture, aperture semi-circular or elliptical 8
 - Test comparatively large, usually above 100 μm , discoidal, largely elliptical, usually irregular in outline, oral aperture circular or round *C. ecornis*
8. Test ovoid in ventral view, aperture semi-circular *C. aerophila*
 - Test hemispherical or elliptical in ventral view, oral aperture formed of two convex arcs
..... *C. aerophila* var. *sphagnicola*

4. *Centropyxis aculeata* (Ehrenberg)

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

1857. *Centropyxis aculeata* (Ehrenberg) Stein, *S. bohn. Ges. Wiss.*, Prague, 5 (10), p. 41.

Material examined : 7 exs.

Diagnosis : Test compressed, cap-shaped, fundus of test obtusely rounded and furnished with a few (usually 4-6) divergent spines at the border, arranged in a single and somewhat regular row; spines usually resembling scrap; test brownish, frequently encrusted with quartz crystals and sometimes with admixture of diatoms and sand particles.

Distribution : India : Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Rajasthan, Sikkim, Tripura and West Bengal; in freshwater bodies amongst vegetation, also in moss.

Remarks : Naidu (1966) reported this species from Chittoor district (non-coastal district) of Andhra Pradesh and collected the same from an "old well near the college in Chittoor town." During the present studies *C. aculeata* was collected from freshwater tanks and wet mosses of East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam and Vishakhapatnam districts of this state.

5. *Centropyxis aerophila* Deflandre

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

Material examined : 10 exs.

Diagnosis : Test small, usually 60-70 μm in length, 'panse' spheroidal in dorsal view and strongly flattened towards oral aperture; in ventral view test oval, 'panse' circular or slightly elliptical converging towards aperture; aperture mostly semicircular, and frequently straight at margin of 'panse'; in lateral view 'panse' much bulged, abruptly sloping near aperture; apertural part of the test very much transparent; test chitinous, finely punctate and rough, bearing foreign particles, and frequently vegetable fragments and, transparent crystals.

Distribution : India : Andhra Pradesh (present report), Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttaranchal and West Bengal; common in moss and *Sphagnum*.

Remarks : This species is reported for the first time from Andhra Pradesh. During the present investigation it has been collected from ground and rock mosses of East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam and West Godavari districts of the state.

6. *Centropyxis aerophila* var. *sphagnicola* Deflandre

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

Material examined : 7 exs.

Diagnosis : Test more or less hemispherical or slightly elliptical in ventral view; oral aperture subterminal, transverse oval and invaginated, its contour formed by two convex arcs; dorsal region rough and apertural region smooth.

Distribution : India : Andhra Pradesh (present record), and Sikkim; in moss.

Remarks : *Centropyxis aerophila* var. *sphagnicola* is also reported for the first time from Andhra Pradesh and collected from the ground moss of Vizianagram district only. In India this ecological variety of *C. aerophila* has so far been reported from moss biotope of Sikkim by Das *et al.* (2000) and Uttaranchal (Chattopadhyay and Das, 2003).

7. *Centropyxis constricta* (Ehrenberg)

1907. *Arcella constricta* Ehrenberg, Abh. Akad. Wiss. Berlin.

1879. *Diffugia constricta* Leidy, Freshwater. Rhizopods of North America, Pl. 18, figs. 29, 30.

1929. *Centropyxis constricta* (Ehrenberg) Deflandre, Arch. Protistenkd., 67, p. 340.

Material examined : 10 exs.

Diagnosis : Test elliptical or ovoidal in ventral view, oral aperture always invaginated very

strongly towards posterior part; aperture at the border of the test accentric, largely elliptical or nearly circular; test covered with closely set sand grains, giving a grey colour to it.

Distribution : India : Andhra Pradesh (present record), Assam, Himachal Pradesh Meghalaya, Mizoram, Sikkim and Tripura, Uttaranchal and West Bengal in moss.

Remarks : This species constitutes first record for Andhra Pradesh. It has been collected from soil and rock mosses of Nellore, Prakasam, Srikakulam, Vishakhapatnam and West Godavari districts of the state.

8. *Centropyxis ecornis* (Ehrenberg)

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

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

Material examined : 15 exs.

Diagnosis : Test comparatively large, sometimes more than 200 μm in length in aquatic habitats and usually about 100 μm in dry moss; discoidal or largely elliptical in shape, most irregular in outline, without any spine and covered with quartz sand grains; aperture usually circular, sometimes irregularly lobed, not much eccentric.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim, Uttaranchal and West Bengal; in freshwater and moss.

Remarks : This species has been collected from freshwater and mosses of East Godavari, Guntur, Krishna, Nellore, Vishakhapatnam and West Godavari districts of Andhra Pradesh and reported for the first time from the state.

9. *Centropyxis minuta* Deflandre

1929. *Centropyxis minuta* Deflandre, *Arch. Protistenkd.*, 67, p. 349.

Material examined : 10 exs.

Diagnosis : Test small, usually less than 50 μm in diameter, circular in ventral view and subspherical in lateral view; oral aperture eccentric and circular.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tripura, Uttaranchal and West Bengal; in moss.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from soil and rock moss of East Godavari, Krishna, Prakasam and Vishakhapatnam districts of the state.

10. *Centropyxis orbicularis* Deflandre

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

Material examined : 4 exs.

Diagnosis : Test brownish, almost circular in ventral view, ventral surface flat; in lateral view test semicircular, displaying considerable invagination towards the oral aperture; oral aperture nearly semicircular, plagiostomic, test encrusted with large stony particles on its dorsal border.

Distribution : India : Andhra Pradesh; in freshwater and in moss.

Remarks : This species has so far been reported once from India, that too, from an "old well near the college in Chittoor town" (Chittoor district) in Andhra Pradesh by Naidu (1966). During the present investigation this species has been collected only from East Godavari district of the state in soil moss. Besides Andhra Pradesh this species has been recorded from Uttaranchal only (Chattopadhyay and Das, 2003) within Indian limit.

11. *Centropyxis platystoma* (Penard)

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

1929. *Centropyxis platystoma* Deflandre, Arch. Protistenkd; 67, p. 338.

Material examined : 18 exs.

Diagnosis : Test elongated, elliptical in ventral view, prolonged to the anterior end resembling a flat lens covering oral aperture; a constriction most often visible between 'sleeve' of the test and oral aperture; in lateral view posterior part of the test strongly convex and anterior part more or less flat; oral aperture circular or semicircular; test chitinous covered with siliceous and quartz particles and, occasionally small pebbles.

Distribution : India : Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh Manipur, Meghalaya, Nagaland, Sikkim and Tripura; in moss.

Remarks : Naidu (1966) was the first to report this species from Andhra Pradesh. He collected it from an old well of Chittoor district of the state. During the present investigation this species has been collected from soil and rock mosses of Guntur, Nellore, Prakasam, Vishakhapatnam, Vizianagram and West Godavari districts of Andhra Pradesh.

12. *Centropyxis spinosa* (Cash & Hopkinson)

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

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

Material examined : 12 exs.

Diagnosis : Test more or less circular and considerably flat, oral aperture eccentric and circular with irregular border, test furnished with 6-8 spines frequently curved and distributed irregularly on dorsal side, test chitinous with few quartz crystals or diatom fistules.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Uttaranchal and West Bengal; in freshwater bottom ooze and in wet moss.

Remarks : This species constitutes first record for Andhra Pradesh. It has been collected from freshwater tanks and wet mosses of Nellore, Srikakulam, Vishakhapatnam, Vizianagram and West Godavari districts of the state.

Genus *Cyclopyxis* (Deflandre)

1929. *Centropyxis* (*Cyclopyxis*) Deflandre, *Arch. Protistenkd.*, **67**, p. 330, 337.

Diagnosis : Test regularly arched, oral aperture centrally located.

13. *Cyclopyxis arcelloides* (Penard)

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

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

Material examined : 30 exs.

Diagnosis : Test circular in ventral view and hemispherical in lateral view, brown, chitinous, covered with small flat siliceous scale like structures; oral aperture centrally located, circular in shape, faintly invaginated, about half the diameter of that of width.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Assam, Himachal Pradesh Manipur, Meghalaya, Mizoram, Sikkim, Tripura, Uttaranchal and West Bengal; in freshwater and in moss.

Remarks : This species is reported for the first time from Andhra Pradesh. It is found to be very common amongst soil mosses of the state and has been collected from eight of its coastal districts (out of nine), viz, East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam, Vizianagram and West Godavari.

Genus *Plagiopyxis* Penard

1910. *Plagiopyxis* Penard, *Rev. Suisse Zool.*, **18**, p. 936.

Diagnosis : Test hemispherical in dorsal view and ovoid in side view, oral aperture linear, lunate, superior lip without pores.

Key to the species

1. Test small, below 50 μm in diameter, clear and transparent, aperture short *P. minuta*
- Test large, 90-100 μm in diameter, circular or largely oval in ventral view and hemispherical in lateral view *P. callida*

14. *Plagiopyxis callida* Penard

1910. *Plagiopyxis callida* Penard, *Rev. Suisse Zool.*, **18**, p. 936.

Material examined : 12 exs.

Diagnosis : Test gray, yellow or brown in colour, circular or largely oval in ventral view and hemispherical in lateral view, diameter 90-100 μm , inferior lip dipping far into interior of the test and lips overlapping to such extent that aperture very difficult to observe.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh Manipur, Mizoram, Sikkim and West Bengal; in soil and moss.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from soil moss of East Godavari, Prakasam. Vishakhapatnam and West Godavari districts of the state during the recent surveys.

15. *Plagiopyxis minuta* Bonnet

1959. *Plagiopyxis minuta* Bonnet, *Bull. Soc. Hist. Nat. de Toulouse*, **94**, p. 177.

Material examined : 10 exs.

Diagnosis : Test clear and transparent, circular in dorsal view and semi-elliptical in lateral view, diameter of the present material 40-45 μm , inferior lip shorter in length, projecting inside the test as an elongation of the ventral side; test covered with relatively large siliceous plates especially on ventral side.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh, Manipur and Sikkim in soil and moss.

Remarks : This species was collected from soil mosses of Nellore and Srikakulam districts of Andhra Pradesh during the present investigation. It constitutes first record for this state.

Family DIFFLUGIIDAE**Genus *Diffugia* Leclerc**

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

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

Diagnosis : Test with axial symmetry, its shape varying from globular to elongate, pyriform or acuminate, aperture at the extremity of the test.

Key to the species

1. Test without collar 2
 - Test with collar 3
2. Oral aperture circular without any lobe or crenulation, test spherical to subglobose *D. lithophila*
 - Oral aperture crenulated, crenulations 10-12 in number *D. corona*
3. Test terminated by a pointed extension of the base, usually straight *D. acuminata*
 - Test not terminated by any pointed or horn-like extension 4
4. Test ovoid, oral aperture quadri-lobed in the form of a cross, but very often tri-lobed *D. lobostoma*
 - Test typically pyriform, oral aperture circular and without any lobe *D. pyriformis*

16. *Diffflugia acuminata* Ehrenberg

1838. *Diffflugia acuminata* Ehrenberg, *Infusionsthierchen*, etc., p. 131.

Material examined : 12 exs.

Diagnosis : Test cylindrical without any collar and with a pointed 'horn'-like extension at the base; 'horn' straight and differentiated from the base; quartz crystals of test big, some of them projecting out of the margin of the test giving irregular appearance of test margins.

Distribution : Andhra Pradesh, Meghalaya, Manipur, Tripura and West Bengal; in bottom ooze of freshwater ponds and lakes.

Remarks : Naidu (1966) reported this species from a well near a college in Chittoor town (Chittoor district) in Andhra Pradesh. During the present investigation *D. acuminata* was collected from four coastal districts of the state, namely, East Godavari, Guntur, Srikakulam and Vishakhapatnam.

17. *Diffflugia corona* Wallich

1864. *Diffflugia corona* Wallich, *Ann. Mag. nat. Hist.* (3) 13, p. 244.

Material examined : 20 exs.

Diagnosis : Test more or less spherical, slightly narrow near oral aperture but widened at the base with 5-10 spines; surfaces of test spines smooth formed of quartz crystals, oral

aperture wide, about half the diameter of the test, crenulated; crenulations varying from 8 to 12, sometimes more.

Distribution : India : Andhra Pradesh (present record), Manipur, Tripura and West Bengal; in freshwater ponds and lakes amongst vegetation and bottom ooze.

Remarks : This species constitutes first record for Andhra Pradesh. It has been collected from five coastal districts of the state during the present investigation, namely, Krishna, Prakasam, Nellore, Vishakhapatnam and Vizianagram.

18. *Diffugia lithophila* (Penard)

1902. *Diffugia hydrostatica* var. *lithophila* Penard, *Faune Rhizopodique du bassin Leman*, Geneve, p. 274.

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

Material examined : 8 exs.

Diagnosis : Test ovoid-globular or sub-globose drawn out to the aperture in the form of a short collar, aperture circular without any lobe or crenulation, test covered with well arranged stony particles.

Distribution : India : Andhra Pradesh (present report), Arunachal Pradesh, Meghalaya, Manipur, Nagaland, Tripura and West Bengal; in freshwater ponds and lakes amongst bottom ooze.

Remarks : This species was collected from freshwater tanks of three coastal districts of Andhra Pradesh during the present investigation, namely, East Godavari, Guntur and Srikakulam. It constitutes first report for the state.

19. *Diffugia lobostoma* Leidy

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

Material examined : 15 exs.

Diagnosis : Test ovoidal, oral aperture usually quadrilobed in the form of a cross and sometimes trilobed, not enclosed by collar, test covered with angular quartz particles.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh, Meghalaya, Manipur, Nagaland, Rajasthan, Tripura and West Bengal; in freshwater ponds and lakes amongst vegetation and bottom ooze.

Remarks : This species is also reported for the first time from Andhra Pradesh. It was collected from freshwater ponds and lakes of Krishna, Prakasam, Vishakhapatnam and West Godavari districts of Andhra Pradesh during the present investigation.

20. *Diffugia pyriformis* Perty

1848. *Diffugia pyriformis* Perty, *Mitthail. Naturf. Gessells*, Bern, p. 168.

Material examined : 8 exs.

Diagnosis : Test pyriform or flask-shaped, small angular quartz crystals and mud particles encrusted on the chitinous membrane of the test; oral aperture circular.

Distribution : India : Andhra Pradesh (present report), Meghalaya, Manipur, Rajasthan, Sikkim and West Bengal; in freshwater tanks and lakes amongst bottom ooze.

Remarks : During the present investigation this species was collected from freshwater ponds of four coastal districts of Andhra Pradesh, namely, East Godavari, Nellore, Vizianagram and West Godavari. This species is reported for the first time from the state.

Family NEBELIDAE

Genus *Heliopera* Leidy

1879. *Heliopera* Leidy, *Freshwater Rhizopods of North America*, p. 162.

Diagnosis : Test variously coloured with a little foreign material at the fundus, an elliptic notch visible near oral aperture in narrow lateral view.

21. *Heleopera sphagni* Leidy

1874. *Diffugia (Nebela) sphagni* Leidy, *Proc. Acad. Nat. Sci.*, p. 157.

1876. *Nebela sphagni* Leidy, *Proc. Acad. Nat. Sci.*, p. 119.

1879. *Nebela picta* Leidy, *Freshwater Rhizopods of North America*, p. 162.

Material examined : 5 exs.

Diagnosis : Test broadly ovoid, regular in outline, compressed; chitinous membrane yellowish or brownish; test covered with irregular transparent siliceous plates, fundus sometimes with little foreign material, zoochlorellae present in protoplasm.

Distribution : India : Andhra Pradesh (present record), and in Sikkim; in *Sphagnum* and moss adjacent to water bodies.

Remarks : This species constitutes first report from Andhra Pradesh and was collected from wet moss of two coastal districts of the state during the present investigation, namely, Nellore and Prakasam. In India *H. sphagni* has so far been reported only from Sikkim from moss biotope by Penard (1907) and subsequently by Das *et al.* (2000) and also from Uttaranchal and West Bengal by Chattopadhyay and Das (2003).

Family?

Genus *Phryganella* Penard

1902. *Phryganella* Penard, *Faune Rhizopodique du basin du Lemman Kundig*, Geneve, p. 423.

Diagnosis : Test hemispherical, spheroidal and ovoid, with sand grains, minute diatom shells or other foreign elements, aperture terminal, pseudopods sharply pointed and radiating.

Remarks : This genus has been placed under the suborder Reticulolobosa by Deflandre (1959) mainly based on shape and nature of pseudopodia without assigning any family for it. This classification is followed in the present work.

22. *Phryganella acropodia* (Hertwig and Lesser)

1874. *Diffugia acropodia* Hertwig and Lesser, *Arch. Micr. Anat.*, **10**, p. 107.

1902. *Phryganella hemispherica* Penard, *Faune Rhizopodique du basin du Lemman, Kundig*, Geneve, p. 421.

1960. *Phryganella acropodia* Bonnet and Thomas, *Faune terrestre et d'eau douce*, **5**, p. 43.

Material examined : 12 exs.

Diagnosis : Test hemispherical and subhemispherical in lateral view and circular in apertural view, yellowish or brownish, covered with amorphous scales, and also with sand grains; oral aperture large without any invagination, sometimes bordered with large grains.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Manipur, Sikkim and West Bengal; in moss and also in bottom ooze of freshwater tanks.

Remarks : This species was collected from moss biotops of three coastal districts of Andhra Pradesh during the present investigation, namely, Guntur, Prakasam and Vishakhapatnam. It also constitutes first record for the state. In India this species has generally been collected from mosses (Penard, 1907, Das *et al.*, 2000 and Chattopadhyay and Das 2003). It has also been collected from freshwater tanks of West Bengal (Das *et al.*, 1993).

Class FILOSEA

Order GROMIIDA

Family EUGLYPHIDAE

Diagnosis : Test composed of siliceous scales or platelets cemented together, body hyaline, pseudopodia filiform, often branching, sometimes anastomosing.

Key to the genera

1. Aperture terminal 2
- Aperture subterminal 4

2. Test hyaline, aperture not bordered by any membrane 3
 - Test colourless or brown, aperture bordered by an irregularly denticulated membrane Genus *Assulina*
3. Test with distinct hyaline collar, denticulate or laciniate, aperture bordered by a dentate neck without scale Genus *Tracheleuglypha*
 - Test without any collar, aperture bordered by regularly arranged serrated or denticulated scale Genus *Euglypha*
4. Test ovoid formed of circular imbricated siliceous scales, aperture circular, oblique, invaginated Genus *Trinema*
 - Test ovoid or circular, formed of non-imbricated oval plates, aperture subcircular or oval, oblique Genus *Corythion*

Genus *Assulina* Ehrenberg

1871 (1872). *Assulina* (partim) Ehrenberg, *Abh. Akad. Berlin*, p. 224.

Diagnosis : Test brown or colourless, ovoid, glabrous, compressed, composed of elliptical, imbricated, siliceous scales arranged more or less regularly in diagonal rows; aperture oval, terminal, truncate or with short neck, bordered by a thin chitinous finely dentate membrane.

23. *Assulina semilunum* (Ehrenberg)

1848. *Diffugia semilunum* Ehrenberg, *Ber. Akad. Berlin*, p. 379.

1879. *Assulina semilunum* (partim) Leidy, *Freshwater Rhizopods of North America*, p. 225.

Material examined : Sev. exs.

Diagnosis : Test usually yellowish to dark brown, occasionally colourless, pyriform or ovoid in broad view, compressed, composed of imbricated, oval or elliptical siliceous scales; aperture terminal, oval, surrounded by a thin chitinous membrane with irregularly dentate or undentate margin.

Distribution : India : Andhra Pradesh (present record), Assam, Manipur, Nagaland, Sikkim and West Bengal; in *Sphagnum* and wet moss.

Remarks : This species constitutes first record for Andhra Pradesh. It was collected from wet soil and rock mosses of two coastal districts of the state, namely, Nellore and Prakasam.

Genus *Corythion* Taranek

1881. *Corythion* Taranek in *Sitzb. bohm. Ges. Wiss.*, p. 232.

1915. *Corythion* : Cash, wailes and Hopkinson, *The British Freshwater Rhizopoda and Heliozoa*, 3, p. 96.

Diagnosis : Test small, ovoid or subcircular, hyaline, compressed, formed of non-imbricated oval siliceous plates; aperture subterminal, ventral or oblique, circular or oval.

24. *Corythion dubium* Taranek

1881. *Corythion dubium* Taranek in *Sitzb. bohm. Ges. Wiss.* p. 232.

1915. *Corythion dubium* : Cash, Wailes and Hopkinson, *The British Freshwater Rhizopoda and Heliozoa*, 3, p. 96.

Material examined : 7 exs.

Diagnosis : Test ovoid, compressed unsymmetrically, aperture circular or oval, ventral, subterminal and oblique.

Distribution : India : Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh Manipur, Nagaland, Sikkim, Tripura and West Bengal; in moss.

Remarks : Naidu (1966) was the first to report this species from Andhra Pradesh from Chittoor district. During the present investigation it was collected from ground moss of three coastal districts of the state, namely, East Godavari, Nellore and Vishakhapatnam.

Genus *Euglypha* Dujardin

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

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

Diagnosis : Test hyaline, ovoid or elongated, circular or elliptical in transverse section, formed of circular or oval or scutiform siliceous plates, arranged regularly in alternate longitudinal rows, imbricated, aperture terminal, bordered by serrated or dentate scales.

Key to the species

1. Test furnished with cilia or spines 2
 - Test without any spine 3
2. Test furnished with fine needle like cilia, produced from the margins or distributed over the surface of the test, aperture bordered by 8-14 platelets with 3-5 denticulations in each *E. ciliata*
 - Some platelets of the posterior half of the test and at the base of fundus prolonged into spines, aperture bordered by one or occasionally two rows of serrated platelets
..... *E. acanthophora*
3. Aperture bordered with one or two rows of finely serrated platelets, test platelets oval, rarely circular *E. tuberculata*

- Aperture not bordered with serrated platelets 4
- 4. Apertural platelets terminated with a semicircular projection *E. rotunda*
- Apertural platelets pointed and, always shiny at their margin *E. laevis*

25. *Euglypha acanthophora* (Ehrenberg)

1842. *Diffugia acanthophora* Ehrenberg, *Abh. Acad. Berlin*, 1841 (1842), pp. 413, 414.

1849. *Euglypha acanthophora* (Ehrenberg) Perty, *Mitth. nat. Ges. Bern.*, p. 45.

Material examined : 10 exs.

Diagnosis : Test ovoidal, oral aperture bordered with one or occasionally two rows of finely dentate platelets; test platelets elliptical, some platelets at base of the test and posterior half prolonged into spines.

Distribution : India : Andhra Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and West Bengal; in freshwater tanks amongst vegetation and bottom ooze, also in submerged and wet moss.

Remarks : Naidu (1966) reported this species from Chittoor district of Andhra Pradesh. During the present investigation it was collected from three coastal districts, namely, Krishna, Vizianagram and West Godavari from freshwater tanks and wet mosses.

26. *Euglypha ciliata* (Ehrenberg)

1848. *Diffugia ciliata* Ehrenberg, *Ber. Acad. Berlin*, p. 379.

1878. *Euglypha ciliata* (Ehrenberg) Leidy, *Proc. Acad. Philad.*, p. 172.

Material examined : 20 exs.

Diagnosis : Test oviform, compressed, furnished with short needle like cilia, emerging from margin or distributed over the entire surface of the test; aperture oval, bordered by scales having 3 or 5 serrations in each.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Assam, Jammu & Kashmir, Mizoram, Sikkim, Tripura and West Bengal; in moss.

Remarks : This species is reported for the first time from Andhra Pradesh. It was collected from ground and rock mosses of four coastal districts of the state, namely, East Godavari, Guntur, Nellore and Prakasam.

27. *Euglypha laevis* (Ehrenberg)

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

1849. *Euglypha laevis* (Ehrenberg) Perty, *Minth. Nat. Ges. Bern.*, p. 163.

Material examined : Sev. exs.

Diagnosis : Test oviform, glabrous, oral aperture elliptical to subcircular, bordered by a single row of apertural platelets, pointed terminally, shiny at their margin and leaving a wider gap in between their terminal ends, test platelets oval and slightly imbricated, often displaying a scallariform pattern.

Distribution : India : Andhra Pradesh, Himachal Pradesh, Meghalaya, Tripura, Uttaranchal and West Bengal; in freshwater and in moss.

Remarks : Naidu (1966) was the first to record this species from Andhra Pradesh. He collected the species from freshwater bodies of Chittoor district of the state. During the present investigation it was collected from seven coastal districts of Andhra Pradesh, namely, East Godavari, Krishna, Prakasam, Srikakulam, Vishakhapatnam, Vizianagram and West Godavari from ground moss.

28. *Euglypha rotunda* Wailes and Penard

1911. *Euglypha rotunda* Wailes and Penard, *Proc. roy. Iris. Acad.*, **31**, p. 17.

1915. *Euglypha rotunda* : Cash, Hopkinson and Wailes, *The British Freshwater Rhizopoda and Heliozoa*, **3**, p. 31.

Material examined : Sev. exs.

Diagnosis : Test oval and without any spine, width of test about half of its length; aperture circular bordered by 8 scales, possessing one denticular projection; test platelets oval, about twice as long as broad, slightly imbricated; imbrication of test platelets displaying a hexagonal and rectangular pattern on the surface.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttaranchal and West Bengal; in moss.

Remarks : This species constitutes first record for Andhra Pradesh. It was collected from four coastal districts of the state, namely, Guntur, Nellore, Srikakulam and Vishakhapatnam from ground and rock mosses.

29. *Euglypha tuberculata* Dujardin

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

1915. *Euglypha tuberculata* : Cash, Hopkinson and Wailes, *The British Freshwater Rhizopoda and Heliozoa*, **3**, p. 13.

Material examined : 18 exs.

Diagnosis : Test elongate oviform, glabrous and not compressed, aperture circular bordered

by one or two rows of 8-12 finely serrated platelets, test platelets round or oval, imbricated, presenting a regular hexagonal design.

Distribution : India : Andhra Pradesh, (present record), Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttaranchal and West Bengal; in freshwater amongst vegetation and in bottom ooze; also in submerged and wet moss.

Remarks : This species is reported for the first time from Andhra Pradesh. It was collected from Guntur, Nellore, Prakasam, Srikakulam and Vizianagram districts of this state.

Genus *Tracheleuglypha* Deflandre

1953. *Tracheleuglypha* Deflandre, *Traite de Zoology*, 1(2), p. 133.

Diagnosis : As in the key to this genus

30. *Tracheleuglypha dentata* (Vejdowsky)

1882. *Euglypha dentata* Vejdowsky, *Thier. Org. Brunnenw.*, Prag, pp. 38-39.

1890. *Sphenoderia dentata* : Penard, *Mem. Soc. Geneve*, 31, (1), p. 185.

1953. *Tracheleuglypha dentata* (Vejdowsky) Deflandre, *Traite de zoologie*, 1(2), p. 133.

Material examined : Sev. exs.

Diagnosis : Test oval or pyriform, test platelets elliptical, imbricating, often presenting a hexagonal design; aperture bordered by transparent chitinous dentate membrane drawn out into finger-like processes.

Distribution : India : Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh Manipur, Mizoram, Nagaland, Sikkim, Tripura, Uttaranchal and West Bengal; in moss and freshwater amongst vegetation.

Remarks : Naidu (1966) was the first to report this species from freshwater bodies of Chittoor district, Andhra Pradesh. During the present investigation this species was collected from five coastal districts of the state, namely, East Godavari, Krishna, Nellore, Prakasam and Vishakhapatnam.

Genus *Trinema* Dujardin

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

1915. *Trinema* : Cash, Wailes and Hopkinson, *The British Freshwater Rhizopoda and Heliozoa*, 3, p. 85.

Diagnosis : Test small, hyaline, unsymmetrical, oviform or elongate, compressed anteriorly, covered with circular siliceous platelets; oral aperture circular, oblique or invaginated.

Key to the species

1. Test having nearly equal width in broad view with semicircular ends, in narrow side view test tapering sharply towards aperture and covered with well marked circular platelets *T. complanatum*
 - Test ovoid to elongate 2
2. Test ovoid both in broad and narrow views and covered with easily distinguishable circular platelets *T. enchelys*
 - Test elongate, small, usually homogeneous in appearance *T. lineare*

31. *Trinema complanatum* Penard

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

Material examined : 12 exs.

Diagnosis : Test small, hyaline having nearly equal width in broad view and tapering sharply towards the aperture in narrow side view; test formed of circular, imbricated silicious platelets; aperture circular, oblique, invaginated.

Distribution : India : Andhra Pradesh, (present record), Arunachal Pradesh, Himachal Pradesh, Mizoram Sikkim, Uttaranchal and West Bengal; in moss.

Remarks : This species constitutes first record from Andhra Pradesh. It was collected from mosses of East Godavari and Vishakhapatnam districts of the state.

32. *Trinema enchelys* (Ehrenberg)

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

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

Material examined : Sev. exs.

Diagnosis : Test hyaline, ovoid, compressed anteriorly, covered with siliceous circular platelets, aperture circular, subterminal, oblique, invaginated, surrounded by very minute platelets.

Distribution : Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttaranchal and West Bengal; in moss, *Sphagnum* and freshwater amongst vegetation.

Remarks : Naidu (1966) reported this species from freshwater habitats of Chittoor district of Andhra Pradesh. During the present investigation it was collected from all the nine coastal districts of the state, namely, East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam, Vishakhapatnam, Vizianagram and West Godavari.

33. *Trinema lineare* Penard

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

Material examined : Sev. exs.

Diagnosis : Test small, hyaline, elongate, smooth, composed of small circular platelets distinguishable near the edges where they may appear as minute undulations; aperture circular, oblique, invaginated.

Distribution : India : Andhra Pradesh (present record), Arunachal Pradesh, Assam, Himachal Pradesh, Sikkim, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal; in freshwater amongst vegetation and in bottom ooze; also in moss.

Remarks : This species has been reported for the first time from Andhra Pradesh. It was also collected from moss of all the nine coastal districts of the state as mentioned in preceding species.

B. Symbiotic Protozoa

Phylum	SARCOMASTIGOPHORA
Class	ZOOMASTIGOPHOREA
Order	OXYMONADIDA
Family	OXYMONODIDAE

Diagnosis : Blepharoplast two in number and located near anterior extremity of axostyle, flagella two pairs, one pair arising from each blepharoplast, flagellar cord not spiral as above.

Genus *Oxymonas* Janicki

1915. *Oxymonas* Janicki, *Zeit. Wiss. Zool.*, **112** : p. 608.

Diagnosis : Attached phase with a conspicuous rostellum, anterior end of which forming a tubular or flattened outgrowth for attachment with host's intestine, axostyle conspicuous resembling a slender stiletto, a pennant or a broad scimiter; recurvent portion of axostyle often extending backward from the holdfast into the body; predominantly uninucleate.

Key to the species

1. Axostyle slender resembling a stiletto, nucleus with a karyosome *O. bosei*
- Axostyle broad resembling a scimitar, nucleus without any karyosome *O. grandis*

34. *Oxymonas bosei* Das

1974. *Oxymonas bosei* Das, *Acta Protozool.*, **12** : p. 337.

Material examined : 2 exs.

Diagnosis : Body broadly ovoidal, dimensions 204.6 (172-236.2) μm $\times$ 38.2 (31-48.6) μm ; rostellum conspicuous, axostyle stiletto-shaped extending little below the nucleus; nucleus elliptical, karyosome large, ovoidal, almost centrally located, surrounded by a distinct halo.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh, (present record), Bihar, Nagaland and West Bengal.

Remarks : This species constitutes first record from Andhra Pradesh. It has been collected from Srikakulam district.

35. *Oxymonas grandis* Cleveland

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

Material examined : 2 exs.

Diagnosis : Body ellipsoid, often irregular, dimensions 158.3 (78.7-266.2) μm $\times$ 30.7 (18.7-45) μm ; rostellum conspicuous; axostyle resembling a scimitar in shape; recurvant portion of axostyle also conspicuous, nucleus ovoid, karyosome absent.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh from Srikakulam district.

Order TRICHOMONADIDA

Key to the families

1. Nucleus single, mastigont also single with 3 anterior flagella and a stout trailing flagellum generally adherent in part to body surface, cresta present Family DEVESCOVINIDAE
- Nucleus multiple, four flagella attached to each mastigont, trailing flagellum and cresta absent Family CALONYMPHIDAE

Family DEVESCOVINIDAE

Key to the genera

1. Trailing flagellum 1 to 1.5 times the length of the body, parabasal body spiraling around axostyle or posterior part of the nucleus $\frac{1}{2}$ turn to 5 turns Genus *Devescovina*

- Trailing flagellum exceeding twice the length of the body, parabasal body not coiled around axostyle Genus *Foaina*

Genus *Devescovina* Foa

1905. *Devescovina* Foa, *Atti R. Acad. Lincei*. Ser. 5, Scm 2, 14, p. 546.

Diagnosis : As in the key to the genera.

Key to the species

1. Trailing flagellum cord shaped (posteromedial edge of cresta longer than anteromedial) *D. glabra*
- Trailing flagellum ribbon-shaped (with broad proximal and pointed distal ends) *D. lemniscata*

36. *Devescovina glabra* Grassi

1917. *Devescovina glabra* Grassi, *Mem. R. Acad. Lincei* (5), 12, p. 54.

1941. *Devescovina glabra* : Kirby, *Univ. Calif. Publs. Zool.*, 45, p. 39.

Material examined : Sev. exs.

Diagnosis : Body elongated with pointed posterior end, 34-44.2 μm $\times$ 10.2-15.3 μm in dimensions, trailing flagellum cord-shaped, cresta varying from 5.7-6.2 μm . posteromedial edge of cresta longer than anteromedial edge; parabasal body usually turning 1-5 times around axostyle, straight or little curved with stout anterior and filamentous posterior ends.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh. It has been collected from Srikakulam, Vizianagram and Nellore districts.

37. *Devescovina lemniscata* Kirby

1926. *Devescovina lemniscata* Kirby, *Univ. Calif. Publs. Zool.*, 29, p. 103.

Material examined : Sev. exs.

Diagnosis : Body more or less pyriform with bluntly pointed posterior end, 51-71.4 μm $\times$ 11.9-22.1 μm ; in dimensions; trailing flagellum resembling a broad ribbon in its middle part; cresta measuring 11-12.7 μm with broad proximal and pointed distal ends, number of parabasal turns varying from 1-4; axostyle bent or sinuous in posterior portion of the body.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from Srikakulam and Vizianagram districts.

Genus *Foaina* Janicki

1915. *Foaina* Janicki, *Zeit. Wiss. Zool.*, **92** : p. 615.

Diagnosis : As in the key to the genera.

Key to the species

1. Parabasal body 'U' shaped bend, axostyle stout projecting out from posterior part of the body *F. reflexa*
- Parabasal body without such band, axostyle stout projecting out from posterior part of the body *F. solita*

38. *Foaina reflexa* Kirby

1942. *Foaina reflexa* Kirby, *Univ. Calif. Publs. Zool.*, **45**, p. 206.

Material examined : 4 exs.

Diagnosis : Body ovoidal, 25.5-42.5 μm $\times$ 15.5-28 μm in dimensions, anterior flagella three in number and equal to the length of the body, trailing flagellum resembling a stout cord, but occasionally band-shaped exceeding twice the body length; cresta long but narrow; part of the parabasal body near blepharoplast showing a 'U' shaped band; axostyle stout, projecting out of posterior part of the body to a short distance.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura and West Bengal.

Remarks : This species is recorded for the first time from Andhra Pradesh. It has been collected from Vizianagram and Nellore districts.

39. *Foaina solita* Kirby

1929. *Devescovina kirbyi* de Mello and de Brito (*Partim*), *Archos. Esc. med. cir.* (Nova), Goa (A), **5**, p. 699.

1942. *Foaina solita* Kirby, *Univ. Calif. Publs. Zool.*, **45**, p. 182.

Material examined : 2 exs.

Diagnosis : Small, dimensions $7.6-17\ \mu\text{m} \times 3.2-9.2\ \mu\text{m}$, anterior flagella slender, three in number and longer than the body length, trailing flagellum resembling a stout cord with a length 2-5 times the length of the body; parabasal body short and restricted to dorsal side of nucleus; axostyle moderately stout with or without enlarged cusp and projecting out from posterior part of the body.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from Vishakhapatnam district.

Genus *Stephanonympha* Janicki

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

Diagnosis : Oval but plastic, numerous nuclei spirally arranged in the anterior half; karyomastigont present; axial filament forming a bundle.

Key to the species

1. Nuclei arranged in a single spiral series *S. minuta*
 - Nuclei arranged in more than one spiral series 2
2. Nuclei arranged 2-3 spiral series *S. silvestrii*
 - Nuclei arranged in 8-9 spiral series *S. pyriformis*

40. *Stephanonympha minuta* Das and Choudhury

1972. *Stephanonympha minuta* Das and Choudhury, *Proc. Zool. Soc., Calcutta*, **25**, p. 26.

Material examined : 4 exs.

Diagnosis : Body oval with broad anterior and bluntly pointed posterior ends, $28-36\ \mu\text{m} \times 20-29.7\ \mu\text{m}$ in dimensions; nuclei oval, 6-10 in number and set closely to form a single spiral series near the anterior end of the body.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh. It has been collected from Vishakhapatnam and Nellore districts.

41. *Stephanonympha pyriformis* Das and Choudhury

1972. *Stephanonympha pyriformis* Das and Choudhury, *Proc. Zool. Soc.*, Calcutta, **25**, p. 27.

Material examined : 2 exs.

Diagnosis : Body shape pyriform with bluntly pointed posterior end, 70.2-86.7 μm $\times$ 38-47.5 μm in dimensions, nuclei ovoid or slightly elongated, numerous and embedded in series of 8-9 concentric spirals occupying almost one third portion of anterior end of the body; axial bundle running through the middle of the body and reaching almost its posterior extremity.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh from Vizianagram district.

42. *Stephanonympha silvestrii* Janicki

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

Material examined : 9 exs.

Diagnosis : Oval or rounded, 45-56.2 μm $\times$ 31.5-41.2 μm in dimensions; nuclei fusiform containing distinct chromatin granules and embedded closely in 2 or 3 spiral series occupying anterior portion of the body; axial bundle extending in the same fashion as in the preceeding species.

Host : *Cryptotermes dudleyi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from Vizianagram and Srikakulam districts.

Order HYPERMASTIGIDA

Key to the families

1. Flagella arranged in spiral rows 2
 - Flagella not arranged in spiral rows, entire body covered with flagella leaving a very small posterior region Family EUCOMONYMPHIDAE
2. Spiral rows of flagella 12-40, a mass of dense cytoplasm usually surrounding ovoid nucleus near anterior end of the body Family HOLOMASTIGOTIDAE

- Spiral rows of flagella few, arising from a common point near anterior end of the body, nucleus anchored to rostrum by a nuclear sleeve
.....Family SPIROTRICHONYMPHIDAE

Family HOLOMASTIGOTIDAE

Genus *Holomastigotoides* Grassi and Foa

1911. *Holomastigotoides* Grassi and Foa, *Rend. R. Accad. Lincei* (5), sem 1, 20, p. 279.

Diagnosis : As in the key to the genera.

Key to the species

1. Prenuclear zone present 2
 - Prenuclear absent 7
2. Posterior portion of the body glabrous 3
 - Posterior portion of the body not glabrous 4
3. Posterior one fifth of the body without any flagella *H. magnus*
 - A small portion of the body without any flagella and longer flagella occupying posteriormost portion of the body *H. bengalensis*
4. Flagella of uniform size, body exactly spherical in shape *H. spheroidalis*
 - Flagella of posterior portion of the body much longer 5
5. Longer flagella occupying the posterior fifth of the body *H. rayi*
 - Longer flagella occupying only the posterior extremity of the body 6
6. Body elliptical or club-shaped with considerable elevation at anterior end forming a nipple like structure, axostyle indistinct *H. emersoni*
 - Body reniform, axostyle short but distinct *H. reniformis*
7. Body resembling a bell jar without any apical knob, axostyle short *H. campanula*
 - Body oval, axostyle lacking *H. ovalis*

43. *Holomastigotoides bengalensis* Chakravarty and Banerjee

1956. *Holomastigotoides bengalensis* Chakravarty and Banerjee, *Proc. Zool. Soc., Calcutta*, 9, p. 36.

Material examined : 8 exs.

Diagnosis : Body more or less oval, occasionally elliptical, anterior end bluntly pointed

resembling a nipple and posterior end rounded, $67.3-105.2\ \mu\text{m} \times 41.2-70.5\ \mu\text{m}$ in dimensions; flagella of two types, shorter one covering a major portion of the body in dextrotropic manner, leaving a small glabrous portion; this portion without having any flagella; longer flagella occupying posteriormost portion of the body, axostyle well developed extending almost up to posterior extremity of the body; prenuclear zone conical and densely granulated.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Tripura, Uttar Pradesh and West Bengal.

Remarks : This species constitutes new record for Andhra Pradesh. It has been collected from Vishakhapatnam, East Godavari, West Godavari and Prakasam districts.

44. *Holomastigotoides campanula* (de Mello)

1921. *Leidyia campanula* de Mello, *Arque. Indo-Part Med. Hist. Nat.*, **1**, p. 179.

1927. *Holomastigotoides campanula* de Mello; *Trans. 7th Congr. East. Assoc. Trop. Med.*, **2**, p. 591.

Material examined : 8 exs.

Diagnosis : Body resembling exactly a bell-jar without apical knob; $42.5-69.1\ \mu\text{m} \times 56.1-73.3\ \mu\text{m}$ in dimensions; flagella of two types, shorter ones arranged all over the body in dextrotropic rows and longer ones restricted to posterior extremity of the body; axostyle short but distinct, prenuclear zone absent.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Diu, Karnataka, Nagaland, Sikkim, Tripura and West Bengal.

Remarks : This species has been collected from three coastal districts of this state, namely, Srikakulam, Vishakhapatnam and Guntur. It constitutes first report from Andhra Pradesh.

45. *Holomastigotoides emersoni* Das

1976. *Holomastigotoides emersoni* Das, *Acta Protozool.*, **15**, p. 105.

Material examined : 4 exs.

Diagnosis : Body elliptical or club-shaped, measuring $93.4\ (96.5-110.4)\ \mu\text{m} \times 38.2\ (28.9-47.6)\ \mu\text{m}$ in dimension; maximum being near posterior half of the body; anterior end of the body considerably elevated forming a nipple like structure and posterior end broadly round; flagella of two types, shorter ones covering major portion of the body dextrotropically and longer ones restricted only to posterior extremity; axostyle indistinct, dense and homogeneous prenuclear zone present.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from Vishakhapatnam, West Godavari and Krishna districts.

46. *Holomastigotoides magnus* Uttangi

1962. *Holomastigotoides magnus* Uttangi, *J. Karnatak Univ.*, 7, p. 188.

Material examined : 2 exs.

Diagnosis : Body comparatively large and ovoidal, both anterior and posterior ends broadly round, 100.3-170 μm $\times$ 74.8-102 μm in dimension; flagella of one type covering major portion of the body dextrotropically leaving a posterior glabrous region, measuring about one-fifth of the body length; axostyle fibrous and moderately developed reaching beyond the middle of the body; prenuclear zone clearly visible in stained preparation.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Nagaland, Sikkim, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from Vishakhapatnam district.

47. *Holomastigotoides ovalis* Uttangi

1962. *Holomastigotoides ovalis* Uttangi, *J. Karnatak Univ. Sci.*, 7, p. 185.

Material examined : 5 exs.

Diagnosis : Body oval, anterior end narrowly and posterior end broadly rounded, 105 μm $\times$ 68 μm in dimension; flagella longer, arranged in dextrotropic rows, covering whole of the body excepting posterior glabrous portion which bear short "steriocilia", nucleus oval, located at anterior pole of the body; prenuclear zone and axostyle absent.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Karnataka and Tripura.

Remarks : This species is reported for the first time from Andhra Pradesh. It has been collected from Vishakhapatnam, Krishna and Prakasam districts.

48. *Holomastigotoides rayi* Karandikar and Vittal

1954. *Holomastigotoides rayi* Karandikar and Vittal, *J. Univ. Bombay*, 23B, p. 18.

Material examined : 4 exs.

Diagnosis : Body oval, sometimes with apical pit; $88.4-125.8\ \mu\text{m} \times 61.2-70.5\ \mu\text{m}$ in dimension; flagella of two types, first type covering the body dextrorotically while the second type, sometimes longer, sometimes of almost equal length setting irregularly around one-fifth of the posterior region of the body; axostyle faintly visible, prenuclear zone distinct in stained preparation.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Karnataka, Nagaland, Sikkim, Tripura and West Bengal.

Remarks : This species is reported for the first time from Andhra Pradesh and collected from East Godavari, Vishakhapatnam and Guntur districts.

49. *Holomastigotoides reniformis* de Mello

1937. *Holomastigotoides reniformis* de Mello; C. R. XII Congr. Intern. Zool. Lisb., 2, p. 1373.

Material examined : 2 exs.

Diagnosis : Body reniform; $50-125.5\ \mu\text{m} \times 20.5-45.2\ \mu\text{m}$ in dimension; flagella of one type covering whole of body dextrorotically; axostyle short and reaching slightly below nucleus; prenuclear zone distinct and granular; endoplasm containing ingested wood particles.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Goa, Nagaland, Sikkim and Tripura.

Remarks : This species constitutes first record for Andhra Pradesh. It has been collected from Vizianagram district.

50. *Holomastigotoides spheroidalis* de Mello

1937. *Holomastigotoides spheroidalis* de Mello, C. R. XII Congr. Int. Zool. Lisb. 1935, 2, p. 1373.

Material examined : Sev. exs.

Diagnosis : Body spherical, $67.5-86.2\ \mu\text{m}$ in diameter; flagella of one type, covering entire body dextrorotically; nucleus circular and located very near a point at anterior end from which flagellar bands seem to diverge out; axostyle well developed, prenuclear zone distinct.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Daman, Karnataka, Nagaland, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Remarks : This species has been collected from Vishakapatnam and Guntur districts. It is reported for the first time from Andhra Pradesh.

Family SPIROTRICHONYMPHIDAE

Genus *Spirotrichonympha* Grassi and Foa

1911. *Spirotrichonympha* Grassi and Foa, *Rend. R. Acad. Lincei* (5), 20, p. 727.

Diagnosis : Body elongate, pyriform, flagella deeply embedded in cytoplasm in anterior region arising from flagellar bands, mass of dense cytoplasm conical and its base indistinct.

51. *Spirotrichonympha froilanoi* Karandikar & Vittal

1954. *Spirotrichonympha froilanoi* Karandikar & Vittal, *J. Univ. Bombay*, 23B, p. 20.

Material examined : Sev. exs.

Diagnosis : Body cone-shaped, anterior portion narrowed to a blunt end, posterior extremity broadest $20.4\text{--}42.5\ \mu\text{m} \times 11.9\text{--}27.2\ \mu\text{m}$ in dimensions; nucleus round and located near anterior third of the body; four flagellar bands originating from the centro-blepharoplast, covered by apical operculum; conspicuously long flagella spreading out from posterior surface in a brush-like manner; axostyle distinct and cord-like in postnuclear region extending obliquely towards posterior extremity and occasionally protruding out of the body.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Karnataka, Nagaland, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Remarks : This species is reported for the first time from India. It has been collected from Vishakapatnam, East Godavari, Guntur and Prakasam districts.

Family EUCOMONYMPHIDAE

Genus *Pseudotrichonympha* Grassi and Foa

1911. *Pseudotrichonympha* Grassi and Foa, *Rend. R. Accad. Lincei* Ser 5, Sem. 1, 20, p. 729.

Diagnosis : Anterior portion consisting of apical cap and campanula; campanular surface covered with three types of flagella, first type shortest and immobile, strictly confined to rostral tube, second type longest and arranged below first type in a thick circular band, third type arranged in longitudinal rows in pleiotropic manner covering rest of the body excepting short glabrous end.

Key to the species

1. Campanula anterior and medially placed 2
 - Campanula disposed obliquely one side of the median axis and distinctly subapical *P. subapicalis*
2. Body heart-shaped containing sphaerita-like microorganisms *P. cardiformis*
 - Body elongated and truncated at both ends (nucleus with scattered chromatin granules) *P. indica*

52. *Pseudotriconympha cardiformis* Karandikar & Vittal

1954. *Pseudotriconympha cardiformis* Karandikar & Vittal, *J. Unit. Bombay*, **23B**, p. 2.

Material examined : 2 exs.

Diagnosis : Body typically heart-shaped, anterior part consisting of bell-like campanula demarcated by a faintly stained circlet-like line from the rest of the body; dimensions $105\text{--}181.2\ \mu\text{m} \times 82.2\text{--}130.3\ \mu\text{m}$, campanula placed mid-apically at anterior end of the body; nucleus spherical and located generally above the middle region of the body, endoplasm with sphaerita-like microorganisms.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Karnataka, Nagaland, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Remarks : This species is recorded for the first time from Andhra Pradesh and collected from Vizianagram district.

53. *Pseudotriconympha indica* Chakravarty and Banerjee

1956. *Pseudotriconympha indica*, Chakravarty and Banerjee, *Proc. Zool. Soc. Calcutta*, **9**, p. 42.

Material examined : 7 exs.

Diagnosis : Body much elongated with its broadest part being almost near the middle; $165\text{--}221.2\ \mu\text{m} \times 22.5\text{--}52.5\ \mu\text{m}$ in dimensions; campanular region very short in comparison to body length; campanula located mid-apically at anterior end; nucleus more or less round located near middle of body (rarely near posterior region) containing scattered chromatin granules.

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Bihar, Nagaland, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Remarks : This species constitutes first record from Nagaland. It has been collected from Vishakhapatnam, East Godavari and Krishna districts.

54. *Pseudotrichonympha subapicalis* Karandikar & Vittal

1954. *Pseudotrichonympha subapicalis* Karandikar & Vittal, *J. Univ. Bombay*, **23B**, p. 8.

Material examined : Sev. exs.

Diagnosis : Body generally rounded, swollen anteriorly and narrowed posteriorly to a blunt end; 172.5-205 μm $\times$ 82.5-90 μm in dimensions; campanula disposed obliquely one side of the median axis and distinctly subapical; nucleus spherical, located at the anterior region of the body (occasionally in the middle).

Host : *Coptotermes heimi*; location : gut.

Distribution : India : Andhra Pradesh (present record), Karnataka, Nagaland, Sikkim, Tripura, and West Bengal.

Remarks : This species has been collected from five coastal districts of Andhra Pradesh, namely, Vishakhapatnam, East Godavari, West Godavari, Krishna and Prakasam. It is reported for the first time from the state.

B. TESTACIDS OF NONCOASTAL DISTRICTS

In recent years ZSI Scientists collected 29 species of testacids from eight noncoastal districts of Andhra Pradesh as mentioned earlier. Moreover, Naidu (1966) reported the occurrence of 26 species of testacids from the two noncoastal districts of the state, namely, Cuddapah and Chittoor (Table 1) which were not surveyed by ZSI for freeliving protozoa. A systematic list of all these species and their district-wise distribution is presented in Table 3 to enlighten their taxonomic diversity and extent of distribution in different districts of the state. However, taxonomic account of the species collected by ZSI from noncoastal districts is not dealt with as done for the species of coastal districts to avoid repetition.

GENERAL REMARKS ON TAXONOMIC DIVERSITY AND DISTRIBUTION

Analysis of Table 1 and 2 reveals that 58 species of testacid rhizopods have been collected so far from Andhra Pradesh. These tables also show that seven species of testacids collected from the coastal districts of Andhra Pradesh, namely, *Arcella conica*, *Centropyxis minuta*, *Plagiopyxis minuta*, *Diffugia corona*, *Diffugia pyriformis*, *Assulina semilunum* and *Trinema complanatum* and, one ecological variety, *Centropyxis aerophila* var. *sphagnicola* have not been found so far from the noncoastal districts. On the other hand, 22 species of testacids found in noncoastal districts are yet to be recorded from the coastal districts. These species are : *Arcella gibbosa*, *Arcella hemispherica*, *Arcella papyracea*, *Arcella rotunda*, *Lesquereusia*

minor, *Lesquereusia modesta*, *Lesquereusia spiralis*, *Diplochlamys timida*, *Centropyxis cassis*, *Cyclopyxis eurystoma*, *Plagiopyxis declivis*, *Diffugia amphora*, *Diffugia carinata*, *Diffugia difficilis*, *Diffugia globulosa*, *Diffugia gramen*, *Diffugia kabylica*, *Diffugia leidy*, *Diffugia oblonga*, *Diffugia penardi*, *Diffugia tuberculata* and *Nebela collaris*.

Amongst freeliving protozoa only testacid rhizopods were collected from these districts during the recent surveys leaving aside other rhizopods and diversified groups of flagellates and ciliates. So far as symbiotic protozoa are concerned, only two species of termite hosts, *Cryptotermes dudleyi* and *Coptotermes heimi* were examined from the coastal districts only and 21 species of symbiotic flagellates have been recovered from those hosts. No symbiotic protozoa were collected from noncoastal districts. Therefore, it is quite evident that large number of protozoan species are yet to be collected from the study area for properly assessing the taxonomic diversity and richness of freeliving and symbiotic protozoa of the state.

SUMMARY

A total of 79 species of freeliving and symbiotic protozoa from 9 coastal and 10 noncoastal have been dealt with in this paper. Freeliving protozoa include 58 species of testacid rhizopods belonging to 2 classes 2 orders, 7 families and 15 genera. From coastal districts 33 species and noncoastal districts 47 species of testacids have been recorded.

Symbiotic flagellates were collected from the gut of two species of wood-eating termites, namely, *Cryptotermes dudleyi* and *Coptotermes heimi*. These flagellates comprise of 21 species collected from the coastal districts only belonging to 3 orders, 6 families and 7 genera. All the symbiotic flagellates constitute first record for Andhra Pradesh.

ACKNOWLEDGEMENT

The authors are grateful to Dr. J.R.B. Alfred, Director, Zoological Survey of India for extending necessary facilities for this work.

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Table 1 : List of testacid species reported by Naidu (1966) from Andhra Pradesh
 (*species not reported from coastal districts; hence, their taxonomic account not dealt with in this paper)

Sl. No.	Name of the species	Collecting district
1.	<i>Arcella conica</i> (Playfair	Krishna (coastal district)
2.	* <i>Arcella gibbosa</i> Penard	Chittoor
3.	* <i>Arcella hemispherica</i> Perty	Cuddapah
4.	* <i>Arcella papyracea</i> Playfair	Chittoor
5.	* <i>Arcella rotunda</i> Playfair	Chittoor
6.	<i>Centropyxis aculeata</i> (Ehrenberg)	Chittoor
7.	* <i>Centropyxis cassis</i> (Wallich)	Chittoor
8.	<i>Centropyxis orbicularis</i> Defflandre	Chittoor
9.	<i>Centropyxis platystoma</i> (Penard)	Chittoor
10.	<i>Diffugia acuminata</i> Ehrenberg	Chittoor
11.	* <i>Diffugia amphora</i> Leidy	Chittoor
12.	* <i>Diffugia carinata</i> Van Oye	Chittoor
13.	* <i>Diffugia difficilis</i> Thomas	Chittoor
14.	* <i>Diffugia globulosa</i> Dujardin	Chittoor
15.	* <i>Diffugia gramen</i> Penard	Chittoor
16.	* <i>Diffugia kabylica</i> Gauthier-Lievre & Thomas	Chittoor
17.	* <i>Diffugia leidy</i> Wailes	Chittoor
18.	* <i>Diffugia oblonga</i> Ehrenberg	Chittoor
19.	* <i>Diffugia penardi</i> (Penard)	Chittoor
20.	* <i>Lesquereusia minor</i> Walton	Chittoor
21.	* <i>Lesquereusia spiralis</i> (Ehrenberg)	Chittoor
22.	* <i>Nebela collaris</i> (Ehrenberg)	Chittoor
23.	<i>Corythion dubium</i> Taranek	Chittoor
24.	<i>Euglypha acanthophora</i> (Ehrenberg)	Chittoor
25.	<i>Euglypha laevis</i> (Ehrenberg)	Chittoor
26.	<i>Tracheleuglypha dentata</i> (Vejdovsky)	Chittoor
27.	<i>Trinema enchelys</i> (Ehrenberg)	Chittoor

Table 2 : District-wise distribution of Protozoan species in coastal districts of Andhra Pradesh. (Sri : Srikakulam; Vizi : Vizianagram; Vish. : Vishakhapatnam; Egod : East Godavari; Wgod : West Godavari; Kri : Krishna; Gun : Guntur; Prak : Prakasam; Nell : Nellore)

[illegible]

Table 2. Contd.

Species	Districts								
	Sri	Vizi	Vish	Egod	Wgod	Kri	Gun	Prak	Nell
28. <i>Euglypha rotunda</i>	+		+				+		+
29. <i>Euglypha tuberculata</i>	+						+	+	+
30. <i>Tracheleuglypha dentata</i>			+	+		+		+	+
31. <i>Trinema complanatum</i>			+	+					
32. <i>Trinema enchelys</i>	+	+	+	+	+	+	+	+	+
33. <i>Trinema lineare</i>	+	+	+	+	+	+	+	+	+
B. Symbiotic Protozoa									
34. <i>Oxymonas bosei</i>	+								
35. <i>Oxymonas grandis</i>	+								
36. <i>Devescovina glabra</i>	+	+							+
37. <i>Devescovina lemniscata</i>	+	+							
38. <i>Foaina reflexa</i>		+							+
39. <i>Foaina solita</i>			+						
40. <i>Stephanonympha minuta</i>			+						+
41. <i>Stephanonympha pyriformis</i>		+							
42. <i>Stephanonympha sylvestri</i>	+	+							
43. <i>Holomastigotoides bengalensis</i>			+	+	+			+	
44. <i>Holomastigotoides campanula</i>	+		+					+	
45. <i>Holomastigotoides emersoni</i>			+		+	+			
46. <i>Holomastigotoides magnus</i>			+						
47. <i>Holomastigotoides ovalis</i>			+			+		+	
48. <i>Holomastigotoides rayi</i>			+	+			+		
49. <i>Holomastigotoides reniformis</i>		+							
50. <i>Holomastigotoides spheroidalis</i>			+				+		
51. <i>Spirotrichonympha froilanoi</i>			+	+			+	+	
52. <i>Pseudotrichonympha cardiformis</i>		+							
53. <i>Pseudotrichonympha indica</i>			+	+		+			
54. <i>Pseudotrichonympha subapicalis</i>			+	+	+	+		+	

(War : Warangal; Niz : Nizamabad; Ran : Rangareddi; Nal : Nalgonda; Kar : Karimnagar; Adi : Adilabad; Med : Medak; Kha : Khammam; Cud : Cuddapah; Chi : Chittoor; * : recorded by Naidu (1966); ** : not collected by ZSI)

[illegible]

Table 3. Contd.[illegible]