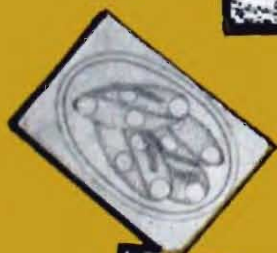
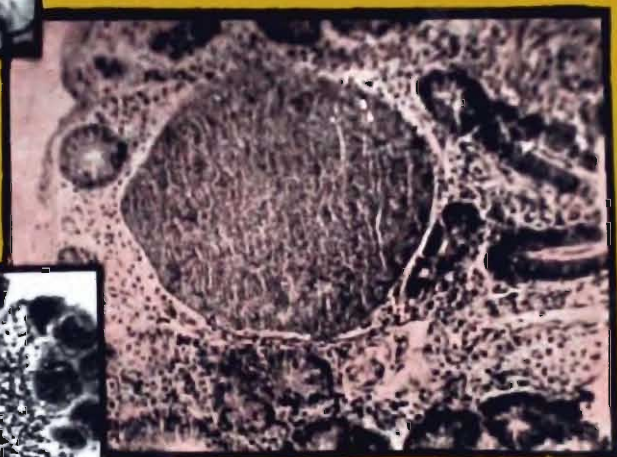


Fauna of India

PROTOZOA
EIMERIIDAE



By
A. K. MANDAL

In this book the author has included 277 species spread over 11 genera of the Family Eimeriidae and made an attempt to provide the upto date information keeping in mind the consequent changes in the concept of taxonomy of the group due to electromicroscopic studies. Apart from the taxonomic treatment provided herein, special attention has been paid as these parasites are of veterinary importance and as such a chapter on Eimeriids of poultry and farm animals of India has been added along with a discussion on host-parasite relationship.

The host-parasite index and *vice versa* as appended at the end has become the special attraction to the workers dealing with the group. The glossary of the technical terms used has been added as additional information which are very much useful to the beginners.

FAUNA OF INDIA
AND
THE ADJACENT COUNTRIES

PROTOZOA
SPOROZOA . EUCOCCIDIIDA
EIMERIIDAE

By
A. K. MANDAL
ZOOLOGICAL SURVEY OF INDIA
CALCUTTA-700 053



Edited by the Director, Zoological Survey of India
1987

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Published : July, 1987

PRICE :	Inland :	Rs.	240·00
	Foreign :	£	26·00
		\$	40·00

PRINTED IN INDIA BY SRI AUROBINDO PRESS, 16 HEMENDRA SEN
STREET, CALCUTTA-700 006 ; PRODUCED BY THE PUBLICATION
DIVISION AND PUBLISHED BY THE DIRECTOR, ZOOLOGICAL
SURVEY OF INDIA, CALCUTTA-700 020

EDITOR'S PREFACE

Since the publication of the Fauna of British India, Protozoa : Sporozoa written by Bhatia (1936), in which the present family Eimeriidae was included, a considerable amount of work has been done on this group. With the advancement of knowledge, specially due to electron microscopic studies, taxonomic concepts of these parasites have considerably changed. While Bhatia (1936) could include 6 genera and 33 species of Eimeriidae in his fauna, the present volume deals with 11 genera and 277 species of this family, most of which have been available to the author for study as a part of his own collection of three decads or collection of different experts of the field, lying in different Universities and Institutions.

It is now worth while to write a separate fauna of the family Eimeriidae alone not only due to addition of many more species from this country and considerable change in taxonomic concepts but also due to immense veterinary importance of this group as a causative agent of the disease 'Coccidiosis'. Keeping this in mind the author, apart from taxonomic dealings of the group has given special emphasis to deal with the Eimeriids of poultry and farm animals of India in a separate chapter of the volume. This will be very much useful for the veterinarians and medical personnel as well as for those who intend to work in this particular field.

In the present volume the author has covered upto date information on the group and given adequate weightage to the ultrastructural observations to cope up with the recent taxonomic concepts of these parasites. He has also made critical taxonomic assessment of each species wherever necessary. It is hoped that this book will provide a handy tool not only to the specialists and research workers but also to the veterinarians and academicians for multifaceted studies of this group.

6th July, 1987
Zoological Survey of India
Calcutta-700 020

B. S. LAMBA
Acting Director

AUTHOR'S PREFACE

When I began writing the Fauna of India on the family Eimeriidae of the Indian subcontinent, three monumental works on Sporozoa were already available. One was by Bhatia, 'The Fauna of British India', Protozoa : Sporozoa (1938), the second, a classical book by Pellerdy on 'Coccidia and Coccidiosis' (first edition, 1965), and the third was 'The Coccidian Parasites of Rodents' by Levine and Ivens (1965). My own work on 'Coccidia of Indian Vertebrates' was ready by 1967, but it came out only in 1976.

More than three decades have elapsed since Bhatia's work was published, and in the meantime about 200 species and additional information have been added to this family from the Indian subcontinent. Pellerdy's (1965) book appeared to have omitted a number of eimeriids occurring in the Indian Region, and in Levine and Ivens' monograph on the Coccidia of Rodents only two species then known from India were included. Mandal's work on the Coccidia of Indian Vertebrates dealt with 92 species examined by him and a few by others, covering 125 species in all.

When a substantial part of the present work was already completed another monumental work, 'The Coccidian Parasites of Ruminants' by Levine and Ivens (1970) was published. Subsequently the thoroughly revised edition of Pellerdy's book came out in 1974. Though these classical works were matchless in covering the Coccidian parasites of the world, yet both these publications were restricted in their contents and scope. Meanwhile, a monograph on 'The Coccidia and Coccidiosis of Poultry and Farm animals of India', covering over over 54 species of veterinary importance was published by me in 1980.

All the previous publications were devoted to particular fields of interests with specific application due to which the details in many cases were either entirely lacking or incomplete, and since some new taxa have been added to this family it was decided to complete the present work.

The end-product of my labour in this volume provides an up to date and comprehensive account of each species of Indian eimeriid known so far, occurring in different group of hosts and their inter-relationship.

In addition, a critical assessment of the taxonomy of this group along with a key to each taxon has been provided. I hope this book

will be useful to all working in this field. Every endeavour has been made to keep the text as succinct as possible. However, constructive criticism will be highly appreciated.

I express my indebtedness to Dr. B. K. Tikader, former Director, Zoological Survey of India, for being kind enough to entrust me with the stupendous task of writing the fauna volume. But for his constant persuasion, encouragement and ever extended facilities to me this work would not have been completed.

My thanks are due to Dr. B. Dasgupta, Principal, Darjeeling Government College, Darjeeling, West Bengal and Dr. A. Choudhury, Professor of Zoology, Calcutta University for many helpful suggestions.

Dr. T. N. Ghosh, Professor of Protozoology, School of Tropical Medicine, Calcutta, in spite of his preoccupation, gave many patient hearings and wise counsels, which I sought on innumerable occasions at various stages of completion.

I am thankful to Dr. S. S. Ahluwalia, Professor of Parasitology, Dr. P. P. S. Chauhan, Research Officer, Mathura Veterinary College, Mathura, United Province and Dr. B. B. Bhatia, Professor of Parasitology Pant Nagar University, United Province for their kind help in number of ways and liberally agreed to incorporate some of their published photographs in this book.

Some publishers, duly cited in the text, have given their kind consent to reproduce few photographs/diagrams in this volume, I am also thankful to them.

Dr. B. S. Gill, Punjab Agricultural University, Ludhiana, Dr. C. C. N. Murthi, Professor of Zoology, Andhra University, Waltair, Andhra Pradesh and R. Krishnamurthy, Reader in Zoology, Marathwada University, Aurangabad, Maharashtra provided the relevant literature and materials at my disposal during the preparation of this work, my sincere thanks are due to all of them.

I express my deep sense of gratitude to Dr. N. D. Levine, College of Veterinary Medicine, University of Illinois, Urbana, U. S. A. for his help whenever approached and to Dr. B. Biswas, Emeritus Scientist, Zoological Survey of India, for many valuable suggestions.

My grateful thanks are due to my colleagues Dr. A. K. Das, for going through the manuscript and offering many useful suggestions,

Dr. A. Bhattacharjee and Sri K. N. Nair for their keen interest in my work, Sri P. K. Das, Sri R. K. Ghosh and Sri S. S. Saha for identifying the hosts.

My thanks are also due to Dr. A. K. Ghosh, Deputy Director, Zoological Survey of India for his kind help in finalising this work.

Lastly, I would like to thank Sri N. C. Sarkar of this department who assisted me in a number of ways, Sri Sitaram Mandal, Artist for drawing the diagrams of this volume and Sri F. N. Murmu and also Sri Ranajit Banerjee, L. D. C., for painstakingly typing the manuscript.

A. K. MANDAL

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II. INTRODUCTION

The members of the family Eimeriidae are known to a very large number of protozoologists, veterinarians and medical men, as they are one of the causative agents of a dreadful disease, coccidiosis, in poultry, cattle, sheep and goats. Investigations on these parasites were started in the Indian subcontinent in the early part of the twentieth century. Many new forms have been discovered and some new information have been added on the old ones, particularly those occurring in vertebrate hosts of economic importance (Mandal, 1980).

In total, more than 250 species are known so far from the Indian subcontinent, including Nepal, Sikkim, Bhutan, Bangladesh, Pakistan and Sri Lanka.

While reviewing each species, the morphology of the oocyst has been given in the beginning followed by the type host and type locality along with the developmental stages wherever available. Generally the original morphological description of each species has been retained as such with slight modifications in the terminology to bring uniformity, except for 92 species which have been redescribed by the present author earlier.

Synonymies have been given under each species along with the references for all the records from the Indian subcontinent. The localities of the species described from Zoo specimens have been given at the location of the Zoos unless the actual locality of the host is known.

A basic pattern of life-cycle, a general historical review, phylogeny of the family Eimeriidae and its systematic position have been given separately. In the systematic account, the various taxonomic categories have been defined from family to generic level and under each genus, the parasites have been dealt with host-groupwise e.g. fish, amphibian, reptile, bird and mammal. A key to the species has been given according to the group of host in which they occur. The generic key has also been provided.

Almost equal importance has been given to the parasites of systematically lower orders of animals in relation to the higher groups like the birds and mammals of economic importance. However, a chapter dealing with the eimeriids of poultry and domestic livestock has been added to cover mostly the veterinary aspects of those parasites. A host-parasite index and a parasite-host index have also been appended.

With the advancement of knowledge due to electron microscopy, the systematics of Coccidia, particularly of the family Eimeriidae, appears

to have become somewhat confusing. Even the group like *Toxoplasma* has extended its arm to enter into this family. However, the group of parasites dealt with here is the Coccidian parasites where the male and female gametes are dissimilar and their development takes place independently, and the male gametocyte produces many microgametes.

III. HISTORICAL REVIEW

The Eimeriids have been considered as a subject of active investigation mainly because they produce a dreadful disease coccidiosis which leads to heavy loss in the poultry, cattle, sheep and goats. They belong to the order Eucoccidiida with 3 suborders Adelina, Eimeriina and Haemosporina. The parasites belonging to the family Eimeriidae comes under suborder Eimeriina. A large number of species have so far been described since after the first one was seen by Leeuwenhock in 1674. Hake (1839) published the earliest account of a coccidian oocyst of *Eimeria stiedai* from rabbit's liver, but did not interpret it as of parasitic origin. Kloss (1855) described an organism now regarded as *Klossia helicina* from the renal organ of the snail. Eimer (1870) made important investigations on the parasites of the gut and the liver of various animals including man, which have been referred to the genera *Eimeria* and *Isospora* by many successive workers. However, many contributions have been made by different authors from abroad of which monumental works of Dobell (1922a, b), Becker (1934, 1956), Levine (1963, 1974), Horton-Smith and Long (1963), Levine and Ivens (1965a, 1970), Todd and Hammond (1971), Cheissin (1972) Hammond and Long (1973) and Pellerdy (1974) Svanbeav (1977) are worthy to mention.

This study was undertaken in this country by the end of the last century. Since then India has been the field of active investigation of many workers resulting the description or reports of 9 genera of the family Eimeriidae out of total 15 genera known so far with nearly 250 species.

In India, only one species of this family has been reported from an invertebrate host (Narashimamurti, 1976), but a considerable amount of work has been done on the parasites of vertebrate hosts and it will be convenient to review the work by dealing with the various groups one by one.

PISCES

The presence of eimeriids in Indian fishes was noted for the first time by Halawani (1930a, b) who described a species of *Eimeria* from the

devil fish, *Aetobatis narinari*. Satna and Bana (1935a) observed *E. harpodoni* in the Bombay duck. A species of *Eimeria* was also described by Chakrabarty and Kar (1944c) after obtaining the specimen from *Notopterus notopterus*. Mandal and Chakrabarty (1965) recorded *E. zygaenae* from a hammer-headed shark collected from Digha, West Bengal. Patnaik and Acharjya (1972) described a species of *Eimeria* from *Barbus ambassis*.

AMPHIBIA

Ray (1935) and Ray and Dasgupta (1935b) described two species of this parasite from the common Indian toad, *Bufo melanostictus*. Ray and Misra (1942) recorded a species of *Eimeria* from Himalayan toad. Two more species of coccidia were also recovered by Chakravarty and Kar (1944d, 1952) from toads and frogs.

REPTILIA

Setna and Bana (1935b), described a species of *Eimeria* from a lizard. Subsequently, Knowles and Dasgupta (1935), Ray and Dasgupta (1935c) and Bhatia (1936, 1938) described a few more species. The work on ophidian coccidia in India was initiated by Mitra and Dasgupta (1937a) who reported a species of *Isospora* from an Indian Cobra. Ray and Dasgupta (1936a, b ; 1937b, d) described two species of *Eimeria* from the snake and a genus *Pythonella* from an Indian Python. Some species of parasites were described by Dasgupta (1938a, b) and Chakravarty and Kar (1943) from turtles and tortoises. Ray and Raghavachari (1942) described the genus *Octosporella* and Ray, Raghavachari and Sapre (1942) described a species of *Eimeria* from a lizard, *Mabuia* sp. A report on the occurrence of *Caryospora gekkonis* from a wall lizard was made by Chakravarty and Kar (1947b). The presence of *Isospora dirumpens* from a snake, *Natrix platyceps* was also noted by Ray and Singh (1948). While working at Shillong, Mandal (1966b) described *Isospora rayi* from a lizard *Ptyctolimus* sp. and Mandal and Nair (1973a) recorded a species of *Eimeria* from another lizard of the Andaman Islands. While working at Mathura, Bhatia and Chauhan (1972) described a species of *Eimeria* from *Varanus monitor*.

AVES

In India a considerable amount of work has been done on avian eimeriids. Mitra and Dasgupta (1937b) described a species of *Eimeria* from the pigeon and Naik (1937) observed coccidiosis in the crow.

Kar (1944a) reported *E. barbata* from the blue-throated barbet. Chakravarty and Kar (1944a, b) described a number of these parasites from avian hosts. A species of *Tyzzeria* was recorded from the cotton teal by Chakravarty and Basu (1947). Observations on coccidia and coccidiosis of domestic fowl were made by a number of workers like Ray (1945a), Gill (1954a, c and 1955), Gill and Ray (1957), Nath *et al.* (1960) and Bhatia and Pande (1968a, b, c).

The coccidian parasites of hill birds were studied by Ray (1952a) and Ray *et al.* (1952a, b). Some birds from Alipore Zoological Garden were examined by Ray and Hiregaudar (1959), who described some species of coccidia. Malhotra and Ray (1961) and Chatterjee and Ray (1969) recorded a few parasites from the domestic pigeon of Calcutta. Coccidia and coccidiosis of domestic ducks were also studied by a number of workers like Dubey and Pande (1963b and d), Pande and Bhatia and Srivastava (1965), Sarkar and Ray (1968) and Bhatia (1968b).

A species of *Dorisiella* (= *Dorisa*) was described by Mandal and Chakravarty (1963) from Indian tree pie. This genus is now treated as the genus *Dorisa*. As Levine (1980) has erected the genus *Dorisa* for the genus *Dorisiella* occurring in vertebrates due to the possession of definite oocystic wall. Mandal and Chakravarty (1964) recorded some avian coccidia belonging to the genus *Isospora*. Mandal (1965a) described five species of *Eimeria* with a sub-species of *E. roscoviensis* from avian hosts. Banik and Ray (1961, 1964) described *E. pavonina* and *E. mandali* from Indian peacock. *E. cristata* and *E. pavonina* were also described by Patnaik (1965b) from Indian peacock which were synonymised with *E. pavonis* Mandal (1965), and *E. patnaiki* Ray (1966) respectively. Bhatia and Pande (1966c) described *E. mayauri* from the peacock. The same authors (1968d) experimentally inoculated it into baby pea fowl and found it to be pathogenic. In 1962 Banik and Ray described a species of *Isospora* from a crane. Bhatia, Pandey and Pande (1966) reported *E. teetari* from Indian partridges. Bhatia and Pande (1965, 1966b and 1967c) recovered some avian coccidia after examining the hosts from Mathura. Ray and Sarkar (1967a, b, 1968) described some species of coccidia, including *Dorisiella chakravartyi* and *D. mandali* (= *Dorisa chakravartyi* and *Dorisa mandali*) and a genus *Sivatoshella* from some passerine birds. Turkey coccidia have been studied in India by Gill (1954b) and Bhatia (1968a). The latter (1971a) discussed some problems of poultry coccidiosis in India. Pande, Bhatia, Chauhan and Garg (1970) reported some avian and mammalian coccidia from the Lucknow Zoo. Mandal (1971) elucidated the occurrence and distribution of avian coccidia. Bhatia, Chauhan, Arora and Agarwal

(1972) observed some species from the Delhi Zoo and the same authors (1973) discussed the species in mammals and birds of both these zoological gardens.

MAMMALIA

The mammalian coccidia were not studied in India until Cooper (1924) reported bovine coccidiosis. The same author (1926a, b and 1927) along with Gulati (1926), Naik (1927) and Sen (1932) contributed much in the field. Knowles and Dasgupta (1931, 1934) reported coccidial infection in the mongoose and domestic cat. Ray and Dasgupta (1935a, 1937a) described a species of *Wenyonella* from an Indian squirrel. Aiyar (1937a, b) reported coccidiosis in the domestic dog. Dasgupta (1934) and Mukherjee (1948) observed human coccidiosis. Kar (1943) reported coccidian parasites from goats and Ray (1952b, 1961) from sheep and goats. Coccidia and coccidiosis of sheep and goats were described in detail by Shah (1963 and 1965) and Shah and Joshi (1963). Biswal (1948) ranked coccidiosis first among epizootics of buffalo. A detailed account of bovine coccidiosis was given by Rao (1952), Rao and Hiregaudar (1954a), Hiregaudar (1956a), (equine coccidia, 1956b) Rao and Bhatawadaker (1959), Gill (1960a, 1968), Ray and Mandal (1961), Gill, Chhabra and Lall (1963), Patnaik (1965c) and Patnaik and Pande (1965a), Bhatia (1971b), Bhatia and Pande (1967b), Pande *et al.* (1968), Bhatia *et al.* (1968, 1971) and Pande *et al.* (1971). Coccidiosis in domestic ruminants in India was discussed by Pande *et al.* (1968, 1971) and considered one of the major problems. The coccidian parasites of the domestic pig in India was reported for the first time by Ahluwalia (1959) and reviewed by Gill (1960b), Mishra (1967a, b) and Srivastava and Shah (1968). Contributions to the knowledge of carnivore coccidia were made by Mandal and Ray (1960), Dubey (1963a, b), Dubey and Pande (1963a and c), Ray and Banik (1965c), Mukherjee and Krassner (1965), Patnaik and Ray (1965). Some species of coccidian parasites from Indian camels were described by Dubey and Pande (1963c, and 1964a). The coccidia of lagomorphs were studied by Kar (1947, 1949) and Gill and Ray (1960) and of rodents by Ray and Singh (1949, 1950), and Ray, Banik and Mukherjee (1965). Coccidia of bats remain unexplored in India until the work of Mandal and Nair (1973b), who described a species of *Eimeria* from a bat, *Taphozous melanopogon*. A species of *Eimeria* from the Indian black buck, *Antelope cervicapra* was described by Pande *et al.* (1972). Mandal and Nair (1974) found *E. wassilewskyi* Rastegaieff in the spotted deer of the Andaman Islands.

IV. GENERAL MORPHOLOGY AND ULTRASTRUCTURE

Morphology : A brief account on the general organisation and structure of the organisms belonging to the family Eimeriidae is given below. This will give a general idea of the group and explain the technical terms used in describing them.

All the members of this family are obligatory parasites. The transfer of parasites from one host to another is effected by means of oocysts (Fig. 1) which may exist independently and can be defined as

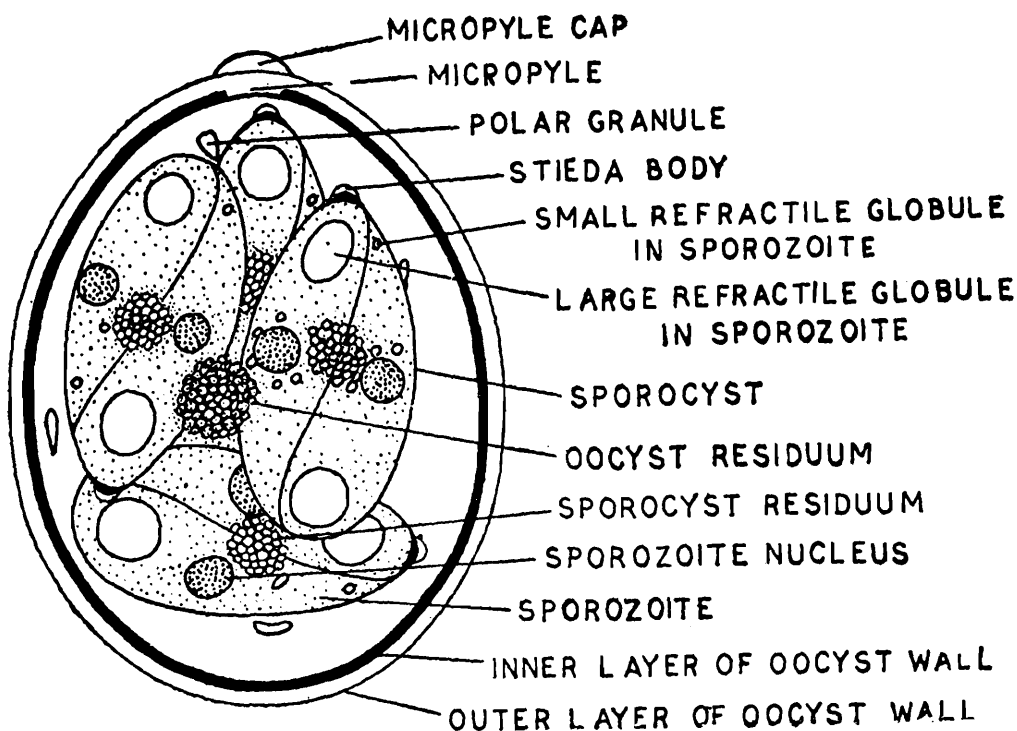


Fig. 1. A typical sporulated *Eimeria* oocyst.

resistant seed-like bodies protected by a capsule containing one or more sporocysts or sporozoites inside. The oocysts are charged with overcoming the difficulties outside until they enter again into the body of another suitable host. Once the oocyst gets entrance into the body of the new host, the sporozoites are liberated and initiate the infection. The method of infection is contaminative.

The food materials which these organisms take from the host may be present in dissolved cytoplasm, tissue fluid, body fluid or in the digested food material from the alimentary canal of the host. The intracellular forms appear to ingest material from the parasitophorous vacuole by pinocytosis.

This family has representatives in almost every group of animals.

Some of them are not pathogenic, while others may cause more or less pathogenic symptoms or even death.

In the life-cycle (Fig. 2) of the members of the family Eimeriidae, the starting point may be considered as *sporozoite* which has a sickle-

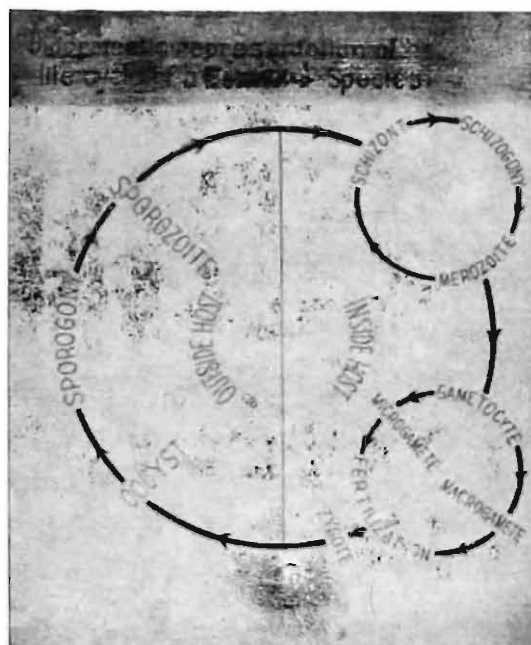


Fig. 2. Diagrammatic representation of the life-cycle of an *Eimeriid* species

shaped or fusiform body. After being set free in the body of the new host the sporozoites nourish themselves and grow at the expense of the host. This is the trophic phase and the organism during this phase is described as the trophozoite; it absorbs nourishment in the fluid state. There is evidence that the host cell cytoplasm may be ingested through the cytostome of the trophozoite. Sometimes the food vacuole is surrounded by a unit membrane frequently located near the cytostome. The trophozoite is known as a *schizont* when it is about to reproduce asexually. Such divisionary process is termed *schizogony* and the products of division are called *merozoites*. Some of the merozoites become *gametocytes*, differentiate into *macro* and *microgametocytes* which ultimately give rise to *macro* and *microgametes* respectively. This process is called *gametogony*. The sexual reproduction initiates with the union of anisogametes. The fusion of two gametes results in the formation of a *zygote*, which secretes a distinct membrane around itself, becoming a passive spherical body known as *oocyst* which is the resistant stage, and can survive for a long period outside the host and is regarded as the transmissive phase. Cellular division of

the protoplasm within the oocyst gives rise to the formation of number of *sporoblasts* each of which becomes a *sporocyst*. The sporocyst develops a small or large number of minute germs or *sporozoites* within it. The sporozoites are infective bodies and start the cycle again. During *excystation*, the *Steida body* of the sporocyst disappears in some cases or sometimes a portion of it remains. The sporozoite becomes active and leaves cyst after the removal of the *substeidal* body.

Ultrastructure :

Sporozoites (Fig. 3) of the members of the family Eimeriidae are fusiform and situated within a parasitophorous vacuole which is formed after their entry into the host cells. Ultrastructural study reveals that they are surrounded by a pellicular complex consisting of an outer membrane or plasmalemma, inner membrane complex and a row of sub-pellicular microtubules. The outer membrane is about 90°A in thickness while the inner membrane complex is 150°A thick. In many parasites this complex appears as two membranes in close apposition. Varying numbers of microtubules radiate from the most distal polar ring and extend posteriorly as far the nucleus.

Usually near the anterior end of the nucleus there is a cytostome which may be functional as in *Eimeria ninakohlyakimovae*. The anterior end of the sporozoite is nipple-like and demarcated by two electron-dense polar rings. There is a hollow, truncated cone-shaped structure within the anterior end of the sporozoite. This is termed as conoid, the wall of which consists of spirally arranged fibrillar structures. In addition to these, rhoptries are present in the anterior region and micronemes are found in the anterior and middle portions of the sporozoites. Rhoptries are generally two in number among the species of *Eimeria* while micronemes are numerous.

Merozoites of the Eimeriidae have the same shape and location as the sporozoites. They are generally smaller. But ultrastructurally, merozoites closely resemble sporozoites excepting for some minor points. For example, (i) in merozoites some of the microtubules reach to the posterior end of the parasite and (ii) the merozoites of some Coccidia (viz. *E. dinophili*, *E. bovis* and *E. stiedai*) have only one polar ring in each.

The gametocytes of eimeriids are also found within a parasitophorous vacuole. They are surrounded by a membrane originating from the host cell. The pellicle of the gametocyte of *Eimeria* usually consists of two membranes excepting in a few species in which it appears as a single

membrane. The outer membrane is termed plasmalemma. The inner membrane appears to be composed of two closely apposed unit membranes excepting in some species in which it appears to be interrupted.

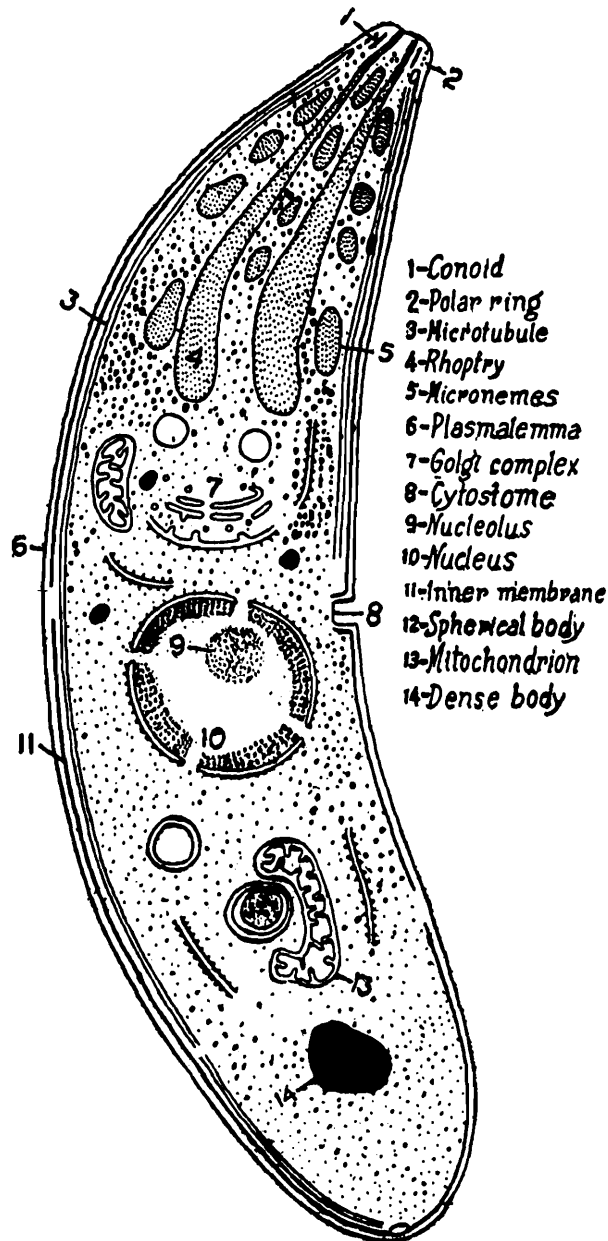


Fig. 3. Schematic diagram of Sporozoite / merozoite of an Eimeriid observed under EM

In the macrogametocytes of some *Eimeria* species there are some intravacuolar tubules extending from the pellicle to the membrane of the parasitophorous vacuole. Some workers think that these vacuoles help in the transportation of material between the parasite and the host-cell. Few cytosomes are also present along the pellicles of the gametocytes.

There are many wall-forming bodies in macrogametocyte which help in the formation of the oocyst wall. These bodies are of two

types, one is homogenously osmiophilic and located beneath the pellicle, while the other is sponge-like usually located more centrally, and associated with endoplasmic reticulum or the Golgi complex. The macrogametocyte nucleus is single and relatively large, usually with a compact nucleolus.

The mature microgametocyte has many peripherally located nuclei which lack nucleolus. Of course, a nucleolus is visible in immature microgametocyte. During gametogenesis the axonemes of the microgamete are apparently formed from the centrioles which lie near the nucleus. With the outward growth of the axoneme the plasmalemma of the microgametocyte starts invaginating around its anterior portion. By that time a condensed portion of the nucleus and an elongated mitochondrion move into the developing microgamete. The basal bodies of the axoneme lie near the anterior end of the microgamete whereas the mitochondrion and the nucleus lie posterior to the basal bodies. The microgamete when completely formed may be having two or three flagella, depending on the species of *Eimeria*.

V. LIFE-CYCLE

In the life-cycle of the members of the family Eimeriidae a regular alternation of sexual and asexual generations (Fig. 2) takes place in a single host. This can be divided into merogony (=schizogony), gametogony and sporogony. The infection generally initiates directly with swallowing of the mature oocyst by the host and the liberation of sporozoites inside the intestine.

The sporozoites from the oocyst reach the epithelial cells of the intestinal tract, become round and grow larger to form trophozoites which ultimately give rise to schizonts. The schizonts multiply by repeated nuclear division with the accumulation of cytoplasm to produce merozoites ; this process is called merogony.

The number of merozoites varies with the species. They are elongated spindle-shaped, motile bodies ; they penetrate the adjacent epithelial cells and then round off to form second stage schizonts which ultimately form second stage merozoites. The number of schizogonic generations is considered to be important criteria for differentiating certain species (Pellerdy, 1974).

Generally the merozoites of the last schizogonic cycle develop into male and female gametes in the newly invaded host cells to initiate the sexual developmental cycle (gametogony). The female gametocyte

accumulates food substances and then mature ; the female stage is called a macrogamete. The nucleus of the male gametocyte multiplies by mitotic division and gives rise to motile microgametes which fertilise the macrogametes to form the zygotes. A wall develops around each and oocyst is formed. Just after liberation from the host's faeces each oocyst contains a single cell known as sporont which undergoes reduction division to form sporoblasts and a residual mass. Each sporoblast usually secretes a sporocystic membrane to form a sporocyst. The sporozoites develop inside by a process called sporogony.

Therefore, it is evident that all the stages of the life-cycle of this parasite are haploid except for the zygote.

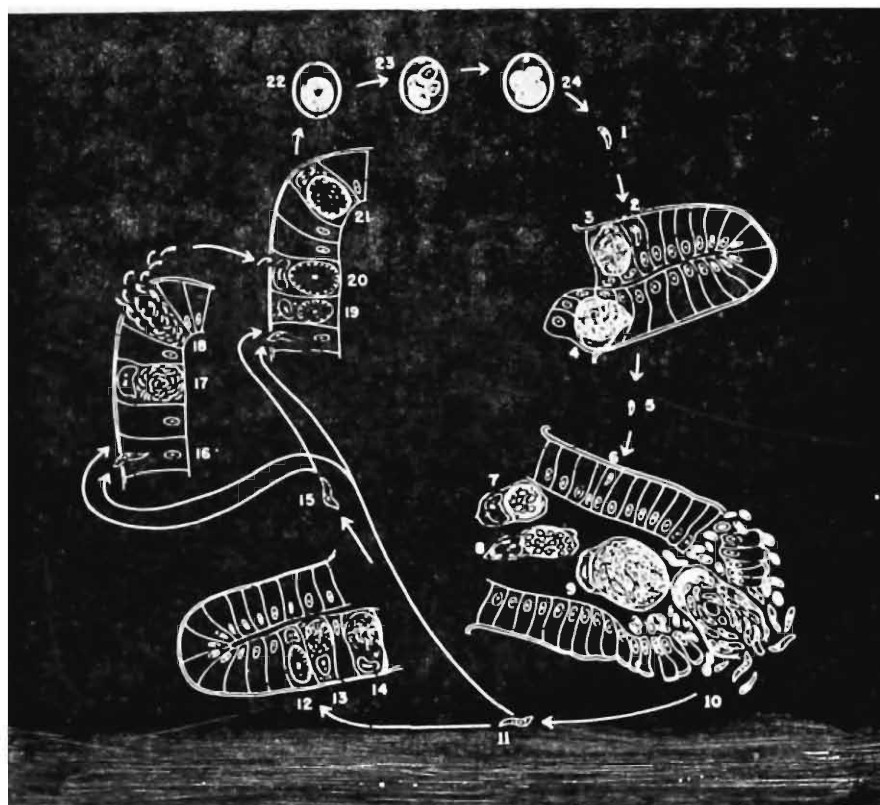


Fig. 4. Life cycle of *Eimeria tenella* (After Levine, 1961)

Sometimes sporocysts are not produced and sporozoites are formed directly inside the oocyst e. g. *Tyzzeria*.

A typical life-cycle of the member of the family Eimeriidae is that of *Eimeria tenella*, which is found in the caeca of the chicken (Fig. 4). It was first worked out by Tyzzer (1929). The oocysts are passed in the faeces. When eaten by a chicken, the wall on the oocyst breaks and the sporozoites enter the cells of the intestinal epithelium. They develop along the basement membrane and pass through it into

the lamina propria of the intestine. They are engulfed by macrophages and carried by them to the glands of Lieberkuhn. Finally they leave the macrophages and enter the epithelial cells of the gland ; where they are generally found below the host cell nuclei. In the glandular epithelial cells, each sporozoite rounds up and forms a first generation schizont which ultimately forms a large number of merozoites by schizogony. They are liberated into the lumen of the caecum about 2-3 days after infection. The merozoites then enter new host cells, round up and form second generation schizonts. These schizonts lie above the host cell nucleus. The merozoites ultimately form second generation merozoites by multiple fission. They appear 5 days after the date of infection. A few of them enter new cells and round up to form third generation schizonts, which lie beneath the host cell nuclei. These schizonts produce third generation merozoites.

Most of the second generation merozoites after invading new host cells turn into female gametes or macrogametes. Some of the merozoites become male gametocytes which ultimately give rise to a large number of biflagellated microgametes. They burst out and fertilize the macrogametes. Both macro and micro gametocytes lie below the host cell nuclei. The zygote then forms a wall around itself. Levine (1961) stated that the formation of this wall marks the transition of a fertilized macrogamete into an oocyst. The oocysts come out from the host cells, enter the intestinal lumen and pass out into the faeces. The prepatent (pre—before, patent—exposed, manifest) period, i.e. from the time of infection to the appearance of the first oocysts into the faeces, is 7 days. The oocysts are discharged for a number of days and then disappear. The period from the appearance of the first oocyst in the faeces till the disappearance of the same is called the patent period. In *E. tenella*, 3 generations of merozoites are produced. However, Tyzzer's findings have been reviewed by workers like Scholtyseck (1953) Greven (1953), Pattillo (1959), who concluded that there is a little alternation of main principles in the endogenous development of the species.

The localization of some tissue stages of certain species at some particular region of the intestinal tract has been noted by a number of workers (see Hammond and Long, 1973 and Pellerdy, 1974.) This specific localization is sometimes considered to be taxonomically important in differentiating the species. For instance, the giant schizont of *E. gilruthi* has been detected in the abomasum of sheep by Bhatia and Pande (1966a) in India and by many others abroad in

different ovine and bovine groups of animals. The oocystic stage of this parasite is still unknown. Bhatia and Pandey (1968) noticed globidial schizont containing more than one type of merozoite in the abomasum of goat. One of the forms was recognised as a stage in the life-cycle of *E. christenseni*. Bhatia and Pande (1967a) also observed megaloschizonts in the mesenteric lymph nodes of a kid and stated that the coccidian infection had involved lymph nodes because they attacked endothelial cells, transported through lymph vessels outside the intestinal tract. Levine (1961) observed endogenous stages of *E. truncata* in the epithelial cell of the kidney tubules. McCully *et al.* (1970) detected *E. neitzi* in the endometrium of uterus. Lee and Long (1972) saw second generation schizonts of *E. tenella* and *E. necatrix* in connective tissue cells between the intestinal glands.

VI. EIMERIIDS OF POULTRY AND DOMESTIC LIVESTOCK

The coccidiosis, a disease caused by this parasite poses a great problem in farm animals and poultry. It is responsible for both morbidity and mortality. Coccidial infections are easily acquired in poultry and livestock and the parasite has a direct life-cycle inside the host. Moreover, unhygienic and insanitary conditions accelerate the spread of this disease. The young animals in a flock or herd generally suffer most, the older animals sometimes have clinical symptoms and act simply as carriers ; but in chronic cases, they become emaciated, causing a decrease in overall production. Coccidiosis may cause inflammation, oedema, loss of weight, emaciation, haemorrhage, anaemia and death. Sometimes it has been reported that there are alterations in blood sugar values and liver glycogen. This disease also causes reduced milk yield and inferior wool fibres. 'Coccidiosis' with clinical symptoms is to be distinguished from 'coccidiasis' which is an asymptomatic condition and is found in all age groups of various hosts. In order to make the things more clear, Levine (1961, 1973) stated that after recovery from a coccidial infection an animal becomes relatively immune to reinfection with the same species. But this immunity may not be so solid as to prevent reinfection with the same species completely, causing low grade infection. Of course, low grade infection is extremely common, i.e., the animals have 'coccidiasis' rather than 'coccidiosis'.

Both these conditions are equally important for adopting control measures. Sometimes it is very difficult to diagnose the disease. Mere presence of oocysts in the faeces of an animal, even for

highly pathogenic species of coccidia, does not necessarily mean that the animals have clinical coccidiosis (Levine, 1961, 1973). On the other hand, coccidia may cause severe symptoms and even death in their earlier phase of life before any oocysts have been produced. The only authentic way of diagnosing coccidiosis is to find lesions containing coccidia at necropsy. The characteristic endogenous stages located in smears or by histological examination should also be taken into consideration for confirming coccidiosis.

Now a days various types of sulpha drugs and other chemical compounds are used both prophylactically and therapeutically. P. P. Levine (1939) first introduced sulphanilamide as anticoccidial drug and Herrick and Holmes (1936) found that sulphur as an effective drug. Many drugs like the derivatives of phenylarsenic acid, diphenylmethane, diphenyldisulphide, nitrofurazone, triazine, carbanilide, imidazole and benzamide are used as coccidiostats. However, Levine (1961, 1973) stated 'No drug would be effective if used after the appearance of symptoms of the disease'. He further suggested that most of the drugs are prophylactic and must be administered at the time of exposure or soon thereafter in order to be effective.

The real effective therapy depends upon correct time at which the remedies exert their optimal effect against the endogenous phase of the different species of coccidia. Treatment of the disease depends somehow destroying on the endogenous stages particularly during the asexual phase. If the disease is not controlled after repeated infections, therapeutic measures alone may not check the outbreaks.

Before adopting any control measure one should be aware of different types of coccidia and coccidiosis caused by them in various livestock and poultry. They are treated below groupwise, along with the symptoms.

SHEEP AND GOATS

So far, 16 species of *Eimeria* have been reported from sheep and goats and some of them are interchangeable to some extent in between these two hosts. However, in a personal communication Levine (1981) stated that the parasites of sheep are distinct from those of goats. In India, 10 species of *Eimeria* viz., *E. arloingi*, *E. intricata*, *E. crandallis*, *E. ahsata*, *E. faurei*, *E. ninakholyakimovae*, *E. parva*, *E. granulosa*, *E. christenseni* and *E. tirupatiensis* have been reported, of which the last two are recorded only from goat. Single infection is rare. The symptoms of disease initiate with the discharge of foul-smelling diarr-

hoeric stools with or without streaks of blood. It may persist for more than a week and sometimes be preceded by heavy constipation.

Severe abdominal pain, anaemia, inappetence unthriftiness, loss of weight and sometimes paralysis also appear in coccidiosis. In acute cases, the entire small intestine is thickened, congested, oedematous and even haemorrhagic. Well-developed mature schizonts (pin-point to

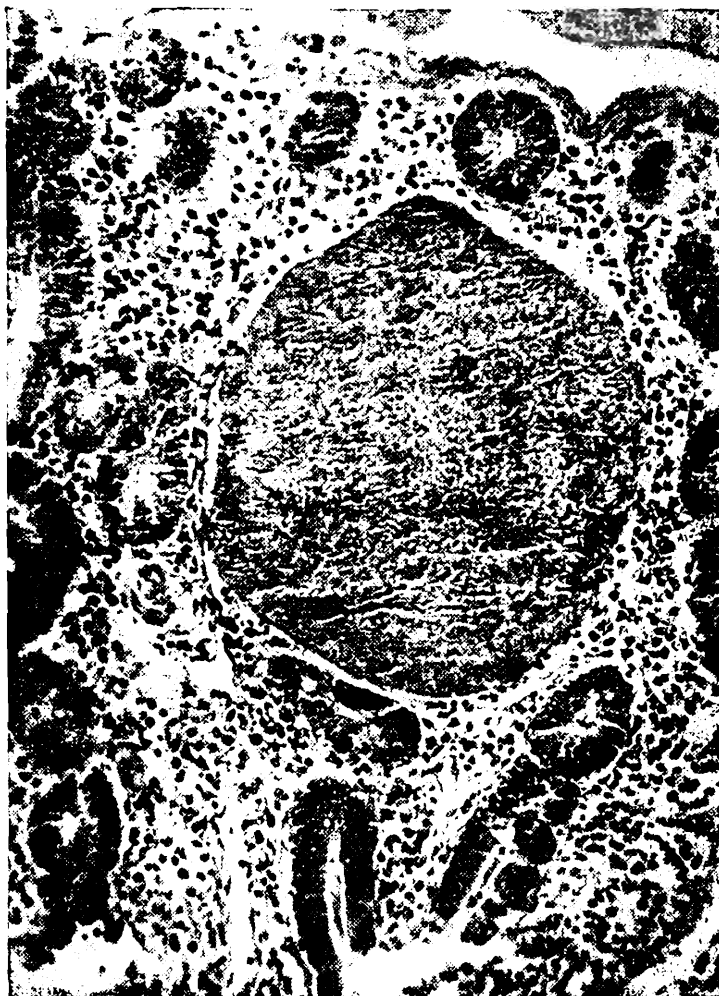


Fig. 5. Photomicrograph of a mature giant schizont in the mucosa of small intestine of sheep.

pin-head size white cysts) are found scattered throughout the small intestine. These are sometimes regarded as developing and mature giant schizonts (Fig. 5). White or greyish white papillomata areas throughout the length of the small intestine are also seen due to the aggregation of gametocytes and developing oocysts (Fig. 6). Bhatia and Pande (1966a) observed these bodies in the caecum of a sheep and concluded that this stage is more pathogenic than the sexual phase. It



Fig. 6. Piece of small intestine showing gametocystic patches.

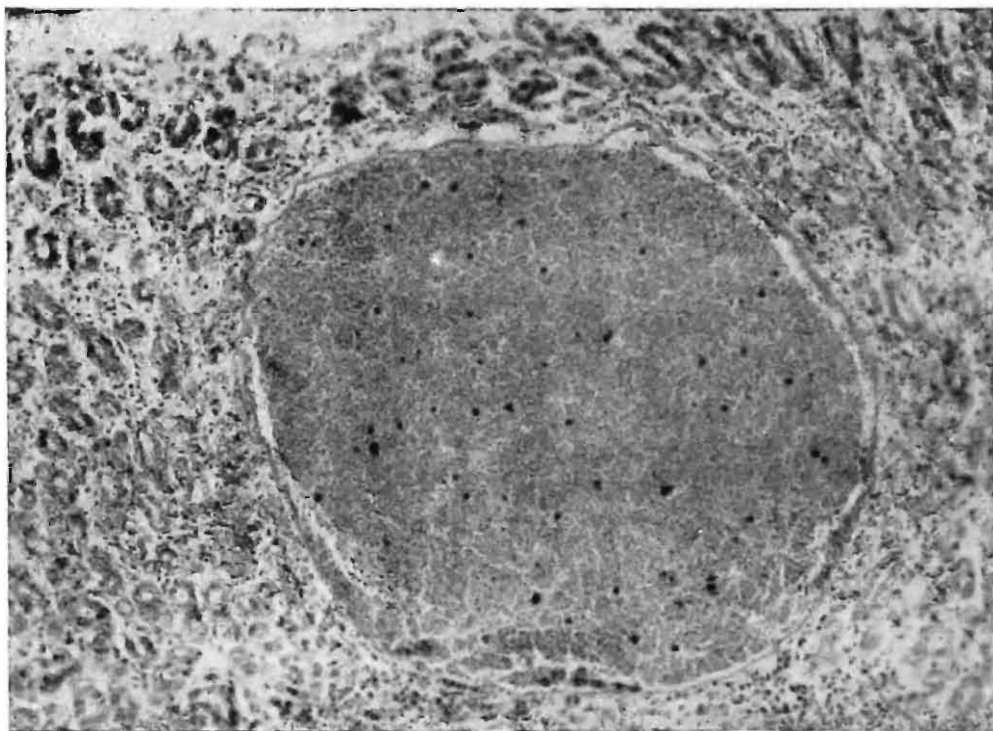


Fig. 7. Photomicrograph of abomasal giant or globidial schizont in the mucosa of abomasum of sheep.

leads to the destruction of villi, and areas of the small intestine became oedematous and thickened. These cystic bodies are also frequently marked in the mucosa of the abomasum. These are considered abomesal giant or globidial schizonts (Fig. 7). In acute cases of coccidiosis in goat, Bhatia and Pande (1967a) observed giant schizonts in the enlarged mesenteric lymph nodes (Fig. 8). A heavy concentration of male and female gametocytes along with oocysts at different developmental stages

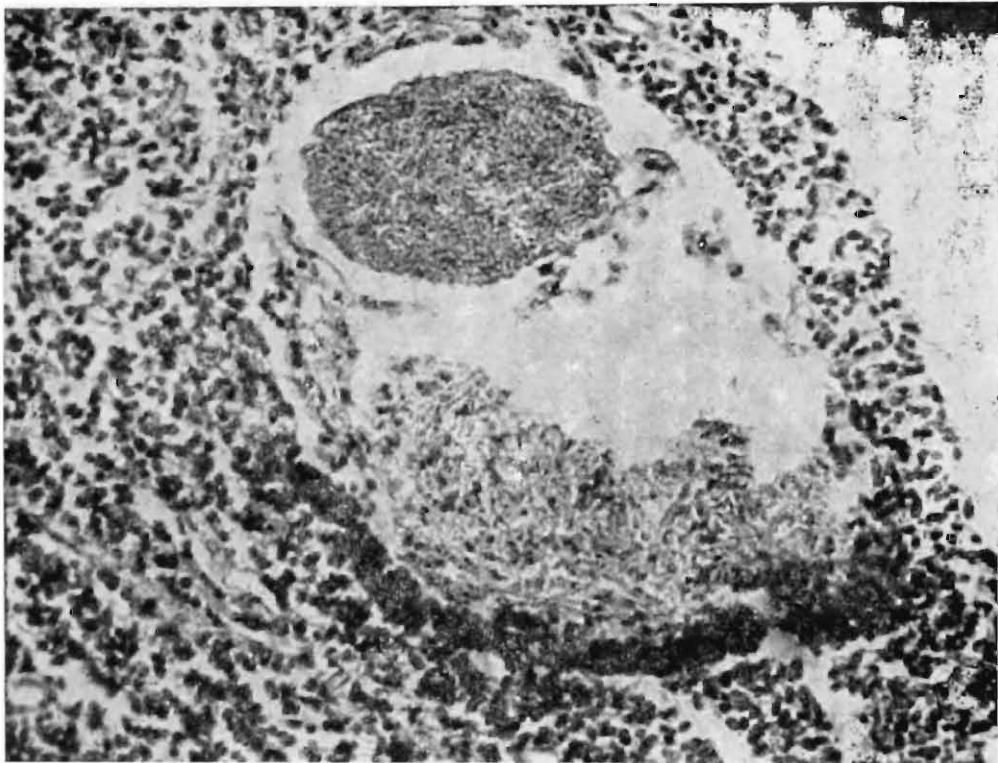


Fig. 8. Photomicrograph of giant schizont in the mesenteric lymph node of a kid.

is found in the enlarged epithelial cells of the villi superficially and deep inside the crypts (Fig. 9). Developing and mature multinucleate giant schizont with a thick wall filled with hundreds to thousand of elongated merozoites of different shape and size have been reported. Such giant schizonts have also been noticed in different parts of the mesenteric lymph nodes. Matta and Pande (1966) observed globidial schizonts in the abomasum of sheep. In addition, various histopathological pictures in sheep and goats from our country may be seen on Pande, Singh and Kala (1964), Pande *et al.* (1964, 1966, 1967), Pande and Bhatia (1966), Bhatia and Pande (1964, 1966d, 1969) and Bhatia and Pandey (1968). Workers like Sharma (1951-52), Munjrekar (1954), Ray 1961, Shah 1963, Sivdas *et al.* (1965), Misra and Goutam (1970), and Bali (1972) and

Rama, Singh and Singha (1977) made contributions on the coccidiosis of sheep and goats in our country. Though the actual loss due to coccidiosis



Fig. 9. Photomicrograph showing heavy congregation of gametocytes and oocysts in the small intestine of sheep.

has not been estimated, a high percentage of the population of sheep and goats, particularly the younger ones, die every year due to this disease. (Figs 5-13 are due to courtesy of Prof. B. B. Bhatia)

CATTLE

Coccidiosis in cattle causes a heavy economic loss in our country. In India, outbreaks of red dysentery in dairy cattle due to bovine and bubaline coccidiosis have been reported from time to time. The mortality or morbidity is frequently high. Coccidiosis is predominant in calves particularly less than one year of age. Adults are practically symptomless although they carry coccidia and pass oocysts continuously.

More than 15 species (Pellerdy, 1965) of *Eimeria* and one species of *Isospora* are found in cattle, of which Indian buffalo and cattle harbour 13 species of *Eimeria*. They are *E. auburnensis*, *E. bovis*, *E. ellipsoidalis*, *E. zuernii*, *E. subspherica*, *E. cylindrica*, *E. canadensis*, *E. bareillyi*, *E. pellita*, *E. wyomingensis*, *E. alabamensis*, *E. bukidnonensis* and *E. brasiliensis*. The last 3 species occur less frequently than the other (Bhatia, Pande, Chauhan and Arora, 1968). A foul smelling, reddish diarrhoeic stool due to haemorrhage in the intestine is generally found in acute cases. Sometimes the stool may be just soft or watery. The victims occasionally recover but there may be a sudden flare up of the symptoms associated with recurrent diarrhoea, anorexia, tenesmus, inability to rise on the legs, debility, fever etc. Acutely infected young calves die within a few days, particularly when the stools have a large amount of blood.

Lesions

- (1) White pin-point to pin-head sized bodies lying superficially or deep in the mucosa of small intestine are developing and mature giant schizonts (Fig. 10).
- (2) Irregularly margined but milky white superficial areas about 1-2 mm in diameter are immature and mature large epithelial schizonts (Fig. 11).
- (3) Slightly raised and small whitish, oedematous patches are collections of gametocytes and small epithelial schizonts (Fig. 12).
- (4) Congested and oedematous areas with granular feature from aggregations of minute white structures are the immature and mature microgametocytes of *E. auburnensis*.
- (5) Slightly raised, whitish, opalescent areas 3-6 mm in diameter, with a congested periphery are gametocytes and oocysts of *E. bareillyi* (Fig. 13).

Pellerdy (1974) said that bovine coccidiosis has three periods (i) the first one lasts for 5-7 days and is characterised by debility, diarrhoea, with few oocysts and reduced milk production ; (ii) the second period also has the same duration ; it is characterised by anorexia, a raised respiration rate, loss of weight with no milk and clots of blood with mucus in the fluid faeces, partial paralysis of the anal sphincter usually in a wide open condition ; (iii) the duration of the third period varies to some extent. During this period the victim is unable to stand, cannot take food and water and often has more or less extensive transverse haemorrhagic streaks on the exposed rectal mucosa which

can be seen through the permanently opened anus, mortality rate is fairly high. We know less about the pathogenic action of *Eimeria* other than *E. bovis*, *E. zuernii*, *E. auburnensis*, *E. ellipsoidalis*, *E. bukidnensis* and *E. alabamensis* in cattle from abroad. In our country, various endogenous stages of bubaline and bovine coccidia were described by Bhatia and Pande (1967b), Pande *et al.* (1968, 1971) and

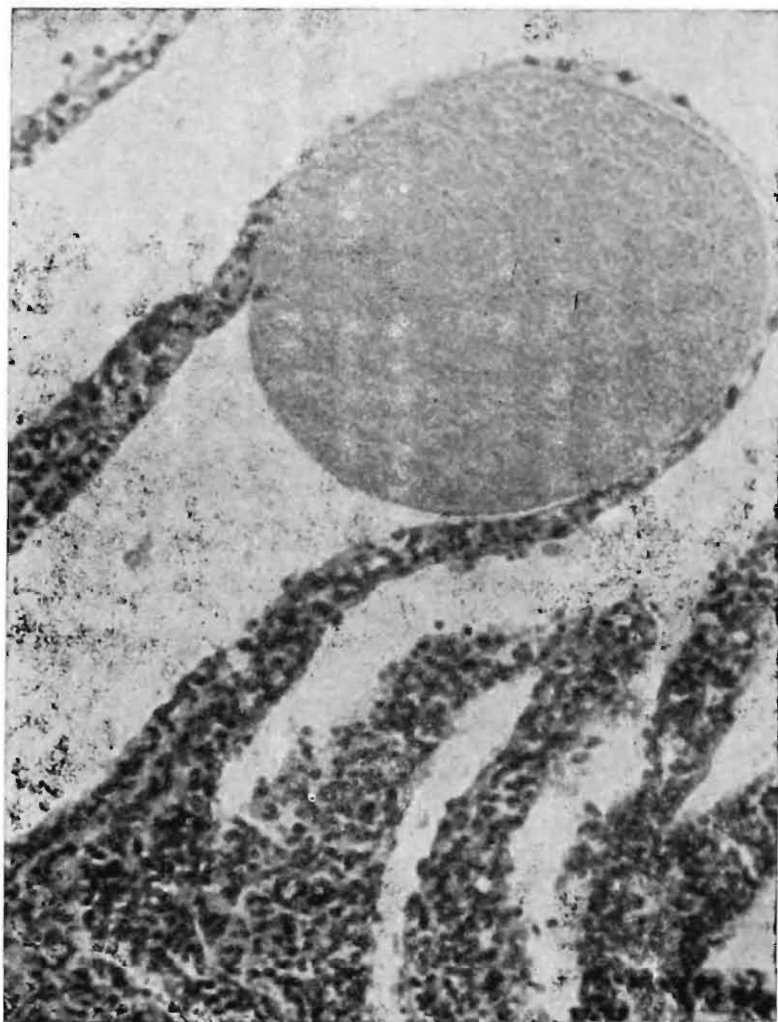


Fig. 10. Photomicrograph showing giant schizont in the small intestine of cattle.

Bhatia *et al.* (1971) particularly for *E. bareillyi* from *Bubalus bubalis*. Authors like Cooper (1924, 1926a, b, 1927), Biswal (1948), Gill (1956a) and Bhatia *et al.* (1972) reported various incidences of bovine and bubaline coccidiosis from our country. Recently, Shastri *et al.* (1973) noted that the inoculation of 50,000 to 100,000 oocysts of *E. bareillyi* produced clinical disease while feeding 300,000 oocysts caused remarkable illness and death. The same authors (1974) recorded that the

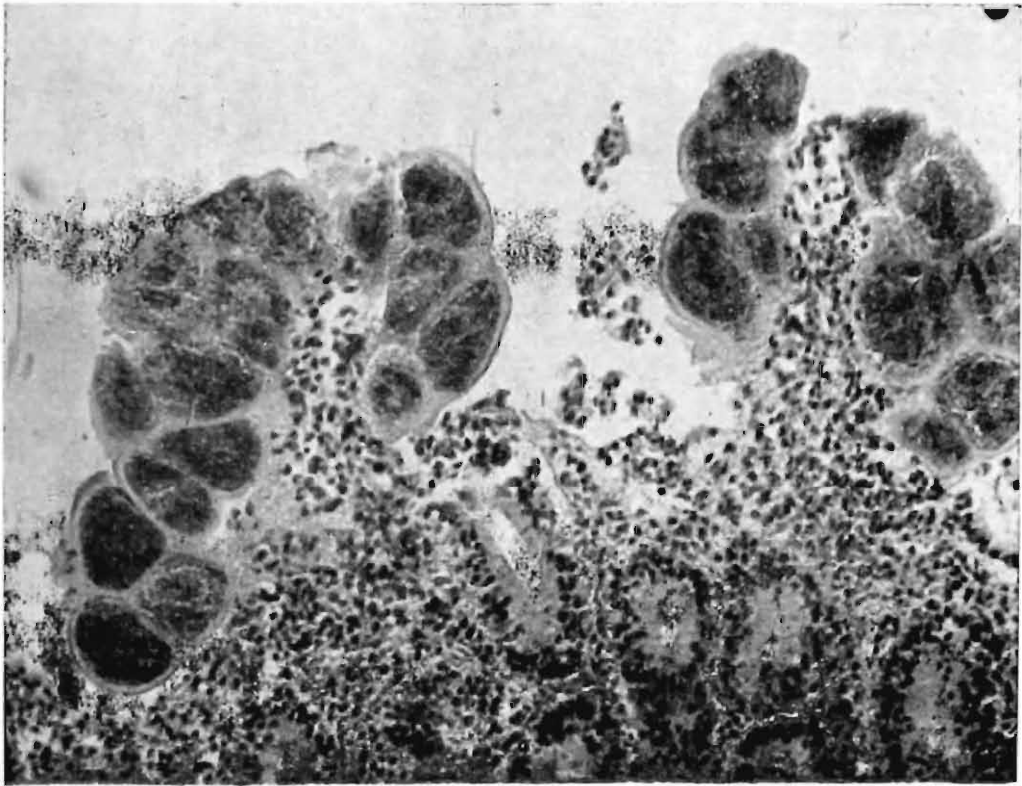


Fig. 11. Photomicrograph showing developing and mature giant schizonts.



Fig. 12. Photomicrograph of gametocyte and small epithelial schizont in the mucosa of small intestine.

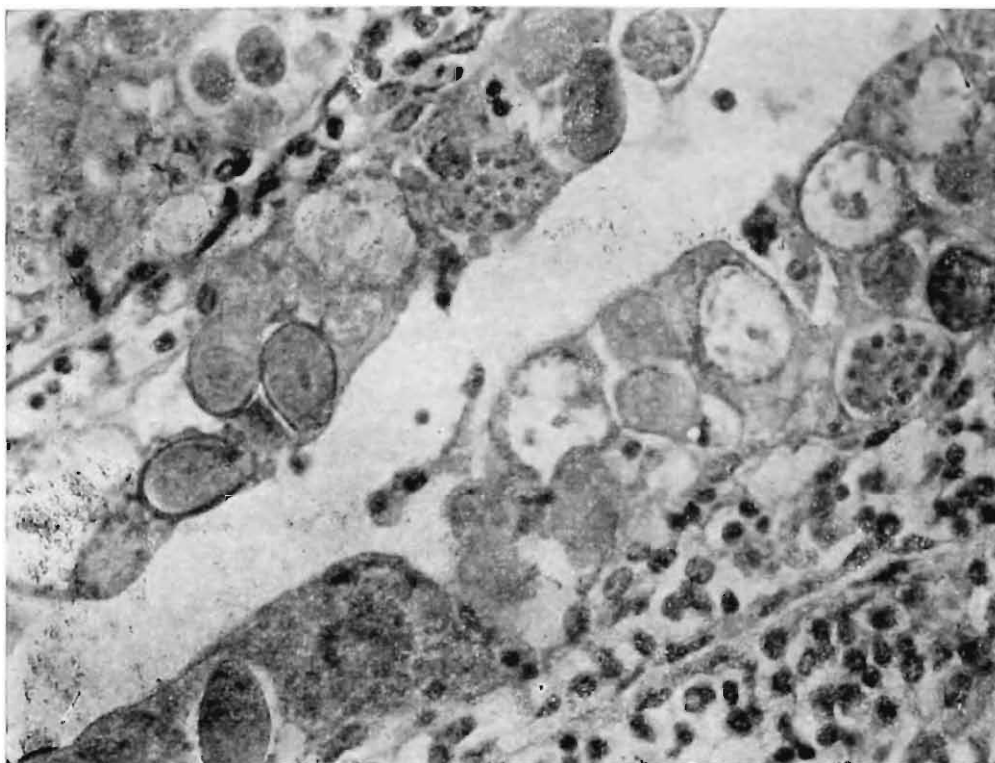


Fig. 13. Photomicrograph showing gametocytes and oocysts of *E. bareillyi*

infection due to *E. bareillyi* leads to diarrhoea and noted 20% mortality in buffalo calves. The pathogenicity of this species has also been noted by Shastri and Krishnamurthi (1975). The mesenteric blood vessels are distended and tortuous, with a swollen intestinal wall and accumulation of fluid in the intestine. Circular growths of 2-6 mm in diameter have also been observed in the mucosa of the jejunum (Pande, Bhatia and Chauhan, 1971 and Pande, Bhatia, Chauhan and Garg, 1971).

SWINE

Pellerdy (1974) listed 10 species of *Eimeria* and 3 species of *Isospora* in pigs. Vetterling (1965) believed that there are 8 valid species of *Eimeria* and 2 of *Isospora* in domestic pig. The first report of swine coccidiosis in India was that of Ahluwalia (1959) who found *E. deblickei* in pigs slaughtered at Aligarh, U. P. Subsequently, 7 species of *Eimeria* and 1 of *Isospora* were recorded from Indian pigs by Srivastav and Shah (1968) and Mishra (1967a, b). An *Isospora* sp. was also been reported from the domestic pig from our country. The present author

(1980) also detected 6 species of *Eimeria* viz., *E. deblickei*, *E. scabra*, *E. spinosa*, *E. perminuta*, *I. suis* and *E. neodeblickei* in pigs of a few slaughter houses and piggeries visited by him. Nevertheless, swine coccidia in our country has been paid to little attention. The information regarding coccidiosis given below is based mainly on the findings of foreign workers. Coccidiosis causes a mild catarrhal-inflammation of the mucous membranes, mainly of the small intestine. In acute infections, there is severe haemorrhagic enteritis and the epithelium is desquamated from the tips of villi. Wiesenhuber (1962a) and Boch and Wiesenhuber (1963) found inflammatory lesions in the small intestine of the domestic pig.

Recently Upadhyay and Ahluwalia (1976a) studied *E. deblickei*, *E. neodeblickei*, *E. perminuta* and *I. suis*, and found four types of schizonts in the different parts of the intestine of pigs. But were not able to find any stages in sections of the stomach, caecum, colon and mesenteric lymph glands.

Upadhyay and Ahluwalia (1977a) also reported *E. deblickei*, *E. neodeblickei* and *E. perminuta* from swine. They (1976) found that Amprolsol was very effective in swine coccidiosis if administered after the 2nd day of infection, particularly with these species.

Upadhyay and Ahluwalia (1978a) infected the pig experimentally with *E. deblickei*, *E. neodeblickei*, *E. perminuta* and *I. suis*; detected micro and macro-gametocytes in the small intestine but could not find any specific differences among these developmental stages. The same authors (1978b) could not detect any marked lesion in the intestine and observed only mild pathogenicity in the experimental hosts.

DOMESTIC CHICKEN

According to Pellerdy (1974) nine valid species of *Eimeria*, two species of *Isospora* and one species of *Wenyonella* occur in the domestic fowl. The nine species of *Eimeria*, one of *Isospora* and one of *Wenyonella* have been reported from India. Of these, six species of *Eimeria* viz., *E. tenella*, *E. necatrix*, *E. brunetti*, *E. mivati*, *E. acervulina* and *E. maxima* are pathogenic.

Amongst them, *E. necatrix*, *E. maxima*, *E. acervulina* and *E. mivati* affect the small intestine, causing intestinal coccidiosis; *E. tenella* infects the caeca, causing caecal coccidiosis; *E. brunetti* is found in the rectum and colon producing rectal coccidiosis. The gametocytic stages of *E. necatrix* in the caeca also add to the severity of the

lesions. Mishra, Enigk and Dey Hazra (1976), working with SEM on the pathogenesis of *E. necatrix*, stated that a gross change in the

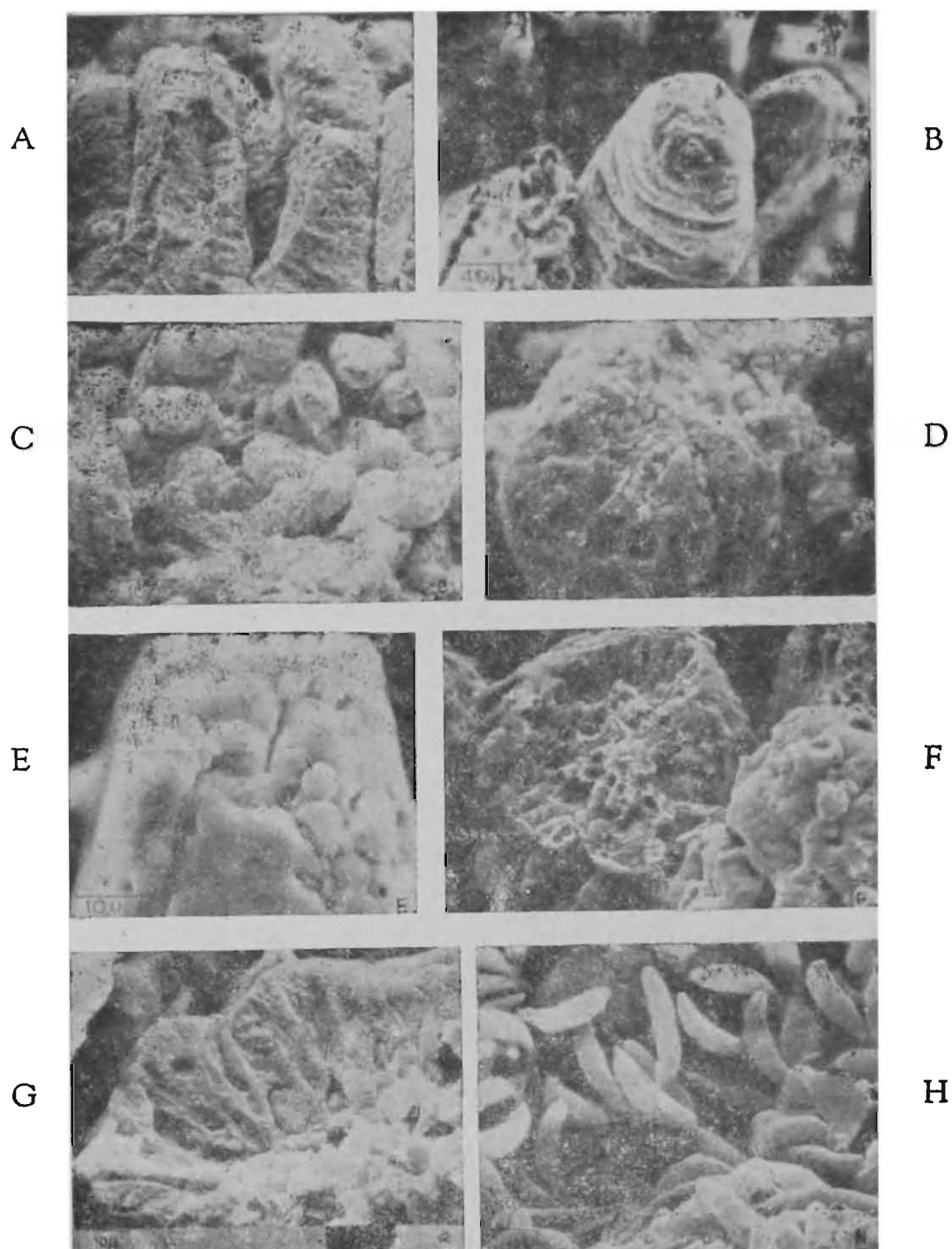


Fig. 14. Photomicrograph showing the dissquamation of Epithelial cells due to *E. necatrix* infection as observed under SEM (After Mishra, Enigk and Dey Hazra, 1976).

A and B. Villi of jejunum of uninfected chicken. Note the columnar cells inside the villi in fig. A ; **C.** jejunum of 4 day infected chicken with heavy haemorrhage and ruptured villi ; **D.** large hole at the top of the villi with loose epithelial cells ; **E.** Tip of villi showing shedding of the epithelial cells ; **F and G.** Tip of villi with intracellular stages of the parasite ; **H.** Free merozoites in the lumen of jejunum.

jejunum is clear from 3rd day after infection in chicken. Desquamation of the epithelial cells with varying degree of disruption has been noticed (fig. 14). The crypts of the villi become filled with blood cells. The villi are stumpy, with blunt tips sometimes marked with heavy bleeding. The holes have been observed at the tips of the villi, sometimes with shedding of blood from the holes. Merozoites may enter the epithelial cells. Occasional liberation of numerous merozoites from the epithelium has also been noticed. The schizonts and gametocytes could not be differentiated within the epithelial cells and were all considered developing stages. The intra-cellular forms are oval or round and their surfaces are rough with very small projections as seen under SEM. The lesions due to coccidiosis in poultry frequently are the result of mixed infections. Sometimes specific differentiation by examination of gross lesions becomes difficult due to their severity and character. In infections with *E. acervulina*, a well-marked thickening with extreme reddening due to the concentration of gametocytes and oocysts (Fig. 15) is found on the duodenal mucosa. In *E. maxima* infections the thickening of the mucosa, particularly in the upper half of the small intestine, with almost orange-coloured intestinal contents and streaks of blood has been

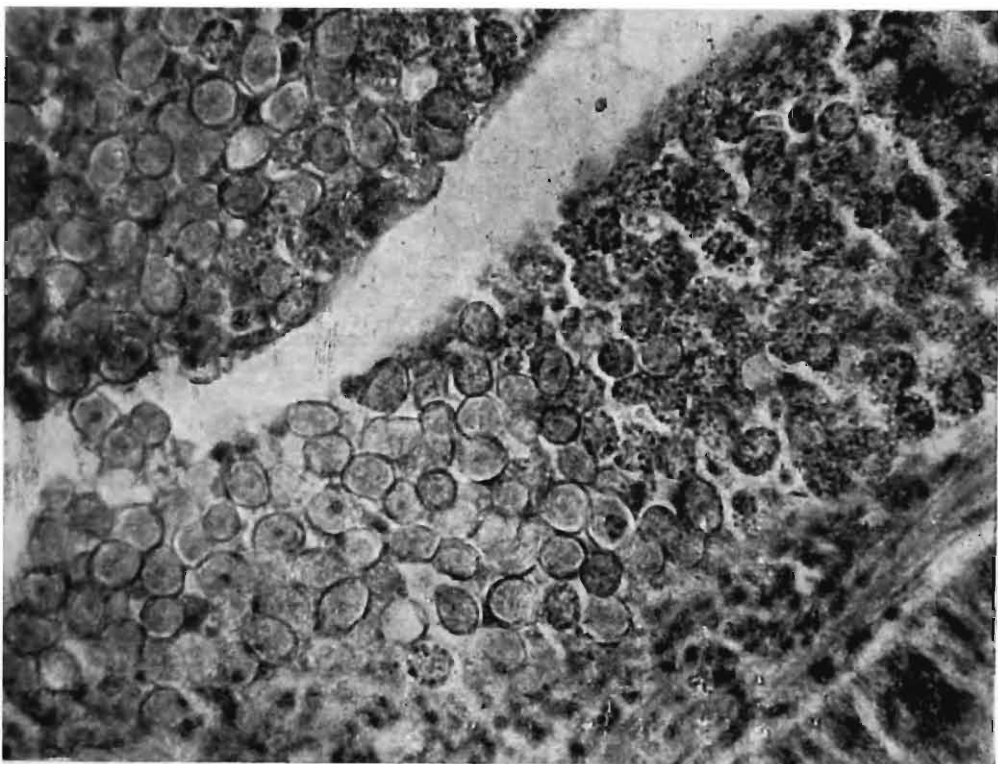


Fig. 15. Photomicrograph showing gametocyte, and oocysts with well marked thickening in duodenal mucosa due to *E. acervulina* infection.

associated with heavy concentrations of micro-and macro gametocytes (Fig. 16). An infection with *E. necatrix*, milkwhite spots of small areas or pin-points due to deep seated aggregations of colonies of asexual stages on the serosal surface of the small intestine with increase of

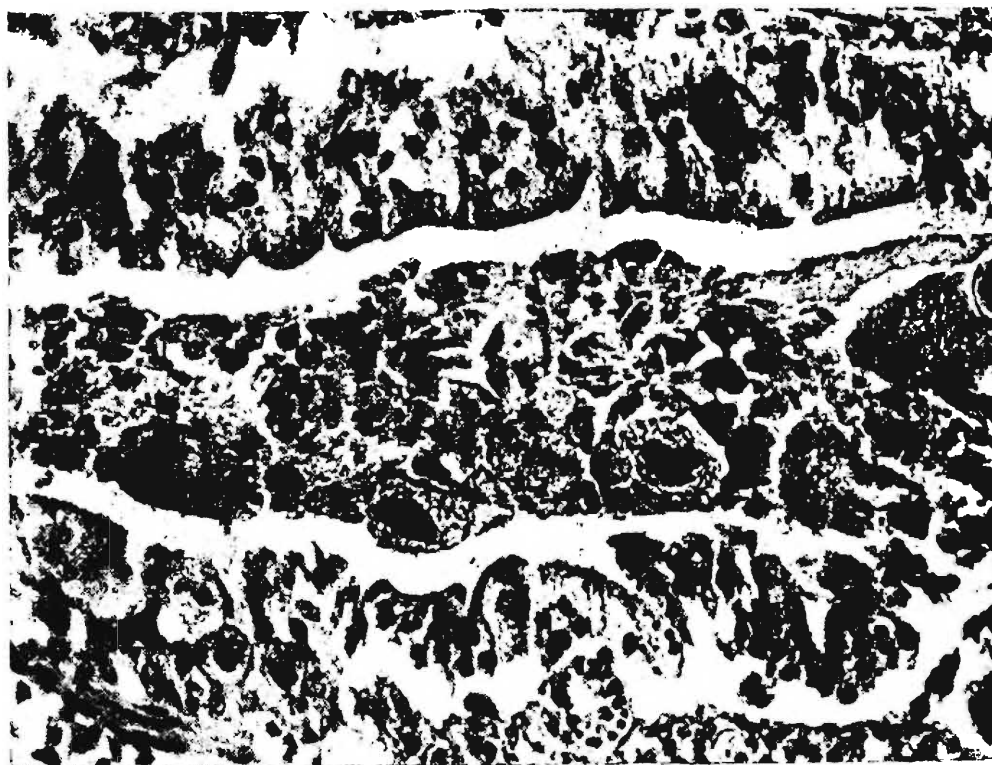


Fig. 16 Photomicrograph showing the concentration of gametocytes of *E. maxima*.

eosinophyl (Fig. 17) have also been reported. In *E. tenella* infections a severe congestion due to aggregation of mature schizonts (Fig. 18) was noted with greatly enlarged caeca (Fig. 19) containing mass of dark red or dark brown core. The wall of the caecum becomes almost membranous and the domestic fowl later dies. The droppings of ailing chicks often contain blood or mucus or both. (Figs. 15-19 are due to courtesy of Prof. B. B. Bhatia)

In the deep-litter system, this disease is very common. It causes a high mortality amongst chicks. The proliferation of the disease takes place due to damages or lickages of the deep litter houses. Hens also are affected by this disease. The best way to prevent it is to keep the floor dry with good ventilation and adequate space for each bird.

Authors like Gill and Ray (1957), Gill (1955, 1956b, 1958), Sharma and Reid (1962), Gill *et al.* (1962, 1963a, b), Das (1963), Prasad (1963),

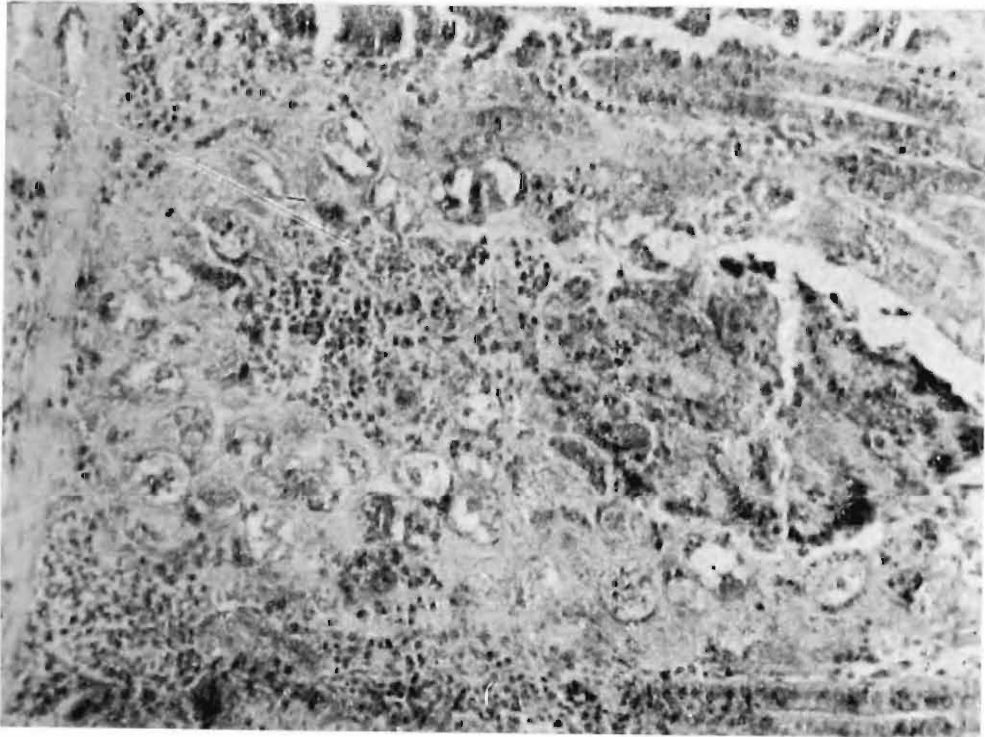


Fig. 17. Photomicrograph showing developing and mature schizonts of *E. necatrix* in the small intestine.

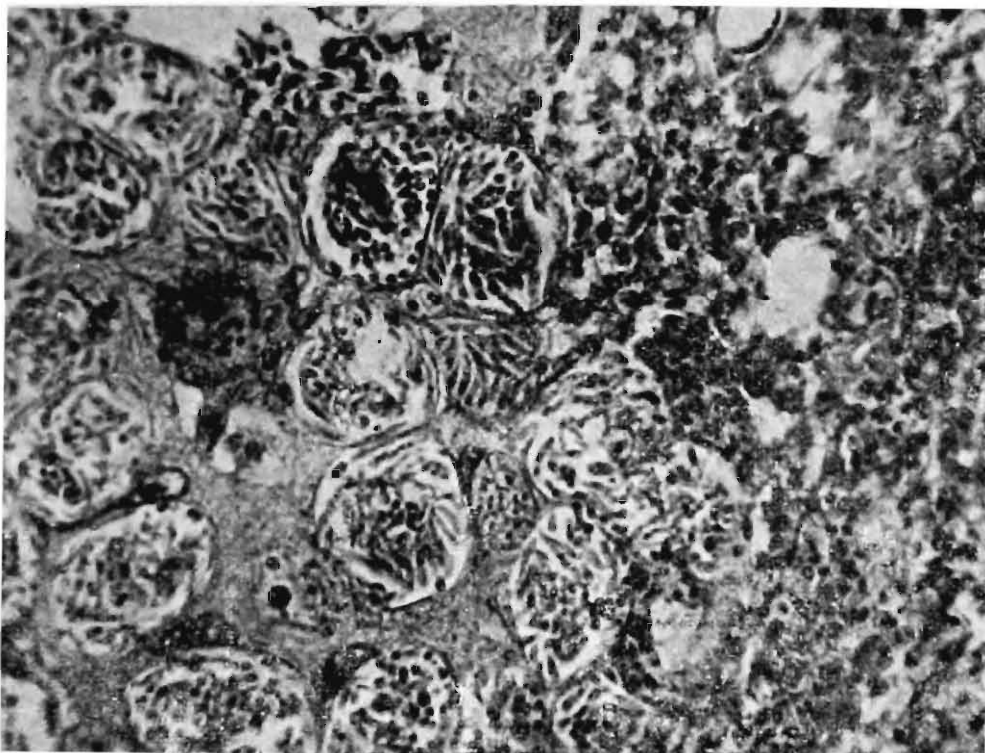


Fig. 18. Photomicrograph showing aggregation of mature schizont of *E. tenella*.

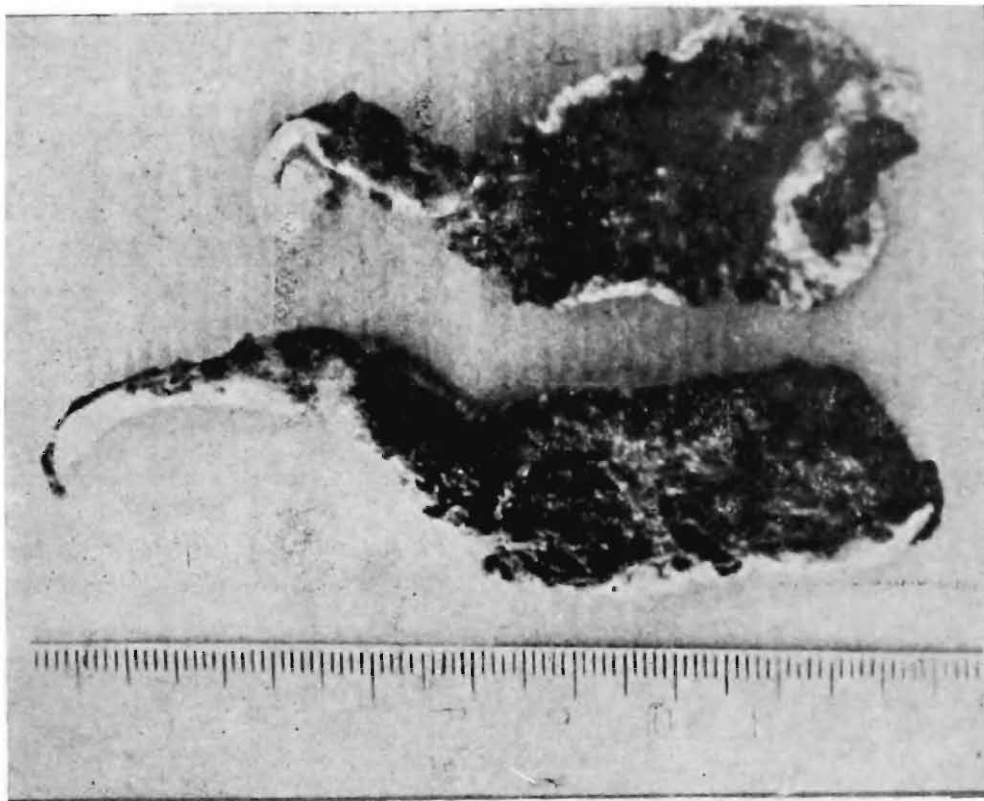


Fig. 19. Photograph showing the caeca of domestic fowl after *E. tenella* infection.

Sharma and Foster (1964), Mishra (1964), Sharma (1964), Patnaik (1966a), Rahman and Anantaman (1970), Bhatia (1971a 1972), Gill and Grewall (1972, 1974), Bhatia *et al.* (1974), Bazwa and Gill (1975, 1977), Singh and Gill (1976), Singh and Hussain (1978) and Gill and Bazwa (1979) have reported much about poultry coccidiosis from our country.

DOMESTIC TURKEY

Seven species of *Eimeria*, viz., *E. meleagridis*, *E. meleagritidis*, *E. gallopavonis*, *E. adenoeodes*, *E. dispersa*, *E. innocua* and *E. subrotunda*, one species of *Isospora*, viz., *I. heissini* are found in domestic turkey (Pellerdy, 1974). Of these, six species of *Eimeria* (except *E. subrotunda*) have been reported from Indian domestic turkeys. Different species of the above mentioned parasites attack different parts of the large and small intestines of the host. In general, there is a catarrhal inflammation occasionally with haemorrhage. There may be caseous-muconous flakes floating in the lumen ; the intestinal contents may be rusty reddish. There may be distention of the caeca and rectum with generalised thickening of their walls.

VII. HOST-PARASITE RELATIONSHIP

The relationship between the host and parasite is used on the mode of association of a particular parasite with the particular host. Various interactions on the part of the host and the parasite play an important role for the growth and multiplication of the parasite as well as the survival of the host. A balance is normally maintained between the two so that neither host nor parasite hampers the interest of the other. This reciprocal relationship between them depends upon the mode of invasion, infection and development of a parasite. The initial outcome of this association leads to host-specificity—the affinity of a particular parasite for a particular host.

HOST SPECIFICITY

As a rule coccidian parasites are strictly host specific. Several experiments hitherto conducted, reveal that the species of the genus *Eimeria* are stenoxenous. Levine and Ivens (1965a) concluded from cross infection studies on rodents that though the cross infection was possible between the members of a host genus, the same was not be possible at the intergeneric level. It has also been found that *Isospora canis* of the dog cannot be transmitted to the domestic cat ; simultaneously *I. felis*, a cat coccidium cannot be transmitted to dog (Nemésere, 1960) ; Levine and Ivens, 1965b). *I. rivolta* from dog cannot be transmitted to the cat (Mahrt, 1966) and *vice versa* (Dubey *et al.* 1970). Ray and Mandal (1961, 62) failed to transmit *E. ovoidalis* of the buffalo to the cowcalf. Though a number of species of *Eimeria* are shared by bovine and bubaline group. Subramanian and Jha (1966) were successfully able to transmit *E. faurei* and *E. ninakohlyakimovae* from the goat to lambs.

E. tenella is common in the caecum of domestic chicken, *Gallus gallus*. It does not complete its life-cycle in hosts of several phylogenetically related genera of fowl (Vetterling, 1976).

As a whole, most of these parasites are limited to a narrow host species range and have an affinity for a particular organ system, portion of the system, specific type of cell and sometimes a particular location within the cells. Their host specificity or host restriction depends upon the compatibility between the host and parasite (Levine, 1972). Some intracellular parasites are capable of modulating the host cell metabolism, creating a favourable environments for themselves. This is an example of the ability of the parasite to adapt (Beyer, 1974).

ASSOCIATION AND EM STUDY

With the improved knowledge of fine structure of this group, the problems of host specificity and the host-parasite relationship have been visualised to a great extent.

It has been observed that the intracellular developmental stages of these parasites lie within the host cell in a vacuolar space known as parasitophorous vacuole (Scholtyseck and Piekarski, 1965 ; Hammond, Scholtyseck and Minar, 1967). The cytoplasmic membrane of the host cell bordering the vacuole is often smooth but sometimes has numerous fine folds or villus-like structure extending into the vacuole. These intravacuolar folds are disconnected from the host cell membrane and disintegrate to form a particular material which is taken by the parasite. These folds may also assist in the transport of nutrient materials from the host cell to the parasite. In this regard the contributions made by Sheffield and Hammond (1966) ; Scholtyseck, Volkmann and Hammond (1966), Hammond, Scholtyseck and Chobotar (1967) ; Colley (1968) ; Andreassen and Behnke (1968) and Scholtyseck (1968) deserve mention.

The exact mechanism of the intake of food materials by these parasites is not clearly known (Hammond, 1970) and the factors affecting susceptibility of hosts to these coccidian parasites are incompletely understood. However, it has been observed that a higher rate of metabolism occurs in parasitised or neighbouring cells followed by an increase in their mitochondria (Scholtyseck, 1963).

INJURIOUS EFFECTS OF PARASITES

Though a condition of equilibrium is maintained between the host and the parasite, the parasite may cause some injurious effect on its host.

The injurious effects inflicted by these parasites are detectable microscopically in the epithelial or other cells where the parasite occurs. Most of the coccidia are intracytoplasmic and a few are intranuclear e.g. *E. alabamensis* in cattle ; *E. ranarum* and *Isospora lieberkuenhi* in frogs, *E. salamandra* in salamanders etc. Initially the affected host-cell and its nucleus undergo hypertrophy ; this is followed by an immediate increase in metabolic and defence activities. Nutrients are derived from the cell, particularly the nucleus. The parasitized cell and its nucleus increase in size to accommodate the developing parasite, leading to displacement of the nucleus and destruction of the cell.

In the life-cycle stages of different species of coccidia of the genera *Eimeria*, *Isospora*, *Wenyonella* and *Tyzzeria* in different groups of vertebrates, the asexual stage (the schizont), usually develops in group or as a colony at different depths of the mucous membrane.

These developmental stages produce superficial erosion or desquamation of the villar tips or of the complete villi with partial or complete sloughing of the mucous membrane. Deep-seated colonies of schizonts cause damage of blood vessels of the submucosa resulting in haemorrhage. Scattered gametocytic stages or oocysts cause less damage than those developing in colonies or as plaques.

In addition to mechanical injury, toxic effects due to metabolic products may also occur. However, only experimental demonstration of toxins liberated by these coccidians would prove this assumption.

The haemorrhagic inflammatory changes found in chickens infected with *E. ienella* are due to the toxicity of the second schizogonic stages and their metabolic products (Scholtyseck, 1956). In *E. tenella* infection, Gill and Ray (1954 a, b, c) and Ray and Gill (1955) said that the lesions of the caecal tissue were purely mechanical for the first 3 days. On maturation of the second generation schizonts, merozoites were liberated, producing a large amount of mucopolysaccharides which appear to act as heparin-like substances (anticoagulant) stimulating the formation of a large number of mast cells.

The sporozoites and immature schizonts are capable of ingesting host cell cytoplasm. In the *in vitro* cultivation of *E. tenella*, no indication of utilising the cell DNA precursor pool has been observed although there may be DNA synthesis in developing schizonts during the asexual generation (Ouellette *et al.* 1973).

In some species, particularly in the genus *Eimeria*, there is a definite number of schizogonic generations, e.g. *E. bovis* has two and *E. nieschulzi* has four (Hammond and Long, 1973), hence the infection is regarded as self-limiting. It has been observed that activation of the arrested endogenous stages of *E. zuernii* may lead to coccidiosis in cattle (Marquardt, 1976).

However, the developmental cycle of an organism is closely programmed and is not readily diverted from attaining its goal (Fairbairn, 1970). The sequential changes likely to occur within a host, appear to be predetermined in the life-cycle of a coccidian.

The pathobiological outcome is dependent on various factors of both the parasite and the host, e.g., age of both parasite and host species,

size and location of the parasites inside the host cells and parasite's developmental stage.

The association or the injurious effect ultimately lead to immunity to the particular disease caused by the parasite.

IMMUNE RESPONSE

Immunity for protecting the host develops after the initial sub-clinical infection. It is specific for the species of a coccidian to which the animal is exposed. Several attempts have been made to immunize animals against the infection. Bachman (1930a, b) attempted to immunize rabbits with a suspension of dried, pulverized oocysts of *E. stiedai*, but did not succeed. Becker (1935) failed to immunize rats, fed ground oocysts and infected intestine. Rose (1961, 1963) and Horton-Smith *et al.* (1963) also failed to immunize rabbits against *E. stiedai* with antigen prepared from bile duct exudate along with a mixture of schizonts and gametocytes, as did so also *E. tenella* in fowl. Lowder (1966) immunized calves against *E. bovis* infection by oral inoculation but failed by intravenous inoculation of a soluble extract of disrupted oocysts.

There are number of records of immunity production after irradiation of oocysts and subsequent inoculation of the host (Fitzgerald 1965, 1968, Kheysin, 1972 and Reid, 1975), but none was completely successful.

Edgar (1958) developed a method of immunization of chickens by inoculating a mixture of oocysts of all the eight species of coccidia during first week of life. It produced light infections, with the production of a small number of oocysts.

Augustin and Ridges (1963) were able to produce a high degree of immunity with a sublethal dose of *E. meleagridis* in the turkey. Long and Rose (1965) attempted immunization, both active and passive, of chickens infected with the sporozoites of *E. tenella* by the intravenous inoculation. A high degree of protection developed when immune serum (globulin) was inoculated $4\frac{1}{2}$ hrs. prior to the inoculation of sporozoites. Little or no protection was observed when immune serum was introduced 19 hrs. after the sporozoite injection. These observations indicate that serum antibodies are effective *in vitro* or *in vivo* if the invasive stages come in contact with the antibody. However, when the parasites have already invaded the epithelium of the intestine, the circulating antibody become

ineffective. Rose (1967a, b & c) studies cross immunity between *E. tenella* and *E. necatrix* and found that the immunity was species-specific. Lumsden (1967) summarised the various types of antibody production by coccidia along with that of other protozoan parasites.

The immunization of one species of coccidia gives little cross-immunity. Only in a few cases are the humoral antibodies effective against merozoites *in vitro* which prove to be ineffective in *in vivo* (Marquardt, 1970).

Upadhyay and Ahluwalia (1976b) observed that in case of mixed infection in pigs, no immunity was developed initially, when the host became resistant to challenge after second infection.

Coccidians are able to impart immunity in varying grades. A single dose of *E. maxima* produces immunity in the domestic fowl whereas several doses of *E. acervulina* fail to do so (Ruff and Reid, 1977). Kennith *et al.* (1977) cited many works reporting humoral antibodies to coccidia in calves, rabbits and mice. However blood or serum from immune hosts failed to produce any response when inoculated into susceptible hosts. Both humoral and cellular immunity play an important role in immunity to coccidiosis. Protection by cells or cell fractions has given very satisfactory results in rat coccidia (Rommel and Heydorn 1971, Liburd *et al.* 1973). The cellular factor is held responsible for immunity to coccidiosis in *E. stiedai* infection (Klesius *et al.* 1973) and *E. tenella* in chicken (Leathem and Burns 1967). Infection of partially immunized hosts acts as a boosting antigenic stimulus in the life-cycle of a parasite (Rose, 1973). The antibodies found in the alimentary canal (copro-antibodies) may be important for immunological defence against infection with intestinal coccidia.

The participation of cellular and / or humoral immunity in the development of coccidial immunity still remains far from clear. The interactions that occur therein are not known to a greater extent.

Finally, it can be concluded that the parasite survives at the expense of its host while causing no deaths. In order to fulfil this objective some biological, physiological and immunological factors play a vital role.

VIII. PHYLOGENY

It is now customary to believe that gregarines are the basal stock in the Sporozoa from which the Coccidia have evolved. According to Baker (1969), this evolution has proceeded to a single main line as sarcomastigophora-gregarina-coccidia-Eimeriina. He also reviewed the evolution of the different groups of Protozoa earlier (1965).

Kudo (1966) thought that the Sporozoa as a whole have a polyphyletic origin. The presence of flagellated microgametes in coccidia indicates that this group as a whole might have originated from the gregarine *Selenococcidium*.

The parasites which restrict themselves to the gut or cells of the alimentary canal of one host (homoxenous), invertebrate or vertebrate, to complete their life-cycle are regarded as the earliest representatives of the group. Some of the vertebrate parasites go deeper into the host cell and a few adapt further by invading the blood and spending part of their life-cycle into the circulation. These parasites can be treated as specialised ones with a tendency to acquire a heteroxenous life-cycle, in which both invertebrate and vertebrate hosts are essential. Sometimes, of course, the invertebrate hosts act only as transmitters.

While reviewing the localization of tissue stages of the parasites at different regions, Hammond and Long (1973) stated that the occurrence of a portion of the life-cycle in cells other than those of the epithelial surface of the intestine may indicate that the species in question is at a more advanced evolutionary stage than those which live in cells at the surface.

Scholtyssek (1974) stated that the protococcidia without schizogony can be treated at the original subgroup of the coccidia. The schizogregarines and the schizococcidia came later in evolution.

In the family Eimeriidae, most of the genera require only one host to complete their life-cycle. They live in the epithelial cells of the intestine of the vertebrate, discharge their oocysts outside the host, and the sporogony takes place with the formation of sporozoites. New infections occur when the new hosts ingest oocysts.

IX. SYSTEMATIC CLASSIFICATION

The family Eimeriidae includes the organisms generally known as coccidian parasites. The systematic classification of coccidian parasites, started in the early part of the present century and was based generally on morphological features ; sometimes biological characteristics were also considered. Authors like Minchin (1912), Reichenow (1921b, 1929) and Wenyon (1926) classified the coccidian on the basis of the biological phenomena observed during development. Schneider (1881), Doflein (1916), Pinto (1928) and Hoare (1933) grouped these parasites according to the number of sporocysts or sporozoites formed after sporulation. Hoare (1933) divided the suborder Eimeriidea into 2 families Selenococcidiidae and Eimeriidae and

divided the Eimeriidae into 6 subfamilies. The criteria mentioned above were followed by most workers for higher taxa like families or genera, but for differentiation of species, the morphological characteristics of oocysts were mainly considered. Bhatia (1938) treated the coccidia as order with Adeledea and Eimeriidea as suborders and included the families Selenococcidae and Eimeriidae in the latter. He divided the family Eimeriidae into 7 subfamilies based on Hoare (1933) and provided keys to the subfamilies and genera. He (1949, 1957) also gave more importance on the periodic system of homologous genera in classifying the family Eimeriidae. Hall (1953) treated these parasites as subclass Coccidia with Adeleida and Eimeriida as 2 suborders and recognised 6 families under the later including the family Eimeriidae. Levine (1961) placed the family Eimeriidae under order Eucoccidiorida and suborder Eimeriorina and defined them as : "Members of this family have a single host. Schizogony and gametogony take place within the host cells, and sporogony ordinarily occurs outside the hosts' body". He also followed Hoare (1933) diagrammed the mathematical division into genera of the family Eimeriidae.

Pellerdy (1963) in his 'Katalog der Eimeriidea' accepted the four families Selenococcidiidae, Eimeriidae, Aggregatidae and Dobellidae and placed 17 genera in the family Eimeriidae. In the scheme proposed by a committee of the Society of Protozoologists, Honigberg *et al.* (1964) classified the subphylum Sporozoa with the coccidia as one of the sub-classes, which contained the orders Protococcidiida and Eucoccidiida. The suborders Adeliina, Eimeriina and Haemosporina were placed under the Eucoccidiida.

However, Poljanskij and Cheissin (1965), while revising Dogeil's General Protozoology placed the suborder Eimeriidea under the order Coccidiida in the subclass Coccidia (= Coccidiomorpha). In a discussion on the classification of Protozoa (Second International Conference on Protozoology held in London (1966) Cheissin stated "In my opinion it would be the most correct to divide the subclass Coccidia into three orders Protococcida, Adeleida and Coccidiida but not into two : Protococcida and Eucoccida", while reviewing the systematic classification of the Coccidia, Pellerdy (1965) placed Eimeriidae under suborder Eimeriidea with another two families Selenococcidiidae and Dobelliidae. In his monograph 'Coccidia and Coccidiosis' he used 8 subfamilies under the family Eimeriidae based on the classification established by Hoare (1933).

Kudo (1966) placed the family Eimeriidae under order Coccidia and suborder Eimeriina with the families Selenococcidiidae, Aggregatidae

and Dobelliidae. Baker (1969) adopted the revised classification of Honigberg *et al.* (1964) and considered the higher taxa, i.e., sub-families and genera of the suborder Eimeriina, to be thought by Pellerdy (1965). The same authors further stated, "The classification of the family Eimeriidae is much disputed and the version of Pellerdy (1965) is probably too artificial"

In his "Supplementum of the "Katalog der Eimeriidea", Pellerdy (1969) excluded the family Dobelliidae and incorporated all its genera into the family Aggregatidae. The number of genera in the family Eimeriidae included by both Kudo (1966) and Pellerdy (1963, 1969) were almost same except for the genera *Octosporella*, *Pythonella*, *Yakimovella*, *Hoarella* and *Sivatoshella*. Of course, the last two genera were recently described and perhaps due to this they could not incorporate them into their books. At any rate, Pellerdy (1969) included 19 genera in the family Eimeriidae in his supplementum this has with seven sub-families viz. Cryptosporidiinae, Caryosporinae, Cyclosporinae, Eimeriinae, Yakimovellinae, Phytonellinae and Barrouxiinae. Cheissin / Kheysin (1972) in his "Life-cycle of Coccidia in domestic animals" [Translated from Russian by F. K. (Jr.) Plous and edited by K. S. (Jr.) Todd], classified the group as order Coccidiida and suborder Eimeriidea with the four families Selenococcidiidae, Eimeriidae, Lankesterellidae and Aggregatidae. Levine (1973a, b) used the families Sarcocystidae, Lankesterellidae and Eimeriidae and included the genus *Toxoplasma* under the Sarcocystidae ; *Lankesterella* under Lankestereliidae, *Cryptosporidium*, under Cryptosporidiidae, and 14 genera viz. *Eimeria*, *Isospora*, *Barrouxia*, *Caryospora*, *Cyclospora*, *Dorisiella*, *Tyzzeria*, *Wenyonella*, *Mantonella*, *Octosporella*, *Sivatoshella*, *Yakimovella*, *Hoarella* and *Pythonella* under the family Eimeriidae. The same author (1980) erected the genus *Dorisa* with the type species *hoarei* (Yakimoff and Gousseff, 1933) and placed under the family Eimeriidae after differentiating from the genus *Dorisiella* Ray (1930) on the basis of their occurrence in vertebrate or invertebrate hosts, though both are having disporocystic octozoic oocyst. The organisms invading the vertebrate hosts have been brought under the genus *Dorisa* and those occurring in invertebrates have been retained under the genus *Dorisiella*. Moreover, the former has a definite oocystic wall whereas the later bears the discernable oocystic wall. This proposition has now been widely accepted and also followed in the present context. Scholtyseck (1974) thought that *Toxoplasma* should be put in a subfamily of the Eimeriidae and the Haemosporidia were a suborder of the Schizococcidia. Frenkel

(1977) gave more stress to the life-cycle in classifying this group and proposed that the homoxenous species of the genus *Isospora* with disporocystic oocysts and tetrazoic sporocysts having a Stieda body could be placed under the family Eimeriidae and the cyst forming genera namely *Cystoisospora*, *Toxoplasma* and *Sarcocystis* without a Stieda body in the sporocyst would be included under the family Sarcocystidae. Levine *et al.* (1980) considered the Sporozoa a class under the phylum Apicomplexa, the Coccidia as subclass in which the three orders Agamococcidiida, Protococcidiida and Eucoccidiida were erected with three (Adelina, Eimeriina and Haemosporina) suborders under the later order. The adeline group was distinguished by the fact that males and females develop in association with each other (syzygy as in gregarines). Most of them live in red or white blood cells and sometimes in the other vertebrate cells. The Eimeriina distinguished from the adelines by the absence of syzygy; the family Eimeriidae occurs here. The Haemosporina are obligate intracellular parasites and have two hosts; a vertebrate, in which asexual reproduction or schizogony occurs and in invertebrate in which sexual reproduction occurs. However, the family Eimeriidae can be defined as the group of organisms whose macro and micro-gametocytes develop independently, whose microgametocytes produce many gametes, and which have an oocyst without any attachment organelle, formed from a pair of anisogametes with a variable number of sporocysts containing one to many sporozoites. They are monoxenous and inhabit the cells of vertebrates though some are found in deeper tissues a few occur in molluscs, arthropods and other invertebrates. The microgamete having two or three flagella.

X. GENERA OF THE FAMILY EIMERIIDAE ALONG WITH THE NUMBER
OF SPECIES IN EACH HOST GROUP FROM INDIAN SUBCONTINENT

Sl. No.	Name of the genus	Number of Sporocysts present	Number of Sporozoites present	(Host group)						
				Centi- pede	Insec- ta	Pisces	Amphi- bia	Repti- lia	Aves	Mamma- lia
				(Number of Species)*						
1.	<i>Eimeria</i>	4	2	1	1	14	3	18	53	93
2.	<i>Isospora</i>	2	4				2	5	36	28
3.	<i>Caryospora</i>	1	8					2		
4.	<i>Dorisa</i>	2	8						6	1
5.	<i>Tyzzeria</i>	0	8						3	
6.	<i>Wenyonella</i>	4	4						7	1
7.	<i>Octosporella</i>	8	2					1		
8.	<i>Sivatoshella</i>	2	16						1	
9.	<i>Pythonella</i>	16	4					1		

* Number of species mentioned includes the undetermined species.

XI. SYSTEMATIC ACCOUNT

Family **Eimeriidae** (Minchin, 1903)

Macro and micro-gametocytes develop independently and micro-gametocyte produces many gametes. The oocyst formed from a pair of anisogametes has 0, 1, 2 or many sporocysts each with one to many sporozoites. Oocyst is devoid of any attachment organelle. Development (schizogony/merogony) within the host cell and sporogony outside the host. Monoxenous, microgamete having two or three flagella.

Type genus : **Eimeria** Schneider, 1875.

Type host : **Mus musculus**, Rodentia, Muridae

Key to the genera of the family Eimeriidae

1. Oocyst with sporocyst	...	2
Oocyst without sporocyst	...	<i>Tyzzeria</i>
2. Oocyst with one sporocyst	...	3
Oocyst with more than one sporocyst	...	4
3. Sporocyst with 4 sporozoites	...	<i>Mantonella</i>
Sporocyst with 8 sporozoites	...	<i>Caryospora</i>
4. Oocyst with 2 sporocysts	...	5
Oocyst with 4 sporocysts	...	7
Oocyst with 8 sporocysts	...	8
Oocyst with 16 sporocysts	...	9
Oocyst with more than 16 sporocysts	...	<i>Barrouxia</i>
5. Each sporocyst with 2 sporozoites	...	<i>Cyclospora</i>
Each sporocyst with 4 sporozoites	...	<i>Isospora</i>
Each sporocyst with 8 sporozoites	...	6
Each sporocyst with 16 sporozoites	...	<i>Sivatoshella</i>
6. Species occurring in invertebrate hosts	...	<i>Dorisiella</i>
Species occurring in vertebrate hosts	...	<i>Dorisa</i>
7. Each sporocyst with 2 sporozoites	...	<i>Eimeria</i>
Each sporocyst with 4 sporozoites	...	<i>Wenyonella</i>
8. Each sporocyst with 2 sporozoites	...	<i>Octosporella</i>
Each sporocyst with more than 2 sporozoites...	...	<i>Yakimovella</i>
9. Each sporocyst with 2 sporozoites	...	<i>Hoarella</i>
Each sporocyst with 4 sporozoites	...	<i>Pythonella</i>

(i) Genus **Tyzzeria** Allen, 1936

1936. *Tyzzeria* Allen, *Arch. Protistenk.*, 87 : 262 ; Type species : *perniciosa* Allen.
Oocyst having eight naked sporozoites ; without any sporocyst.

Type host : **Anas domestica**, Aves : Anseriformes

Three species of this genus have been reported only from birds so far within our limit.

PARASITES OF BIRDS

Key to the species

A. Oocyst oval	...	...	(I)
(1) Size of oocyst	14.48-17.3 μm by 9.63-11.5 μm		<i>T. alleni</i>
Oocyst not oval	...	...	(I) (II)
(i) Oocyst broadly cylindrical, size of oocyst	20.4-27.0 μm by 14.0-20.0 μm	...	<i>T. chenicusae</i>
(ii) Oocyst subspherical to ovoidal, size of oocyst	11.0-16.0 μm by 6.0-11.0 μm	...	<i>T. pellerdyi</i>

1. *Tyzzeria alleni* Chakravarty and Basu

1947. *Tyzzeria allenae* Chakravarty and Basu, *Sci. Cult.*, Calcutta, 12 : 106.

1974. *Tyzzeria alleni* Chakrabarty and Basu, emended., Pellerdy, *Coccidia and Coccidiosis*, Verlag Paul Parey, Berlin und Hamburg, p. 170.

Description : Oocysts oval, immature one is completely filled up with the zygotic mass consisting of a large number of refractile granules. Micropyle present, oocystic residuum absent. Oocyst measures 14.4-17.3 μm in length with a mean of 16.5 and 9.6-11.5 μm in width with a mean of 10.5 μm . The shape index is 1.56. The residual mass is 6.4 μm in diameter. Sporozoites are spherical in shape in early stages and later on become elongated each having a rounded posterior and pointed anterior ends. It measures 5.5-6.8 μm with centrally placed spherical nucleus measuring about 2.4 μm in diameter.

Sporulation time : 24-36 hours.

Type host : Cotton Teal, *Nettapus coromandelianus* Gmelin.

Other hosts : None.

Distribution : Bidyadhari Spill area, Mohis Bathan, 24-Parganas, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

2. *Tyzzeria chenicusae* Ray and Sarkar

1967. *Tyzzeria chenicusae* Ray and Sarkar, *J. Protozool.*, 14, 27 (Suppl.).

Description : Oocyst broadly cylindrical, measuring 20.4-27.6 μm in length and 14.0-20.4 μm in width (average $24.84 \times 16.8 \mu\text{m}$). The shape index 1.5. Micropyle absent, outer wall thick and the inner one is thin. The sporozoites are clubshaped, each measuring 13.2 μm

in length and $4.2\ \mu\text{m}$ in width. They are usually arranged in a circular fashion around a granular mass of residual body, placed towards the broader pole of the sporozoites.

Sporulation time : 3-5 days.

Type host : Cotton Teal, *Chenicus* (= *Nettapus*) *coromandelianus* Gmelin.

Other hosts : Unknown.

Distribution : Basirhat, 24-Parganas, West Bengal.

Endogenous stages : Development is completed within 6 days. No detailed account on the endogenous developmental stages are published but some have been mentioned in the D. Phil. Thesis (A.C.S.).

Types : Not known.

3. *Tyzzeria pellerdyi* Bhatia and Pande

(Fig. 20)

1966. *Tyzzeria pellerdyi* Bhatia and Pande, *Acta vet. hung.*, 16 : 335.

Description : Oocyst subspherical to ovoidal in shape, measuring $11.0\text{-}16.0\ \mu\text{m}$ in length with a mean of $13.0\ \mu\text{m}$ and $8.0\text{-}11.0\ \mu\text{m}$ in width with a mean of $10.0\ \mu\text{m}$. The oocystic wall smooth and colourless of $0.5\text{-}0.7\ \mu\text{m}$ in thickness. Micropyle and micropylar cap absent.

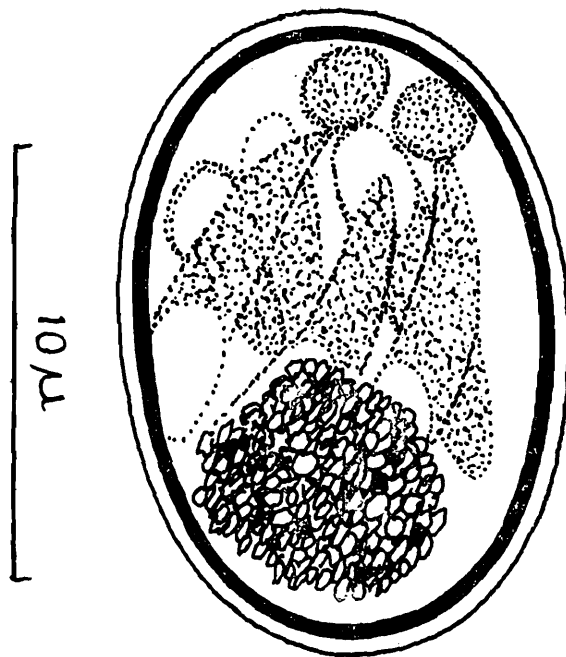


Fig. 20. Mature Oocyst of *Tyzzeria pellerdyi*.

Sporont coarsely granular, almost filling the oocyst ; oocystic residuum 4.0-5.0 μm in diameter, compact, central or polar, darkly granular with different sized globules. Polar granules absent. Sporozoites banana-shaped, each measuring 8.0-10.0 μm in length with a mean of 8.5 μm and 1.7-2.2 μm in width with mean of 2.0 μm , with centrally placed nucleus and a prominent globule at the broader end—the other end being tapering.

Sporulation time : Unknown.

Type host : Gadwall, *Anas strepera* Linn.

Other hosts : (1) White-eyed Pochard, *Aythya nyrioca* (Güld.)
(2) Wild goose, *Anser indicus* (Latham) possibly from Mathura, Uttar Pradesh.

Distribution : Gorakhpur, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Mathura Veterinary College, Mathura, Uttar Pradesh.

Remarks : Bhatia (1968) may be consulted for the hosts record.

(ii) Genus *Caryospora* Leger, 1904

1904. *Karyospora* Leger, transliterated *Caryospora* Leger, *Bull. Ass. fr. Avanc. Sci.*, 9 : 269, Type species : *simplex* Leger.
1933. *Eumonospora* Allen, *Trans. Am. microsc. Soc.*, 52 : 192 ; Type species : *tremula* Allen.
1934. *Caryospora* Hoare, *Trans. Am. microsc. Soc.*, 53 : 6 ; Type species : *tremula* Hoare.

Single sporocyst inside the oocyst, with eight sporozoites.

Type host : *Verpia aspis*, Reptilia : Ophidia.

Represented by two species, occurring in reptile.

PARASITES OF REPTILES

Key to the species

1. Oocyst spherical		
(i) Sporocyst spherical	...	<i>C. gekkonis</i>
(ii) Sporocyst pear-shaped	...	<i>C. bengalensis</i>

4. *Caryospora gekkonis* Chakravarty and Kar (Fig. 21)

1947. *Caryospora gekkonis* Chakravarty and Kar, *J. R. Assist. Soc. Beng.*, 12 : 3.

Description : Oocyst spherical, measuring 18.5-20.8 μm in diameter

with a mean of $19.7\ \mu\text{m}$, double walled, inner wall being $1.1\ \mu\text{m}$ in thickness ; no oocystic residum ; micropyle present. Sporocyst single, almost spherical, thin-walled and measures $10.5\text{-}12.5\ \mu\text{m}$ with a mean of $11.5\ \mu\text{m}$ in diameter. A blunt knob like refractile part is drawn out

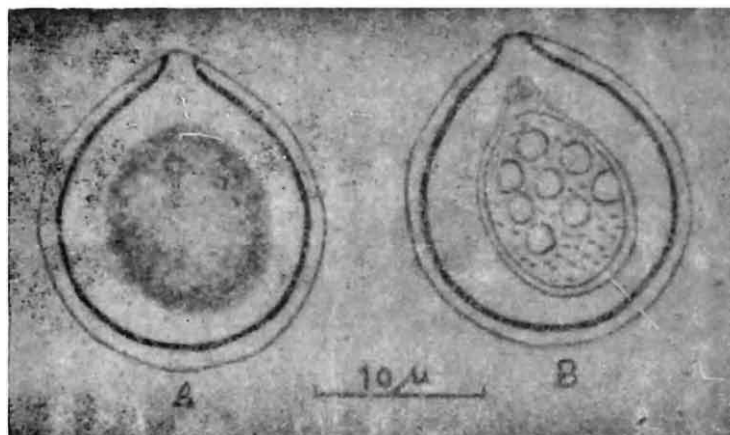


Fig. 21. A, immature and B, mature oocysts of *Caryospora gekkonis*.

from one end. Sporocystic residum scattered as diffuse residual mass. The sporozoites are 8 in number, almost spherical in shape and each measures $2.5\ \mu\text{m}$ in diameter.

Sporulation time : 30-50 hours.

Type host : Takhak or Indian gekko, *Gekko gekko* (Linn.)

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Remarks : Mandal (1976) redescribed this species.

Types : Likely to be present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

5. *Caryospora bengalensis* Mandal

(Fig. 22)

1976. *Caryospora bengalensis* Mandal, *Acta. Protozool.*, 15 : 405.

Description : The oocysts are spherical in shape each measuring $20\ \mu\text{m}\text{-}22.5\ \mu\text{m}$ in diameter with a mean of $21.5\ \mu\text{m}$. The shape index is 1.07. The oocystic wall consists of double layers, appears very thin and with slight pressure it reaptures. A micropyle is visible on the wall

of the oocyst but devoid of any oocystic residuum. The cytoplasm of the oocyst is centrally placed and appears like a globular mass. Only one double-layered pear-shaped sporocyst, measuring $18\ \mu\text{m}$ - $20\ \mu\text{m}$ in length with a mean of $19\ \mu\text{m}$ and $12\ \mu\text{m}$ - $14\ \mu\text{m}$ in width with a mean of $13.5\ \mu\text{m}$ is seen inside the oocyst after development. The shape index of the sporocyst is 1.4. At the pointed end of the sporocyst a

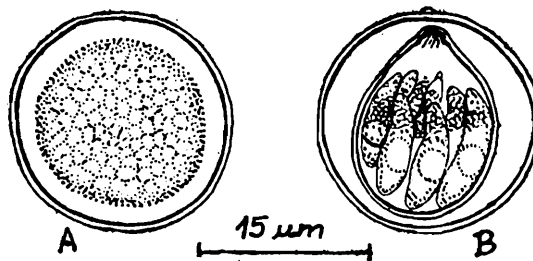


Fig. 22. A, immature and B, mature oocysts of *Caryospora bengalensis*.

stieda body with a shiny plug is found in the preparation. Sporocystic residuum is globular with many variable sized refractile granules scattered throughout. Eight bean-shaped sporozoites are seen, each measuring $10\ \mu\text{m}$ - $12\ \mu\text{m}$ length with a mean of $11.00\ \mu\text{m}$ and $2.5\ \mu\text{m}$ in at its broadest width, with a centrally placed nucleus.

Sporulation time : 50-72 hours at room temperature 30°C - 35°C .

Type host : Common water snake, *Enhydryis enhydryis* (Schneider).

Other hosts : Unknown.

Distribution : Chakdah, Nadia, West Bengal.

Endogenous stages : Unknown.

Types : In the National Collection of Zoological Survey of India, Registration No. Pt 1842.

(iii) Genus *Isospora* Schneider, 1881

- 1870. *Gregarina* Eimer (partim), *Über die ei-und Kugelörmigen sogenannten Psorospermien der Wibelthiere*. Wurzburg, p. ? Type species : ?
- 1878. *Cytospermium* Rivolta (partim), *Gior. Anat. Fisiol. Pat. Anim. Pisa*, 4 : 220, Type species : ?
- 1878. *Psorospermium* Rivolta (partim), *Ibid.*, 4 : 220, Type species : ?
- 1879. *Coccidium* Leuckart, *Die parasiten des Menschen und die Von inen herrührenden Krankheiten*. Leipzig, p. ? Type species : ?
- 1881. *Isospora* Schneider, *Archs. zool. exp. ge'n.*, 9 : 387. Type species : *rara* Schneider.

1893. *Diplospora* Labbé, *C. r. hebd. Se'anc. Acad. Sci.*, Paris, 116 : 1300. Type species : ?
1894. *Klossia* Labbé, *Archs. zool. exp. ge'n.*, 2 : 55. Type species : ?
1894. *Hyalosklossia* Labbé (partim). *C. r. hebd. Se'anc. Acad. Sci.*, Paris, 119 : 537. Type species : ?
1925. *Lucetina* Henry and Leblois, *C. r. hebd. Se'anc. Acad. Sci.*, Paris, 180 : 700 ; 1926, *Annals. Parasit. humb. comp.*, 4 : 22.

Sporocysts two in number inside the oocyst, each with four sporozoites.

Type host : *Limax cinereoniger* ; *Limax griseus*. Mollusca : Gastropoda.

In total 64 species are known ; two from amphibia, five from reptile, 33 from bird and 24 from mammal. In addition, three *Isospora* sp. from bird and four from mammal have been reported.

(A) PARASITIES OF AMPHIBIA

Key to the species

(A) Oocyst sub-cylindrical	
(i) size of oocyst 15.3-20.5 by 13.5-15.5 μm ...	<i>I. wenyoni</i>
(B) Oocyst broadly oval	
(ii) size of oocyst 24.5-26.5 by 15.5-19.5 μm	<i>I. stomaticae</i>

6. *Isospora stomaticae* Chakravarty and Kar

(Fig. 23)

1944. *Isospora stomaticae* Chakravarty and Kar, *Proc. Indian Sci. Congr.*, p. 104 ; 1952. *Proc. zool. Soc. Calcutta*, 5 : 11.

Description : Oocyst oval or spherical, double layered, both the walls are very thin and without any residuum and micropyle. Oocyst measures 24.5-26.5 μm in length with a mean of 25.5 μm and 15.5-19.5 μm in width with a mean of 17.5 μm . The shade index is 1.5. The globular and refractile zygotic mass measures 20.4 μm in diameter. The sporocysts are egg-shaped, each with a thin sporocystic membrane and knob like structure at the anterior end (stieda body). The sporocyst measures 15.5-17.5 μm in length with a mean of 16.5 μm and 10.5-11.5 μm in width with a mean of 10.9 μm . The sporocystic residuum present as granular mass. The shape index is 1.5. Sporozoite elongated, measuring 12.5-14.8 μm in length and 2.5-4.5 μm in width with one of

the end narrower than the other. Nucleus is centrally placed and oval in shape.

Sporulation time : 48-60 hours.

Type host : Marbled Toad, *Bufo stomaticus* Lutken.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : In the epithelial cells of the small intestine spherical schizonts are found, each measuring $6.6\ \mu\text{m}$ by $3.2\ \mu\text{m}$. The mature schizont bears 8-12 elongated merozoites, each measures $6.6\ \mu\text{m}$ by $3.2\ \mu\text{m}$. The microgametocyte measures $17.1-19.3\ \mu\text{m}$ by $8.6-12.8\ \mu\text{m}$

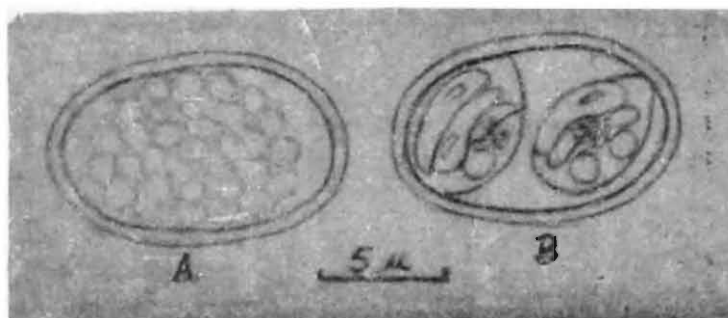


Fig. 23. A, immature and B, mature oocysts of *Isospora stomaticae*

in size and each microgamete measures $3.2-4.3\ \mu\text{m}$ long. Macrogametocytes are round or oval each produces an oval macrogamete measuring $15\ \mu\text{m}$ in diameter. The macrogamete is provided with granular cytoplasm with a conspicuous nucleus.

Remarks : Pellerdy (1974) has made a comment that specific name should be spelt as '*stomatici*' and not '*stomaticae*' which is correct as per rule. Mandal (1976) collected the Topotype and redescribed the species.

Types : Likely to be present in the Protogoology Laboratory, Dept. of Zoology, Calcutta University.

7. *Isospora wenyoni* Ray and Das Gupta (Fig. 24)

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

Description : Oocyst subcylindrical, double layered with thick inner layer. It measures $15.3-20.5\ \mu\text{m}$ in length with a mean of $17.5\ \mu\text{m}$ and

13.5-15.5 μm in width with a mean of 14.5 μm . The shape index is 1.2. Cytoplasm compact and refractile. Oocystic residuum present and micropyle absent. Sporocyst is oval at immature stage and becomes naviculoid afterwards. It measures 10.0-13.5 μm in length with a mean of 11.8 μm and 7.5 μm -9.5 μm in width with a mean of 8.5 μm . The shape index is 1.3. Sporocystic residuum present as compact mass. Sporozoite elongated tapering at one end. The nucleus is situated at the posterior end.

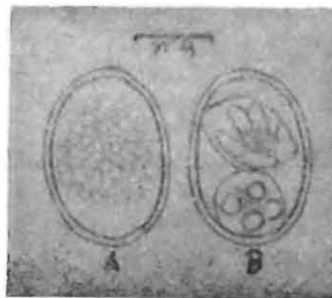


Fig. 24. A, immature and B, mature oocysts of *Isospora wenyoni*.

Sporulation time : 60-70 hours.

Type host : Indian common Toad, *Bufo melanostictus* Schneider.

Other hosts : (1) Indian Bull frog, *Rana tigrina* Daudin.

(2) Paddy-field frog, *Rana limnocharis* Wiegmann.

Distribution : Calcutta, West Bengal.

Endogenous stages : In the epithelial cells of small intestine the early schizonts are found, each measuring 10 μm by 3 μm in size. Mature schizont measures 20-25 μm in diameter. Eight to twelve merozoites, each measuring 12 μm in length and 5 μm in width at its broadest diameter, are present inside the mature schizont. The microgamete measures 2.4 μm by 1.5 μm and provided with a residuum within the microgametocyte. The macrogamete measures 16-20 μm by 11-14 μm in size each is provided with a distinct nucleus.

Types : Lying in the collections of Protogoology Laboratory, Dept. of Zoology, Calcutta University.

Remarks : Bhatia (1938), Chakravarty and Kar (1952) and Mandal (1976) may be consulted for the hosts records and emended description of the species.

(B) PARASITES OF REPTILES

Key to the species

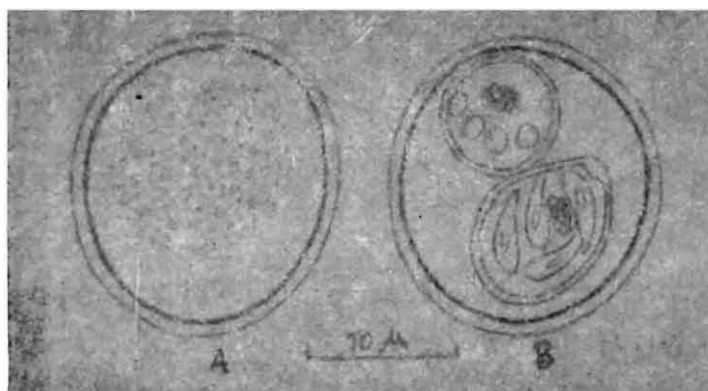
(A) Oocyst irregular	...	...	<i>I. dirumpens</i>
(B) Oocyst cylindrical	...	...	<i>I. minuta</i>
(C) Oocyst spherical or subspherical			
(i) Sporocyst naviculoid	...	...	<i>I. rayi</i>
(ii) Sporocyst elliptical or ellipsoidal			
(a) Oocyst 17.5-23.14 μm in diameter	...	...	<i>I. knowlesi</i>
(b) Oocyst 25.00-37.00 μm in diameter	...	...	<i>I. calotesi</i>

8. *Isospora calotesi* Bhatia

(Fig. 25)

1938. *Isospora* sp. Setna, *Curr. Sci.*, 2 : 97.1938. *Isospora calotesi* Bhatia, *The Fauna of British India, including Ceylon and Burma*, Protozoa : Sporozoa, Taylor and Francis, London, p. 167.

Description : Both unsporulated and sporulated oocysts are usually spherical or subspherical in shape each is provided with double-layer and a micropyle but without any oocystic residuum. The oocyst measures 25.0-37.0 μm with a mean of 32.5 μm . The sporocysts are elliptical in shape, with a small knob at the anterior end (Stieda body) and round posterior end. In some cases the posterior end abruptly

Fig. 25. A, immature and B, mature oocysts of *Isospora calotesi*.

tapers to a blunt point. The sporocystic residual body is aggregated together into an irregular mass. The sporocyst measures 12.5-17.5 μm in length with a mean of 14.5 μm and 9.5-10.5 μm in width with a mean of 9.8 μm . The shape index is 1.5. The sporozoites are irregularly arranged and elongated in shape with one of the ends pointed and other

rounded. The spherical nucleus is situated at the centre. It measures 12.00 μm in length and 2.5 μm in width.

Sporulation time : 48 to 60 hours.

Type host : Garden lizard, *Calotes versicolor* (Daudin).

Other hosts : From the type host.

Distribution : Bombay, Maharastra ; Calcutta, West Bengal.

Endogenous stages : The endogenous stages are found in the intestinal epithelium. The schizonts are round each measuring 22 μm by 17 μm produce two type of merozoites. Small meozoites are vermiform in shape. Sometimes schizonts with large merozoites along with central residud bodies have also been observed by Chakravarty and Kar, 1947. They have also observed with some other schizonts with 100 merozoites. The gametocytes develop within the epithelial cells.

Types : Likely to be present in the Protozoology Laboratory, Dept. of Zoology, Calcutta Univesity.

Remarks : All that is known regarding this species are from the work of Chakravarty and Kar, 1947. The detail morphology of the oocyst can be had from Mandal (1976).

9. *Isospora dirumpens* Hoare

1933. *Isospora dirumpens* Hoare, *Parasitology*, 25 : 359.

Description : The thin-walled unraptured oocyst measures 15.2-16.8 μm in length and 9.6-11.2 μm in width containing mature spores. Sporulation occurs inside the host tissues and generally free sporocysts are available in the faeces. These are ellipsoidal in shape, have well developed yellowish walls and show no evidence whatever of structure at the pole. The sporocyst measures 10.4-11.2 μm in length and 8-9 μm in width or 7.5-10.5 μm by 6-9 μm . The sporozoite elongated with one end tapering and 7 μm long. It lies at random around an inner residual body represented by coarse irregular shaped granules. No other residual body is present.

Type host : Puff Adder, *Bitis arietans*.

Other hosts : Grass snake, *Natrix platyceps* (Blyth).

Distribution : Uganda, Africa ; Mukteswar, Uttar Pradesh.

Endogenous stages : Endogenous development takes place in the small intestine. Gametogonic stages are found in the sub-epithelial and

intraepithelial layers (Hoare, 1933). Ray and Singh (1948) reported this species from Grass Snake, *Natrix platycepes*.

Types : Not known.

10. *Isospora knowlesi* Ray and Das Gupta

(Fig. 26)

1935. *Isospora* sp. Knowles and Das Gupta, *Indian J. med. Res.*, 22 : 701.

1937. *Isospora knowlesi* Ray and Das Gupta, *Arch. Protistenk.*, 88 : 269.

Description : Spherical oocyst with double layer of $1.5\ \mu\text{m}$ thickness. The outer one being thinner than the thick inner one. The oocyst measures $17.5\text{-}23.14\ \mu\text{m}$ in diameter with a mean of $21.7\ \mu\text{m}$. The refractile and granular cytoplasm measures $15.5\text{-}17.3\ \mu\text{m}$ in diameter. Oocystic residuum and micropyle absent. Sporocyst ellipsoidal,

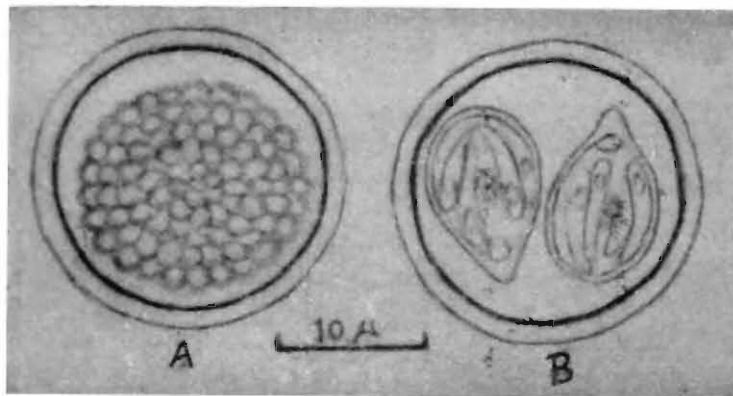


Fig. 26. A, immature and B, mature oocysts of *Isospora knowlesi*.

measuring $12\text{-}0\text{-}15.5\ \mu\text{m}$ in length with a mean of $14.3\ \mu\text{m}$ and $7.3\text{-}10.5\ \mu\text{m}$ in width with a mean of $8.5\ \mu\text{m}$. The shape index is 1.7. Sporozoite elongated tapering at one end, measuring $10.5\text{-}12.5\ \mu\text{m}$ in length.

Sporulation time : 4-5 days.

Type host : House lizard, *Hemidactylus flaviviridis* (Ruppell).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Sporozoites penetrate the intestinal epithelial cells and lie within the parasitophorus vacuoles. The schizonts are

surrounded by the host cells in a ring like fashion. Mature schizonts produce merozoites each measures $8.2\ \mu\text{m}$ by $2\ \mu\text{m}$ with a small karyosome. The mature micragametocyte develops microgametes each measuring $4\text{--}5\ \mu\text{m}$ in length, and carrying two flagella.

Types : Not known.

Remarks : The describer could only come across few schizogonic stages in the intestine and presumed that the process of schizogony might have taken place rapidly. Mandal (1976) redescribed the species.

11. *Isospora minuta* Mitra and Das Gupta

(Fig. 27)

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

Description : Oocyst cylindrical, with a thin single membrane. It measures $14.5\text{--}16.5\ \mu\text{m}$ in length with a mean of $15.5\ \mu\text{m}$ and $6.8\text{--}8.5\ \mu\text{m}$

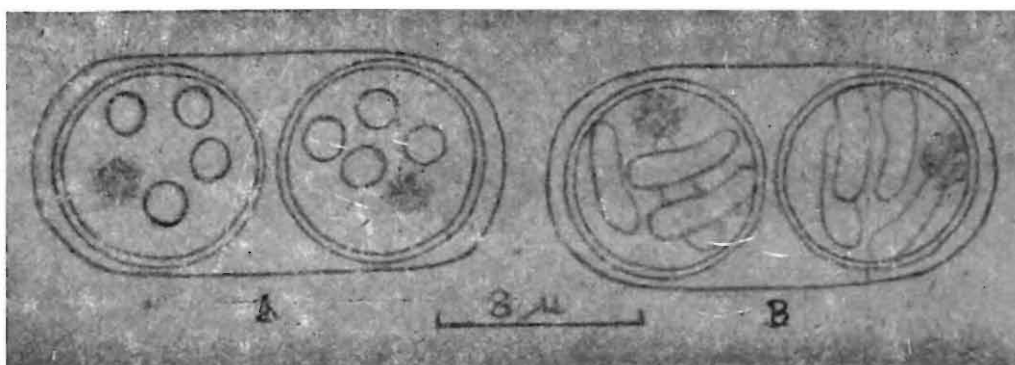


Fig. 27. A, immature and B, mature oocysts of *Isospora minuta*.

in width with a mean of $7.7\ \mu\text{m}$. The shape index is 2.01. No oocystic residuum or any micropyle is seen. The sporocyst spherical in shape measuring $6.5\text{--}9.9\ \mu\text{m}$ in diameter with a mean of $7.7\ \mu\text{m}$. Sporocystic residuum present as compact mass. The sporozoites are elongated tapering at one end measuring $3.5\text{--}4.6\ \mu\text{m}$ in length.

Sporulation time : 50—72 hours.

Type host : Cobra, *Naja naja* Linn.

Other hosts : From the type host and The King Cobra, *N. hanah* (Linn.)

Distribution : Calcutta, West Bengal ; Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Das Gupta (1938) described the species in details followed by Bhatia (1938) and Mandal (1976).

12. *Isospora rayi* Mandal
(Fig. 28)

1966. *Isospora rayi* Mandal, *Sci. Cult.*, 32 : 507.

Description : Immature oocyst spherical in shape with double envelop, the outer wall thin and membranous while the inner one is thick, yellowish red in normal light, measures 1.00-1.50 μm in

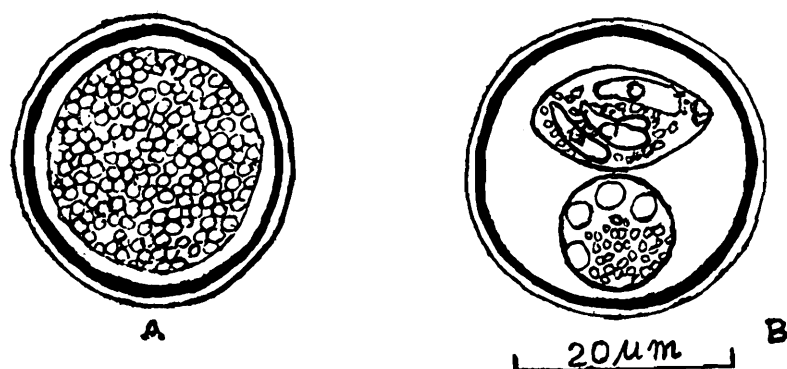


Fig. 28. A, immature and B, mature oocysts of *Isospora rayi*.

thickness ; centrally placed spherical cytoplasm measures 20.0-20.8 μm in diameter and appears as beaded, refringent, refractile globules. Mature oocyst measures 25.5-27.4 μm in diameter with a mean of 26.3 μm , oocystic residuum and micropyle absent. Sporocyst naviculoid in shape, tapering at both ends, measuring 14.5-16.3 μm in length and 9.15-10.5 μm in breadth with a mean of 15.4 μm by 9.75 μm and the shape index is 1.5. Blackish sporocystic residuum is visible as shiny globular materials and scattered irregularly inside the sporocyst. Bean-shaped sporozoite measures 7.5-8.15 μm in length with a mean of 7.9 μm , nucleus is situated at the middle of each sporozoite and appears as a refractile area.

Sporulation time : 50 —60 hours.

Type host : Garden Lizard, *Ptyctolaemus* sp.

Other hosts : Unknown.

Distribution : Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Likely to be present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

(C) PARASITES OF BIRDS

Key to the species

1. Sporocyst pear-shaped
 - (A) Wall of the oocyst showed a bulbous thickening *I. bellericae*
2. Sporocyst ovoid, oval or ellipsoidal
 - (A) Oocyst subspherical
 - (i) Size of the oocyst above 20 μm
 - (ii) Size of the oocyst below 20 μm ... *I. cheeli*
 - (a) Size of sporocyst $15-17 \times 10-12 \mu\text{m}$... *I. temenuchii*
 - (b) Size of sporocyst $14-16 \times 9-10 \mu\text{m}$
 - (i) Sporozoite having one refractyle globule ... *I. koreani*
 - (ii) Sporozoite having two refractyle globule
 - (a) Size of sporozoites $10-14 \times 3-5 \mu\text{m}$... *I. rajuli*
 - (b) Size of Sporozoite $11.97 \times 2.66 \mu\text{m}$... *I. choudari*
 - (B) Oocyst spherical
 - (i) Size of oocyst $24.4-28.4 \mu\text{m}$... *I. upupae*
 - (C) Oocyst spherical to subspherical
 - (a) Size of sporocyst $16-18 \times 10-12 \mu\text{m}$ with sporozoites $12-12.4 \mu\text{m}$ in length ... *I. malabaricae*
 - (b) Size of sporocyst $16-22 \times 9-12 \mu\text{m}$ with sporozoites $13.3-16 \mu\text{m}$ in length ... *I. graculi*
 - (c) Size of sporocyst $11-16 \times 7-11 \mu\text{m}$ with sporozoites $12-13.3 \mu\text{m}$ in length ... *I. mandari*
 - (D) Oocyst oval
 - (i) Size of oocyst over 27 μm ... *I. psittaculae*
 - (ii) Size of oocyst below 27 μm ... *I. zosteropsis*
 - (a) Double layered outer thin
 - (b) Double layered uniformly thick
3. Sporocyst pyriform or spindle-shaped ... *I. ceylonensis*
 - (A) Oocyst with residuum
 - (i) Oocyst spherical or subspherical
 - (a) Size of oocyst 22-28 μm ... *I. parusi*
 - (b) Size of oocyst 15-22 μm
 - (i) Length of sporocyst above 12.00 μm ... *I. garrulae*
 - (ii) Length of sporocyst below 12.00 μm ... *I. corviae*
 - (II) Oocyst oval or ovoid
 - (a) Size of oocyst above $23.00 \mu\text{m} \times 20.00 \mu\text{m}$...
 - (i) Length of sporozoites above 10 μm ... *I. lonchcurae*
 - (ii) Length of sporozoites below 10 μm
 - (x) Width 2.7 μm ... *I. garrulusae*
 - (y) Width 3.3 μm ... *I. scircercusae*

(b)	Size of oocyst below 23.00 $\mu\text{m} \times 20.00 \mu\text{m}$	..	<i>I. emberizae</i>
(B)	Oocyst without residuum		
(I)	Oocyst oval		
(a)	Length of oocyst above 24 μm	...	<i>I. muniae</i>
(b)	Length of oocyst below 24 μm	...	<i>I. pycnonotae</i>
(II)	Oocyst spherical or sub-spherical		
(a)	Micropyle present		
(i)	Sporozoite elongated		
(x)	Size above 10.5 μm	...	<i>I. sturniae</i>
(y)	Size below 10.00 μm	...	<i>I. bengalensis</i>
(ii)	Sporozoite banana-shaped		
(x)	Size 6-7 μm	...	<i>I. mayuri</i>
(b)	Micropyle absent		
(i)	Sporozoites elongated		
(x)	Size above 10.00 μm		
(I)	With central nucleus	...	<i>I. ginginiana</i>
(II)	Without central nucleus	...	<i>I. concinnus</i>
(y)	Size below 7.00 μm	...	<i>I. megalaimae</i>
(ii)	Sporozoites bean-shaped	...	<i>I. lacazei</i>
(iii)	Sporozoites sausage-shaped	...	<i>I. gypsi</i>
(iv)	Sporozoites club-shaped	...	<i>I. capistrata</i>
4.	Sporocyst almond-shaped	...	<i>I. melopsittacus</i>

13. *Isospora bengalensis* Mandal and Chakravarty

(Fig. 29)

1964. *Isospora bengalensis* Mandal and Chakravarty, *Proc. zool. Soc. Calcutta*, 17 : 35.

Description : Oocyst spherical, double walled, the outerwall being thinner than the inner one, measuring 1.1 μm in thickness. It measures 18.7-23.3 μm in diameter with a mean of 20.5 μm . Cytoplasm is provided with highly refractile granules and measures about 16.5 μm in diameter. Micropyle present, oocystic residuum absent. Sporocyst pyriform in shape with a knob at the pointed anterior end, the posterior end being rounded. It measures 14.4-16.4 μm in length with a mean of 15.4 μm and 6.7-8.7 μm in width with a mean of 7.7 μm . The shape index is 2.0. Sporocystic residuum present as compact mass. Sporozoite is elongated in shape with anterior pointed end. It measures 8.8 μm by 3.3 μm with shape index 2.6. The sporozoites lie parallel to the long axis of the sporocysts, but the anterior end of two of them are directed towards the posterior end of the other two. Sometimes 3 sporocysts develop instead of the regular 2; in such cases two of them are small in size and each produced only two sporozoites instead of four.

Sporulation time : 48-60 hours.

Type host : House crow, *Corvus splendens* Vieillot.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

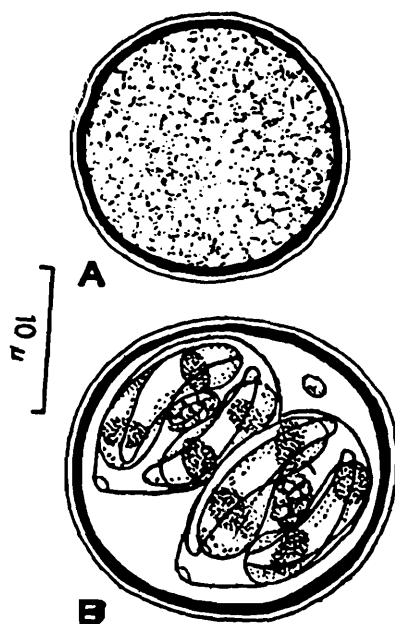


Fig. 29. A, immature and B, mature oocysts of *Isospora bengalensis*.

14. *Isospora bellericae* Banik and Ray

1962. *Isospora bellericae* Banik and Ray, *Bull. Calcutta Sch. trop. Med. Hyg.*, 10 : 16.

Description : Oocyst round or slightly oval, measuring 18.7-24.5 μm in length with a mean of 22.5 μm and 18.5-22.5 μm in width with a mean of 21.5 μm and provided with double wall. At one of the broader poles, the wall showed a bulbous thickening. The oocystic residuum and micropyle absent. Sporocyst pear-shaped with a prominent steida body. It measures 9.5-15.00 μm in length and 7.5-9.5 μm in width. The sporocystic residuum is centrally placed. The sporozoites are elongated in shape and the nucleus is centrally placed.

Sporulation time : 24-48 hours.

Type host : Crowned Crane, *Bellerica* (= *Bellearica*) *pavonina regulorum*.

Other hosts : Unknown.

Distribution : Zoological Garden, Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

15. *Isospora capistrata* Sinha and Sinha
(Fig. 30)

1981. *Isospora capistrata* Sinha and Sinha, *Acta. Protozool.*, 20 : 129.

Description : Oocyst is spherical in shape measuring 18.2-24.6 μm in diameter with a mean of 21.6 μm . The oocystic wall is smooth,

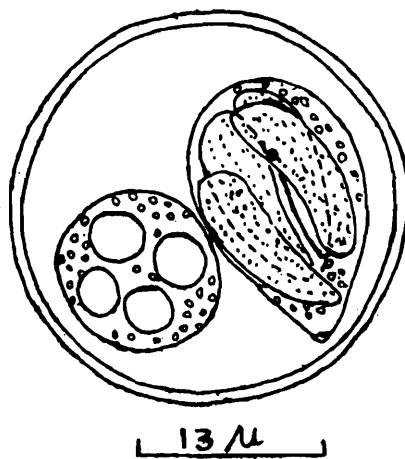


Fig. 30. Mature oocyst of *Isospora capistrata*.

bilayered with uniform thickness of 0.2 μm . The distance between the two walls is 0.65 μm . Oocystic residuum, micropyle, micropylar cap, polar body are absent. Sporocysts are two in number and pyriform in shape. The anterior end of each sporocyst is provided with a knob and the posterior one is rounded. Each sporocyst containing four sporozoites. It measures 11.0-16.9 μm in length and 8.8-10.4 μm in width with a mean of 14.6 μm by 9.6 μm . The single layered sporocystic wall measures 0.13 μm in thickness, and sporocystic residuum is 0.3 μm in diameter is present inside the sporocyst. Sporozoites are club shaped each measuring 7.5-10.2 μm in length and 1.8-2.5 μm in width with a mean of 9.0-2-2 μm .

Sporulation time : 36-48 hours.

Type host : Black-headed sibia, *Leioptila capistrata* Vigors [= *Hetropharia capistrata* (Vigors)].

Other hosts : Unknown.

Distribvtion : Darjeeling, West Bengal.

Location : Intestine.

Endogenous stages : The authors (Sinha and Sinha, 1981) studied the endogenous stages and recorded the ovoid trophozoite with a sub-central nucleus and a thin outer covering. It measures $5.6\ \mu\text{m}$ in length and $2.8\ \mu\text{m}$ in width. Multinucleated schizont provided with nine nuclei measures $7.9\ \mu\text{m}$ by $7.6\ \mu\text{m}$ is also encountered in the preparation. Microgametocyte spherical measuring $13\ \mu\text{m}$ in diameter having small nuclei arranged at the periphery. The mature one is provided with small comma shaped microgametes. A fertilised macrogamete is sub-spherical measuring $12.0\ \mu\text{m}$ by $10.0\ \mu\text{m}$. A clear halo is present around the endosome of the fertilised macrogamete.

Type : Lying with the author's collections.

16. *Isospora ceylonensis* Sinha, Chattoraj, Bandyopadhyay
and Ghosh

(Fig. 31)

1978. *Isospora ceylonensis* Sinha, Sinha, Chattoraj, Bandyopadhyay and Ghosh, *Acta-Protozool.*, 17 : 503.

Description : Oocyst oval or roundish in shape, measuring $20.5\text{--}26.5\ \mu\text{m}$ by $18\text{--}23\ \mu\text{m}$ with a mean of $24.8\ \mu\text{m}$ by $21.5\ \mu\text{m}$. Oocystic wall double layered of uniform thickness. Micropyle or oocystic residuum absent. Sporocysts are oval in shape each measuring $17.5\ \mu\text{m}$ by $18.5\ \mu\text{m}$ with a mean of $18\ \mu\text{m}$. Sporocystic residuum present as



Fig. 31. Mature oocyst of *Isospora ceylonensis*.

clusterous mass. Sporozoite elongated, measuring $10\ \mu\text{m}$ in length and $3\ \mu\text{m}$ in width with a centrally placed nucleus.

Sporulation time : 36-48 hours.

Type host : Common Himalayan grey-headed flycatcher, *Culicicapa ceylonensis calochrysea* Oberholser.

Locality : Known from the type locality, Darjeeling, West Bengal.

Endogenous stages : The describer found the schizogony-cycle in the entire length of the small intestine specially in the epithelial cells. Trophozoite oval with centrally placed nucleus, measuring $5.7\ \mu\text{m}$ by $3\ \mu\text{m}$. They have observed schizont with two or four nuclei. Merozoite measures $9.6\ \mu\text{m}$ by $4.6\ \mu\text{m}$ with centrally placed nucleus. Macrogametocytes round or oval each measuring $12\ \mu\text{m}$ by $9.8\ \mu\text{m}$ with a distinct nuclear membrane. Mature microgametocyte measures $15.7\ \mu\text{m}$ by $13\ \mu\text{m}$ packed compactly with small comma-shaped body.

Types : Lying with the collection of the describer.

17. *Isospora cheeli* Bhatia, Pande and Garg
(Fig. 32)

1970. *Isospora cheeli* Bhatia, Pande and Garg, *Indian J. Microbiol.*, 10 : 49.

Description : The oocyst measures $10\text{--}17\ \mu\text{m}$ in length with a mean of $14.3\ \mu\text{m}$ and $9.0\text{--}12.0\ \mu\text{m}$ in width with a mean of $10.7\ \mu\text{m}$. The length width ratio is $1.1\text{--}1.5$, mean 1.3 . The wall is almost colourless,

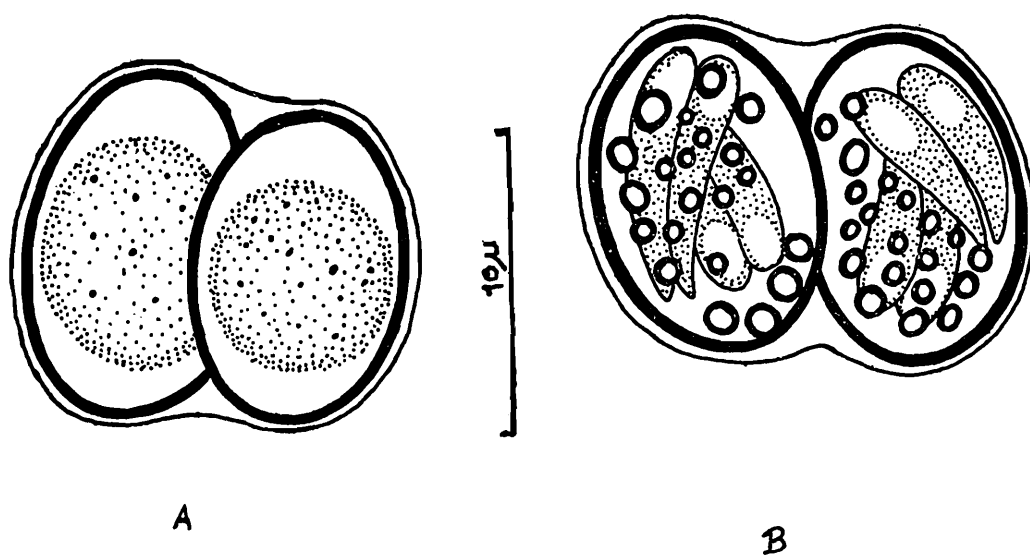


Fig. 32. A, immature and B, mature oocysts of *Isospora cheeli*.

delicate membrane and enclosed two sporocysts. Micropyle, polar cap, polar granule and oocystic residuum absent. The ellipsoidal sporocyst measuring $9.0\text{--}12.0\ \mu\text{m}$ in length with a mean of $10.5\ \mu\text{m}$ and $5.5\text{--}7.8\ \mu\text{m}$ in width with a mean of $6.8\ \mu\text{m}$. The length width ratio $1.3\text{--}1.8$ (mean 1.55). Sporocystic wall $0.43\ \mu\text{m}$ thick, straw-coloured lying either side by side or partly or completely overlapped. Sporocystic residuum present as prominent dark granules scattered around the four sporo-

zoites. Sporozoites elongated, each measuring $7.8\ \mu\text{m}$ in length and $1.7\ \mu\text{m}$ in width, with one end tapering and the other rounded, carrying an inconspicuous refractile globule with the nucleus near the centre.

Sporulation time : Unknown.

Type host : Paria Kite, *Milvus migrans* (Boddaert).

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Likely to be present in the Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

18. ***Isospora choudari*** Bhatia, Chauhan, Arora and Agarwal
(Fig. 33)

1972. *Isospora choudari* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 42 : 625.

Description : Oocyst subspherical, $20\text{--}27\ \mu\text{m}$ by $19.5\text{--}26.6\ \mu\text{m}$ (mean $24\ \mu\text{m}$ by $23.2\ \mu\text{m}$) in size. Oocystic wall $1.3\ \mu\text{m}$ thick, with outer light yellow and inner dark yellowish brown layers. Micropyle

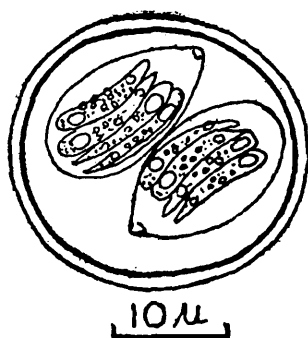


Fig. 33. Mature oocyst of *Isospora choudari*.

and polar cap absent. Oocystic residuum and polar granule absent. Sporocyst ellipsoidal with narrow ends ; lined by single-layered wall, measured $14.6\text{--}15.06\ \mu\text{m}$ by $9.1\text{--}9.3\ \mu\text{m}$; small button like stieda body present along with a coarse dark granular residuum. Sporozoite elongated, with one end broad and the other end tapering, measuring $11.7\ \mu\text{m}$ by $2.6\ \mu\text{m}$ in size with two refractile oval globules and a nearly central nucleus.

Type host : Grey Jungle Fowl, *Gallus sonneratii* Temminck.

Other hosts : From the type host, Bhatia *et al.* (1973), Chauhan *et al.* (1973).

Distribution : Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Likely to be present in the Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

19. *Isospora concinnus* Sinha and Sinha
(Fig. 34)

1979. *Isospora concinnus* Sinha and Sinha, *Acta. Protozool.*, 18 : 455.

Description : Oocyst spherical in shape measuring 23.5–29.0 μm by 21.0–25.0 μm with a mean of 27 μm by 23 μm . The oocystic wall smooth, bilayered with uniform thickness of 2 μ . Neither micropyle nor oocystic residuum are present but one or two refractile bodies are

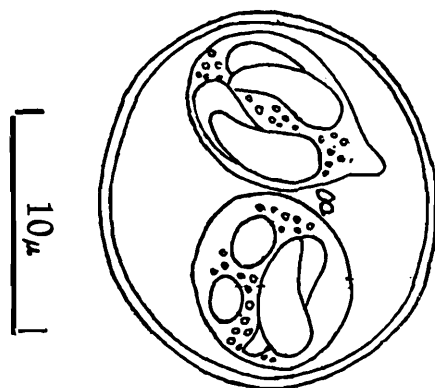


Fig. 34. Mature oocyst of *Isospora concinnus*.

seen to lie towards the outer sporocystic wall. The sporocysts are conical in shape each measuring 16.0–18.0 μm in length and 11.0–12.5 μm in width with a mean of 17.8 μm by 12.0 μm . The anterior end of the sporocyst is to some extent pointed while the posterior part is almost rounded. Each of the two sporocysts is provided with four sporozoites. Mature sporozoites are elongated bodies which overlap each other within the sporocysts. They measure 11.8 μm in length and 4.2 μm in width.

Sporulation time : 24–36 hours.

Type host : Sikkim Red-headed Tit, *Aegithalos concinnus rubricapillus* (Tricehurst).

Other hosts : Not known.

Distribution : Darjeeling, West Bengal.

Endogenous stages : The describer encountered the endogenous stages in the small intestine. The trophozoite is more or less oval in shape with a thin outer covering, measuring $7.0\ \mu\text{m}$ by $4.2\ \mu\text{m}$, with a distinct nucleus. Schizonts are oval or circular with a number of nuclei. A mature schizont measures $13.8\ \mu\text{m}$ in diameter and contains 16 nuclei with a developing merozoite which measures $5.3\ \mu\text{m}$ in length. A large number of macrogametes are encountered in the serial sections of the small intestine, usually in epithelial cells of the mucous membrane, subepithelially in the muscularis mucosae. The early macrogametocyte is oval measuring $9.8\ \mu\text{m}$ by $8.4\ \mu\text{m}$. The cytoplasm is alveolar in nature and contains a few deeply basic stained dots or granules. Each macrogametocyte is having a centrally placed nucleus with distinct nuclear membrane. A clear halo is found encircling the karyosome which occupies the major part of the nucleus. The growing macrogametocyte is spherical or oval in shape. A fully formed female gametocyte measures $16.3\ \mu\text{m}$ by $15.4\ \mu\text{m}$. The microgametocyte is round or oval found abundantly in the sections. The young microgametocyte is multinucleated and measures $7.4\ \mu\text{m}$ in diameter. The mature one is spherical measuring $14.8\ \mu\text{m}$ in diameter. The fully developed one is seen to contain microgametes which are small comma shaped bodies.

Types : Lying with the collection of the describer.

20. *Isospora corviae* Ray, Shivnani, Oommen and Bhaskaran (Fig. 35)

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

Description : Oocyst sub-spherical to spherical with double envelop, grayish-pink in colour. It measures $15.0\text{-}23.0\ \mu\text{m}$ in length with a mean of $20.0\ \mu\text{m}$ and $14.0\text{-}21.5\ \mu\text{m}$ in width with a mean of $17.7\ \mu\text{m}$. The shape index is 1.1. Cytoplasm present as concentrated mass with refractile globules. Micropyle absent, oocystic residuum present. Sporocyst pyriform in shape, with a knob at the tapering anterior end, posterior end being rounded. It measures $7.5\text{-}12.5\ \mu\text{m}$ in length with a mean of $10.8\ \mu\text{m}$ and $6.25\text{-}8.75\ \mu\text{m}$ in width with a mean of $7.75\ \mu\text{m}$. The shape index is 1.3. Sporocystic residuum present as compact mass.

Sporozoite elongated with pointed anterior end, measuring 7.9-9.9 μm

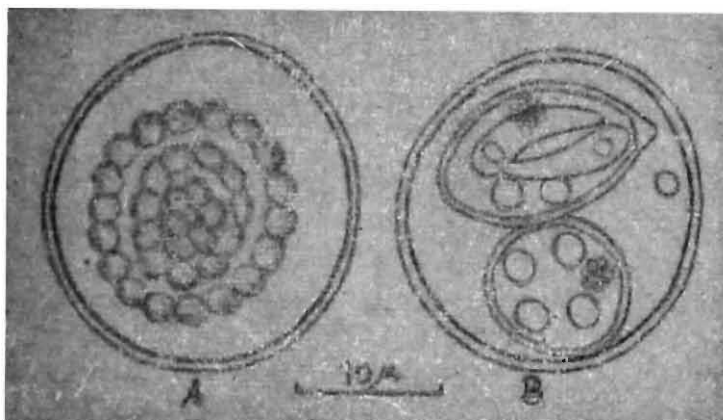


Fig. 35. A, immature and B, mature oocysts of *Isospora corvae*.

in length with a mean of 8.9 μm and 2.2-4.2 μm in width with a mean of 3.2 μm . The shape index is 2.7.

Sporulation time : 36-48 hours.

Type host : Jungle Crow, *Corvus macrorhynchus intermedius* (Adams).

Other hosts : From the Type host, Mandal (1976).

Distribution : Mukteswar, Uttar Pradesh ; Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

21. *Isospora emberizae* Mandal and Chakravarty

(Fig. 36)

1964. *Isospora emberizae* Mandal and Chakravarty, *Proc. zool. Soc. Calcutta*, 17 : 35.

Description : Oocyst oval with three envelopes. The middle layer is thicker than the other two layers. It measures 22.2-24.2 μm in length with a mean of 23.2 μm and 18.8-20.8 μm in width with a mean of 19.8 μm . The shape index is 1.1. Coarsely granular cytoplasm is present within the oocyst. Micropyle and oocystic residuum present. Sporocyst pyriform in shape with slightly curved anterior end having a small knob. It measures 18.8-20.8 μm in length with a mean of 19.8 μm and 14.4-16.4 μm in width with a mean of 15.4 μm . The shape index is 1.2. Sporocytic residuum present as scattered mass. Sporozoite is elongated in shape with tapering anterior end, measures

13.5-15.5 μm in length with a mean of 14.5 μm and 2.5-3.5 μm in width with a mean of 3.00 μm . The shape index is 4.8.

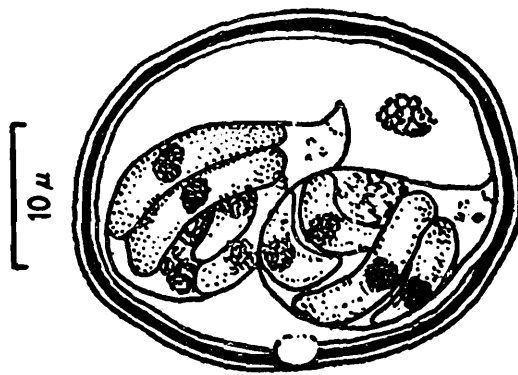


Fig. 36. Mature oocyst of *Isospora emberizae*.

Sporulation time : 24-36 hours.

Type host : Red headed bunting, *Emberiza bruniceps* Brandt.

Other hosts : Unknown.

Distribution : Sundarban, West Bengal.

Endogenous stages : The microgametocyte measures 19.9 μm in diameter. The comma-shaped microgametes are formed with tapering ends. Macrogametocyte measures 11 μm in diameter, gives rise to spherical macrogamete measuring 13.2 μm with a central nucleus.

Types : Present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

22. *Isospora garrulae* Ray, Shivnani, Oommen and Bhaskaran (Fig. 37)

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

Description : Oocyst spherical to sub-spherical in shape, with double contour of brownish colour. The outerwall being thinner than the inner one. It measures 20.0-22.5 μm in length with a mean of 21.25 μm and 17.5-21.25 μm in width with a mean of 19.75 μm . The shape index is 1.05. Globular cytoplasm present. Micropyle absent, oocystic residuum present as small granule. Sporocyst pyriform in shape, with a knob at the tapering anterior end and the posterior end being rounded. It measures 10.0-15.5 μm in length with a mean of

13.40 μm and 7.5-12.5 μm in width with a mean of 8.5 μm . The shape index is 1.5. Sporocystic residuum is found in the form of granular

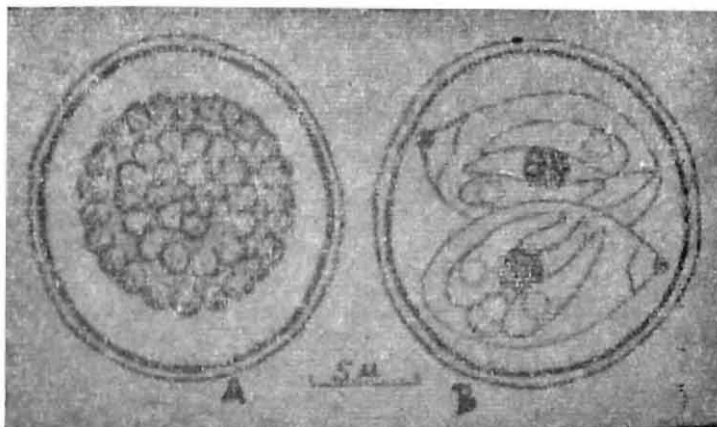


Fig. 37. A, immature and B, mature oocysts of *Isospora garrulae*.

mass. Sporozoite elongated with bluntly pointed anterior end and round posterior end. It measures 9.3 μm by 2.6 μm . The shape index is 3.9.

Sporulation time : 24-36 hours.

Type host : Jay, *Garrulax lineatus lineatus* (Vigors).

Other hosts : From the Type host, Mandal (1976).

Distribution : Mukteswar, Uttar Pradesh ; Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

23. *Isospora garrulusae* Ray, Shivnani, Oommen and Bhaskaran (Fig. 38)

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

Description : Oocyst oval to subspherical provided with double wall. General colour is greyish. It measures 25.0-27.5 μm in length with a mean of 25.20 μm and 20.0-25.0 μm in width with a mean of 21.00 μm . The shape index is 1.1. The cytoplasm is globular and appears as a compact mass. Micropyle and oocystic residuum or polar granules present. The sporocyst pear-shaped with pointed anterior and rounded posterior ends. The anterior end is provided with a stieda

body. It measures 12.5-17.5 μm in length with a mean of 16.07 μm and 7.5-10.0 μm in width with a mean of 9.60 μm . The shape index is 1.6.

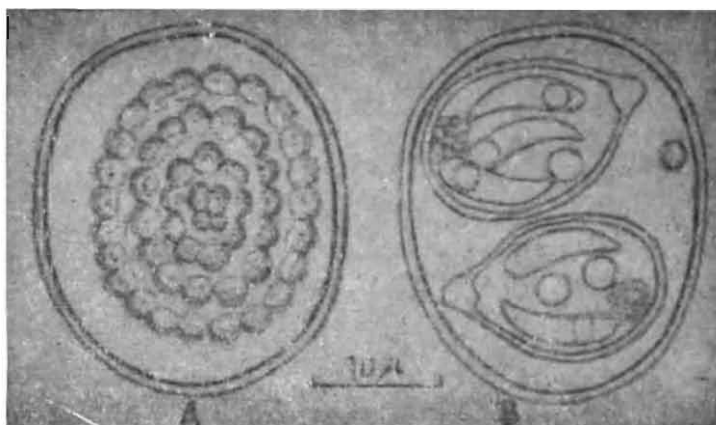


Fig. 38. A, immature and B, mature oocysts of *Isospora garrulusae*.

The sporocystic residuum is present as a compact mass. The sporozoite elongated, pointed at the anterior end and a rounded posterior end. It measures 8.3 μm in length and 2.7 μm in width. The shape index is 3.07. The nucleus is situated at the middle.

Sporulation time : 48-72 hours.

Type host : Himalayan Jay, *Garrulus glandarieus bispecularis* (Vigors).

Other hosts : From the type host, Mandal (1976).

Distribution : Mukteswar, Uttar Pradesh ; Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

24. *Isospora ginginiana* Chakravarty and Kar (Fig. 39)

1944. *Isospora ginginiana* Chakravarty and Kar, *Proc. Indian Acad. Sci.*, 20 (B) : 102.

Description : Oocyst round with double envelop, measuring 22.3-24.5 μm in diameter with a mean of 23.4 μm . Micropyle and oocystic residuum absent. Spherical cytoplasm is 15.5 μm in diameter. Sporocyst pyriform with anterior pointed end having a refractile knob and other end rounded. Sporocyst measures 15.5-17.5 μm in length with a mean of 16.5 μm and 10.5-11.5 μm in width with a mean of

11 μm . The shape index is 1.5. It is provided with granular residuum and a thick wall. The sporozoite elongated with pointed anterior end, measuring 10.5 μm in length and 4.2 μm in width. The nucleus is situated at the middle.



Fig. 39. A, immature and B, mature oocysts of *Isospora ginginiana*.

Sporulation time : 72 hours. Chakravarty and Kar (1946) studied the effect of different tempt. on the oocyst of this species and found that 37°C is most favourable for the sporulation.

Type host : Bank Mayna, *Acridotheres ginginianus* (Lath.)

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Schizonts are found in the small intestine, each measuring 8.8 μm in diameter. Mature schizont produces 8-16 nuclei. The microgametocyte round, measuring 11-13.2 μm in diameter, produces comma-shaped microgametes, each is provided with a single short flagellum. Macrogamete round, measuring 11 μm in diameter with a granular cytoplasm and a distinct excentric nuclear karyosome.

Types : Lying in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

25. *Isospora ginginiana tristis* Chakravarty and Kar (Fig. 40)

1947. *Isospora ginginiana tristis* Chakarvarty and Kar, *Proc. R. Soc., Edinb.* 62 : 225.

Description : Oocyst subspherical or slightly oval with double envelop. It measures 24.00-30.00 μm in length with a mean of 26.00 μm and 19.5-24.5 μm in width with a mean of 21.9 μm . The shape index is 1.18. Cytoplasm globular, oocystic residuum and micropyle absent. Sporocyst pyriform in shape with a small knob at the anterior pointed end. It measures 15.5-17.5 μm in length with a mean of 16.5 μm and

8.5-11.5 μm in width with a mean of 10.5 μm . The shape index is 1.5. Sporocystic residuum present as compact mass. Sporozoite elongated in shape measuring 15.4 μm in length and 2.2 μm in width. The shape index is 7.00.

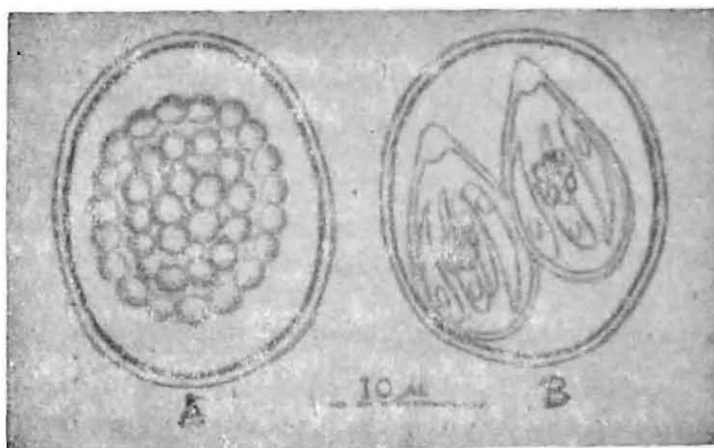


Fig. 40. A, immature and B, mature oocysts of *Isospora ginginiana tristis*.

Sporulation time : 60—70 hours.

Type host : Common Mayna, *Acridotheres tristis tristis* (Linn.)

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

Remarks : Pellerdy (1974), is of opinion that there is no reason to accept the validity of sub-species in Sporozoa. Therefore, *ginginiana tristis* should be treated as separate species *I. tristis*. However, the present author believes in retaining the sub-species and followed here.

26. *Isospora graculi* Bhatia, Chauhan, Arora and Agarwal

(Fig. 41)

1973. *Isospora graculi* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 43 : 944.

Description : Oocyst spherical to sub-spherical in shape, measures 21.3-29.3 μm in length and 18.6-25.3 μm in width (mean 24.5 μm by

22.6 μm), has a 1.5 μm thick wall with an outer yellowish-green and inner yellowish-brown layers. The length width ratio is 1.00-1.31 (mean 1.08). Micropyle and polar cap absent. Oocystic residuum absent. One or rarely 2 prominent dark polar granules present. The

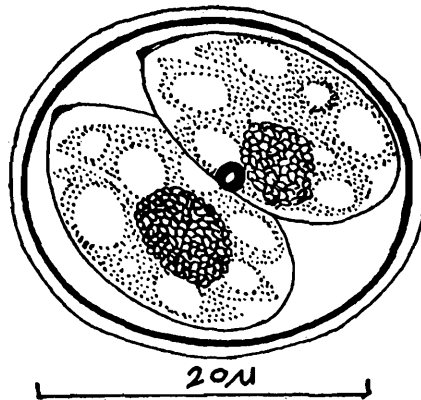


Fig. 41. Mature oocyst of *Isospora graculi*.

sporocyst ellipsoidal, with a narrower anterior end, carrying a vestigial stieda body. It measures 16.0-21.3 μm by 9.3-12.0 μm (mean 18.4 μm by 10.0 μm). Sporocystic residuum is observed as a clump of coarse dark granules in two different forms, viz. small and large clumps. Sporozoite elongated, measuring 13.3-16.0 μm by 2.6-3.3 μm (mean 14.6 μm by 2.8 μm) in size, carrying a large refractile globule at the broad end and a smaller one towards the narrower end with nucleus in the centre.

Sporulation time : Unknown.

Type hosts : Hill Mayna, *Gracula religiosa* (Linn.).

Other hosts : Unknown.

Distribution : Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Likely to be present in the Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

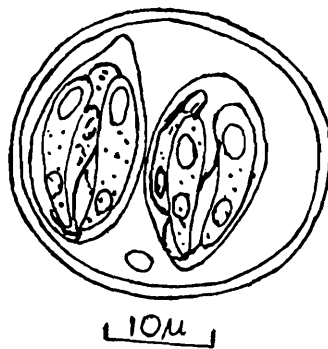
Remarks : Chakravarty and Kar (1947) described, *I. ginginiana tristis* from the Common Mayna, *Acridotheres t. tristis* which comes very close to *I. graculi* Bhatia *et al.* (1973) in all respects except the shape of the sporocyst. But until or unless some cross transmission experiments are being carried out it would be difficult to comment on the validity of this species.

27. *Isospora gypsi* Patnaik and Mohanty

(Fig. 42)

1969. *Isospora gypsi* Patnaik and Mohanty, *Curr. Sci.*, 38 : 316

Description : Oocyst spherical to sub-spherical, double walled of equal thickness measuring $1.3\ \mu\text{m}$ and smooth. It measures $17.00\ \mu\text{m}$ - $23.5\ \mu\text{m}$ (mean $20.4\ \mu\text{m}$) in length and $14.5\ \mu\text{m}$ - $19.5\ \mu\text{m}$ (mean $17.5\ \mu\text{m}$) in width with shape index 1.5. The cytoplasm completely fills up the inner space ; residuum and micropyle absent, one or more polar

Fig. 42. Mature oocyst of *Isospora gypsi*.

granules present. Sporocyst pyriform, ellipsoidal, measuring $11.5\ \mu\text{m}$ - $16.5\ \mu\text{m}$ (mean $13.2\ \mu\text{m}$) in length and $8.2\ \mu\text{m}$ - $8.5\ \mu\text{m}$ (mean $8.5\ \mu\text{m}$) in maximum width with a refractile plug like stieda body at the narrow anterior end. Sporocystic residuum present as dark granules. Sporozoite sausage-shaped with pointed anterior end. It measures $6.00\ \mu\text{m}$ in length and $1.6\ \mu\text{m}$ in maximum width. The tapering end is provided with two refractile globules and the nucleus is placed centrally.

Sporulation time : 20-24 hours.

Type host : Indian white-backed Vulture, *Gyps bengalensis* (Gmelin).

Other hosts : From the type host, Garg and Chauhan (1970), Mandal (1976).

Distribution : Bhubaneswar, Orissa ; Mathura, Uttar Pradesh ; Beliaghata, Calcutta, West Bengal.

Endogenous stages : Unknown. Garg and Chauhan (1970) expressed a desire to work out the endogenous stages but no such account is available so far.

Types : Not known.

28. *Isospora koreani* Bhatia, Chauhan, Arora and Agarwal
(Fig. 43)

1972. *Isospora koreani* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 42 : 625.

Description : Subspherical oocyst ; measuring 20-24 μm by 16.9-20 μm (mean 22.4 by 19.2 μm) in size ; lined by double contoured oocystic wall ; outer being straw-coloured and inner light-brown. Micropyle and polar cap absent. Oocystic residuum absent. Polar

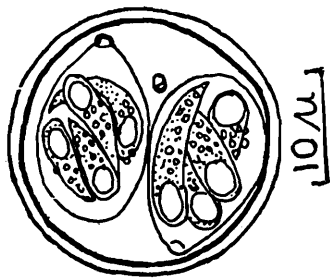


Fig. 43. Mature oocyst of *Isospora koreani*.

granules present. Sporocyst broadly ellipsoidal ; 14.3-16.0 by 8-9.3 μm (mean 15.6 by 8.8 μm) in size ; carries a plug-like stieda body at one pole. Sporocystic residuum present as clump of coarse granules. Sporozoite banana-shaped with one end narrow and tapering, and the other end broader with a large refractile globule.

Sporulation time : Unknown.

Type host : Korean Pheasant, *Phasianus colchicus* Linn.

Other hosts : Japanese green Pheasant, *Phasianus versicolor* Vieillot, Bhatia *et al.* (1973) ; Chauhan *et al.* (1973).

Distribution : Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Likely to be present in the Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

29. *Isospora lacazei* (Labbé)
(Fig. 44)

1893. *Diplospora rivolta* Labbé, *C. r. hebl. Se'anc Acad. Sci., Paris*, 117 : 407.

1893. *Diplospora lacazii* Labbé, *C. r. hebl. Se'anc Acad. Sci., Paris*, 117 : 407.

1893. *Isospora lacazei* Labbé, *C. r. hebl. Se'anc Acad. Sci., Paris*, 117 : 407.

1970. *Isospora lacazei* var *indicus* Satyanarayancharyula, Subba Rao and Christopher, *Sci. Cult.*, 36 : 162.
 1897. *Isospora comunis passerum* Sjobring, *Zentbl. Bkt. I. Abt. Orig.*, 22 : 675.
 1887. *Isospora passerum* Sjobring, *Zentbl. Bkt. I. Abt. Orig.*, 22 : 675.

Description : Oocyst spherical or sub-spherical double walled, inner one is thicker than the outer. Oocyst measures 24.0-32.0 μm in length with a mean of 26.8 μm and 20.0-30.0 μm in width with a mean of 27.4 μm . The shape index is 1.09. Cytoplasm is granular with several

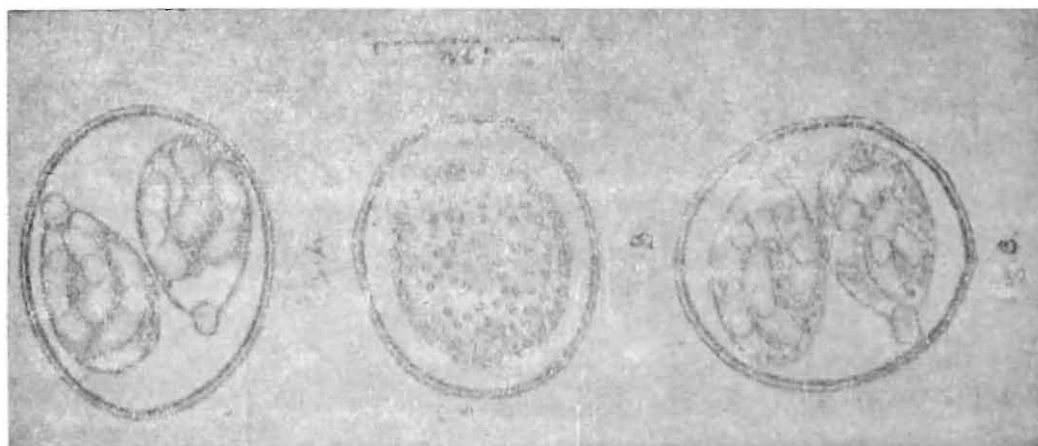


Fig. 44. A, mature B, immature and C, mature oocysts of *Isospora lacazei*.

refractile granules. Micropyle and oocystic residuum absent. Sporocyst ovoid to pyriform with a button-shaped plug at the narrow anterior end. It measures 14-22 μm in length with a mean of 17.2 μm and 10.0-11.0 μm in width with a mean of 10.3 μm . The shape index is 1.56. Sporocystic residuum finely granular and present as scattered mass. Sporozoite bean-shaped, measuring 8.5 μm in length and 2.3 μm in width. The shape index is 3.7. Nucleus is situated at the middle.

Sporulation time : 48-60 hours.

Type host : House Sparrow, *Passer domesticus* (Linn.)

Other hosts : From the type host ; Baya, *Ploceus philippinus* (Linn.) ; Magpie robin, *Copsichus saularis* (Linn.) ; Red-vented Bulbul, *Pycnonotus cafer* (Linn.). Pied Mayna, *Sturnia* (= *Sturnus*) *contra* (Linn.) ; Common Mayna, *Acridotheres tristis tristis* (Linn.) ; Bank Mayna, *Acridotheres ginginianus* (Latham), Chakravarty and Kar (1944) ; Mandal (1965).

Distribution : Calcutta, West Bengal.

Endogenous stages : Schizonts are found in the epithelial cells of the small intestine. Mature schizont measuring $14\ \mu\text{m}$ by $10\ \mu\text{m}$ in size having 12-15 sickle-shaped merozoites. Microgametocyte round measuring $16\ \mu\text{m}$ in diameter produces spindle-shaped microgametes each with a short flagellum on maturation. Macrogamete measuring $11\text{-}16\ \mu\text{m}$ in diameter having a prominent nucleus with a distinct Karyosome. Shortest period to complete the endogenous development is about 6 days which has been noticed on the basis of experimental inoculation by Mandal and Bhattacharjee (1970).

Remarks : The endogenous development and the description of the oocyst are based on the author's own observations and after Chakravarty and Kar (1944). Pellerdy (1974) gave a detail account of this parasite and the contributions made by the different authors. The new variety 'indicus' described by Satyanarayanacharlu *et al.* (1970) does not hold good due to the world-wide distribution of the species.

Types : Not known.

30. *Isospora lonchurae* Mandal and Chakravarty
(Fig. 45)

1964. *Isospora lonchurae* Mandal and Chakravarty, *Proc. zool. Soc., Calcutta*, 17 : 35.

Description : Oocyst oval and provided with double envelop, the outer being thinner than the inner one. It measures $24.3\text{-}26.4\ \mu\text{m}$ in

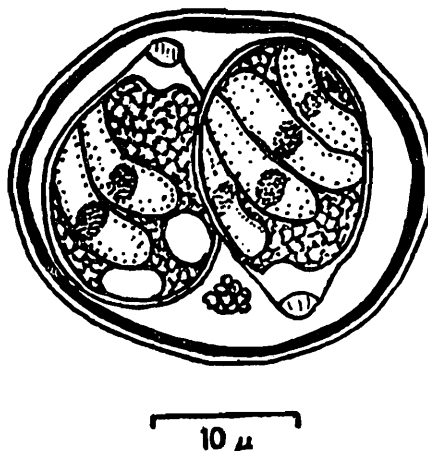


Fig. 45. Mature oocyst of *Isospora lonchurae*.

length with a mean of $25.8\ \mu\text{m}$ and $20.9\text{-}23.1\ \mu\text{m}$ in width with a mean of $21.8\ \mu\text{m}$. The shape index is 1.1. Cytoplasm spherical with highly refractile globules. Micropyle absent and oocystic residuum present.

Sporocyst is pyriform in shape, the anterior end is bluntly pointed with a small knob while the posterior end is round. It measures $18.7\ \mu\text{m}$ - $20.9\ \mu\text{m}$ in length with a mean of $19.5\ \mu\text{m}$ and $11\ \mu\text{m}$ - $13.2\ \mu\text{m}$ in width with a mean of $12.1\ \mu\text{m}$. The shape index is 1.6. Sporocystic residuum is present as scattered mass. The sporozoite elongated bluntly pointed at both ends. It measures 9.2 - $10.4\ \mu\text{m}$ in length with a mean of $9.6\ \mu\text{m}$ and 2.5 - $3.5\ \mu\text{m}$ in width with a mean of $2.8\ \mu\text{m}$. The shape index is 3.4. The nucleus is centrally placed. A vacuolated area is seen at one end of the sporozoite.

Sporulation time : 60-72 hours.

Type host : Spotted Munia, *Lonchura punctulata* (Linn.).

Other hosts : Pied Mayna, *Sturnus contra* Linn., Mandal (1976)

Distribution : Suberb of Calcutta, West Bengal.

Endogenous stages : Schizogony has not been observed. The microgametocytes are round each measuring $6.6\ \mu\text{m}$ in diameter, on maturation it gives rise to many comma shaped microgametes. The macrogametocytes are also round and measuring initially 8.8 - $11.0\ \mu\text{m}$ in diameter, when fully formed it measures $15.4\ \mu\text{m}$ in diameter.

Types : Lying in the Collection of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

31. *Isospora malabaricae* Swarup and Chauhan

1975. *Isospora malabaricae* Swarup and Chauhan. *Orissa vet. J.*, 10 : 18.

Description : Oocyst spherical to subspherical in shape, measuring 19.5 - $25.5\ \mu\text{m}$ in length and 19.5 - $24.0\ \mu\text{m}$ in width with a mean of $22.3\ \mu\text{m}$ by $21.8\ \mu\text{m}$. The length width ratio is 1.0-1.06 mean 1.02. The oocystic wall is single layered, about $1.0\ \mu\text{m}$ thick and it is light-yellow in colour. Micropyle and polar cap absent. In unsporulated stage, the sporont filled almost all the inner space. Oocystic residuum, polar granules vary in shape and size (one to five in number). The ovoid sporocyst, with small knob-like stieda body and pluy-like substiedal body at the narrow end ; measuring 16.5 - $18.0\ \mu\text{m}$ in length and 10.5 - $12.0\ \mu\text{m}$ in width with a mean of $16.8\ \mu\text{m}$ by $10.8\ \mu\text{m}$. The elongated sporozoite with one end narrower and the other round, lying head to tail and surrounded by sporocystic residuum, dispersed as coarse dark granules. It measures 12.0 - $12.7\ \mu\text{m}$ in length and $3.0\ \mu\text{m}$ in width with the mean of $12.2\ \mu\text{m}$ by $3.0\ \mu\text{m}$ and carries two refractile globules with a centrally placed nucleus.

Sporulation time : 2-3 days.

Type host : Grey-headed Mayna, *Sturnia malabarica malabarica* (Gmel.), [= *Sturnus m. malabaricus* (Gmel.)].

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : This species is named after the specific name of the type host. Therefore as per rule it should be *Isospora malabarica* instead of 'malabaricae'.

32. *Isospora mandari* Bhatia, Chauhan, Arora and Agarwal

(Fig. 46)

1972. *Isospora mandari* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 42 : 625.

Description : Spherical to sub-spherical oocyst, measures 19.5-23.4 μm in length and 18.2-22.2 μm in width (mean 21.4 μm by 20.5 μm). The double contoured oocystic wall of 1.0-1.3 μm thickness, has outer

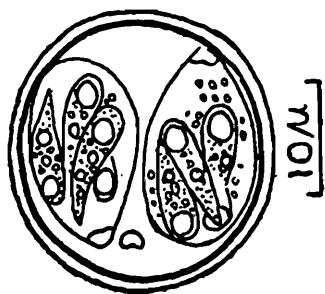


Fig. 46. Mature oocyst of *Isospora mandari*.

transparent straw coloured and inner light brownish blue layers. Micropyle and polar cap absent. Oocystic residuum absent. A large polar granule present. Sporocyst ellipsoidal measuring 11.7-16.0 μm in length and 7.8-10.4 μm in width (mean 14.0 μm by 9.8 μm); has a prominent plug-like stieda body. Sporocystic residuum present as coarse dark granules dispersed around the sporozoites. Sporozoite banana-shaped measuring 12.0-13.3 in length and 2.8 μm in width (mean 12.5 μm by 2.7 μm) carried large refractile globule at the broader end and the other towards narrower end.

Type host : Mandarin Duck, *Aix galericulata* (Linn.)

Other hosts : Unknown.

Distribution : Zoological garden, Delhi.

Endogenous stages : Unknown.

Types : Not known,

33. *Isospora mayuri* Patnaik (Fig. 47)

1965. *Isospora pellerdyi* Patnaik, *Indian J. Microbiol.*, 5 : 67.

1966. *Isospora mayuri* Patnaik, *Indian J. Microbiol.*, 6 : 53 ; Pande, Bhatia, Chauhan and Garg, 1970, *Indian J. Anim. Sci.*, 40 : 154.

Description : The oocyst sub-spherical in shape, yellowish brown in colour and double walled. It measures 20-27.4 μm in length with a mean of 23.37 μm and 18-24.1 μm in width a mean of 21.36 μm . The shape index varies from 1.0-1.21, mean 1.09. Oocystic wall smooth and 1.5 μm thick, residuum and micropyle absent. Sporocyst pyriform

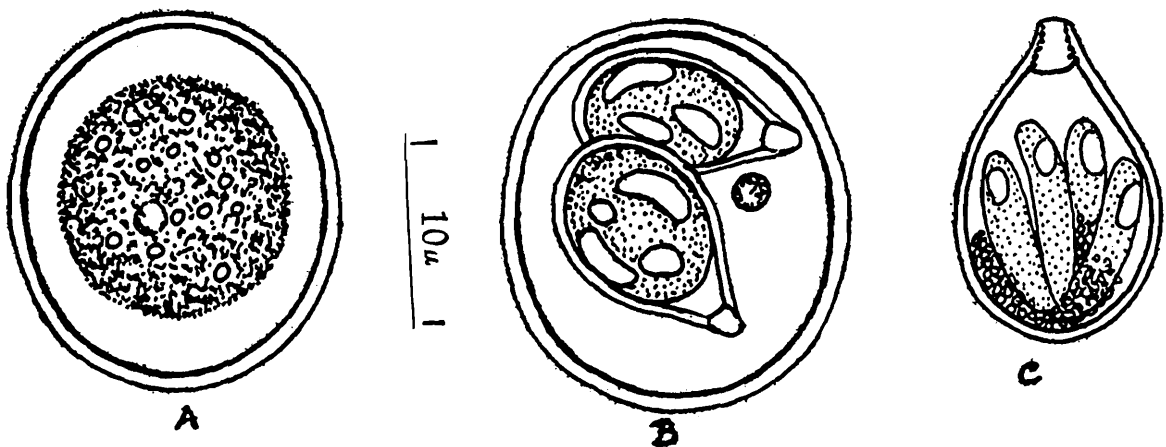


Fig. 47. A, immature B, mature oocysts and C, sporocyst with sporozoite of *Isospora mayuri*.

in shape measuring 14.5-16.1 μm in length with a mean of 15.9 μm and 9.6-11.23 μm in width with a mean of 10.17 μm . It is provided with distinct wall and button like refractile stieda body at the pointed end. Sporozoites banana-shaped, each measuring 6-7 μm in length and 1.5-2 μm in width.

Sporulation time : 72 hours.

Type host : Indian Pea Fowl, *Pavo cristatus* Linn.

Other hosts : From the type host, Bhatia *et al.* (1972), Chauhan *et al.* (1973) and Mandal (1976).

Distribution : Bhubaneswar, Orissa ; Calcutta market, West Bengal ; and Zoological garden, Delhi ; Lucknow, Uttar Pradesh.

Endogenous stages ; Unknown.

Types : Not known.

Remarks : Pande *et al.* (1970) recovered the spherical or subspherical oocysts from the faecal sample of *Pavo cristatus*, each measuring 19-22 μm by 17-29 μm with the mean of 20.8 μm by 18 μm and identified as *Isospora mayuri* Patnaik (1966). Pellerdy (1974) has made a comment that this species though differs to some extent from *Isospora mayuri* but can also be treated as independent species. He further noted that both the species are likely to be *Isospora lacazei* picked up from the droppings of sparrow.

34. *Isospora megalaimae* Mandal and Chakravarty

(Fig. 48)

1964. *Isospora megalaimae* Mandal and Chakravarty, *Proc. zool. Soc. Calcutta*, **17** : 35.

Description : Oocysts round, each measuring 23.2-25.4 μm in diameter ; possesses double envelop, without any micropyle. Oocystic

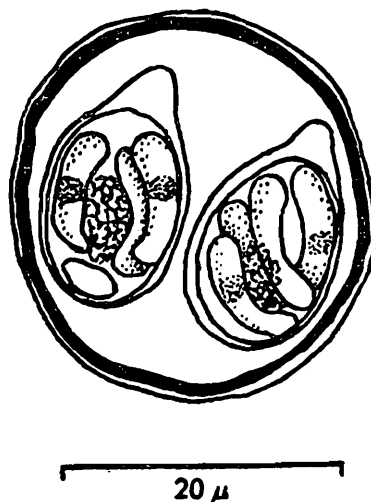


Fig. 48. Mature oocyst of *Isospora megalaima*.

residuum absent. The sporocyst pyriform in shape and has broader posterior and bluntly pointed anterior ends. It measures 17.6 by 9.9 μm .

The sporocystic residual mass scattered irregularly. Sporozoites elongated each measuring $7.7\ \mu\text{m}$ in length and arranged irregularly.

Sporulation time : 24-36 hours.

Type host : Crimson breasted Barbet, *Megalaima haemocephala* (P. L. S. Meiller).

Other hosts : Unknown.

Distribution : Suberb of Calcutta, West Bengal.

Endogenous stages : Mature schizont round, measuring $6.6\ \mu\text{m}$ in diameter. The merozoites are elongated with tapering ends, each measuring $5.5\ \mu\text{m}$ long with a centrally placed nucleus. Microgametocyte round, measuring $5.5\ \mu\text{m}$ in diameter provided with many scattered dot-like vesicular nuclei which develop to comma-shaped bodies, each is rounded at one end and provided with a small flagellum at the opposite end. The macrogametocyte round measuring $15.5\ \mu\text{m}$ in diameter and provided with granular cytoplasm. The zygote measures 14.4 by $9.9\ \mu\text{m}$.

Types : Present in the Collection of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

35. *Isospora melopsittacus* Bhatia, Chauhan, Arora and Agarwal
(Fig. 49)

1973. *Isospora melopsittacus* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 43 : 944.

Description : Oocyst ovoid, $20\text{-}28\ \mu\text{m}$ in length and $17.3\text{-}21.3\ \mu\text{m}$ in width (mean $24.0\ \mu\text{m}$ by $18.5\ \mu\text{m}$) has an oocystic wall of $1.3\ \mu\text{m}$ thickness and composed of outer straw-coloured and inner yellowish-

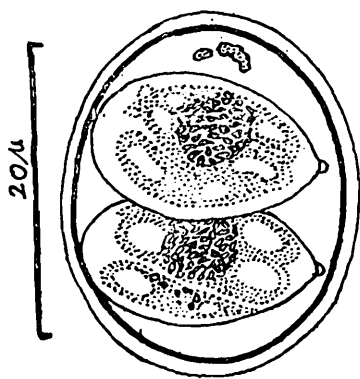


Fig. 49. Mature oocyst of *Isospora melopsittacus*.

brown layers with length-width ratio of 1.15-1.42 (mean 1.29). Micropyle and polar cap absent. Oocystic residuum absent. One or more polar granules present. Sporocyst almond shaped, measuring 16.0-18.6 μm in length and 8.0-9.3 μm in width (mean 17.0 μm by 8.3 μm) carries a small knob-like stieda body at the narrow anterior end. Sporocystic residuum present as a loose clump of dark coarse granules. Sporozoites elongated each measuring 3.3 μm by 2.6 μm in size, and provided with two refractile globules.

Type host : Budgeriger, *Melopsittacus undulatus* Shaw.

Other hosts : Unknown.

Distribution : Zoological garden, Delhi.

Endogenous stages : Unknown.

Types : Likely to be present in the Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

Remarks : The describer includes this host under the order Cuculiformes but it should come under the order Psittasiformes. Brada (1966) reported *Eimeria* sp. from this host species at South America. The oocyst was measured as 23-35 μm in length and 20-28 μm in width mean (33.7 μm by 22.8 μm). Sporulation was completed by 24 hours at 28° c. The oval sporocyst measured 12 μm in length and 9 μm in width with granular sporocystic residuum. He further stated that the species might be pathogenic, as he recovered oocysts from a host with diarrhoea. Experimentally it has been proved that this species is host specific.

36. *Isospora muniae* Chakravarty and Kar

(Fig. 50)

1944. *Isospora muniae* Chakravarty and Kar, *Proc. Indian Acad. Sci.*, 20(B) : 102.

Description : Oocyst broadly or elongately oval, measuring 24.5-31.5 μm in length with a mean of 28.3 μm and 15.5-19.5 μm in width with a mean of 17.5 μm . The shape index is 1.6. Oocyst is provided with double envelop of 1.5 μm thickness. The cytoplasm is granular with several refringent globules, 15.6 μm in diameter and placed centrally. Micropyle present, oocystic residuum absent. The sporocyst is pyriform with the anterior end pointed and the posterior end rounded, measuring 14.5-16.5 μm in length with a mean of 15.5 μm and 10.2-11.2 μm in width with a mean of 10.7 μm . The shape index is 1.4. It is provided with double layers and having a refractile knob at the pointed anterior end. Sporocystic residual mass is granular and scattered irregularly.

Sporozoites are sickle-shaped, each measuring $6.5\ \mu\text{m}$ by $2.00\ \mu\text{m}$. The anterior end is pointed and the posterior end rounded where the nucleus is situated.

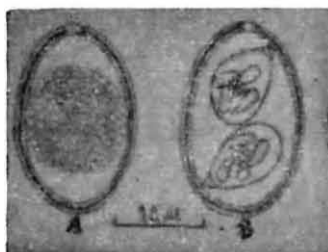


Fig. 50. A, immature and B, mature oocysts of *Isospora muniae*.

Sporulation time : 48-60 hours.

Type host : Black-headed Munia, *Munia* (= *Lonchura*) *malacca malacca* Linn.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Elongately oval schizont measures $10-13.2\ \mu\text{m}$ in length and $6.6-8.8\ \mu\text{m}$ in width. The mature one produces sixteen-sickle-shaped merozoites, each measuring $8.8\ \mu\text{m}$ by $1.5\ \mu\text{m}$ in size. Microgametocyte oval, measures $15.4\ \mu\text{m}$ by $11.0\ \mu\text{m}$. The microgamete measures $4.4\ \mu\text{m}$ in length with a long flagellum. Macrogamete oval measuring $18.8\ \mu\text{m}$ by $13.2\ \mu\text{m}$ in size with a large nucleus of $4.5\ \mu\text{m}$ in diameter. The macrogametes are characterised by large granules presumably reserve food materials as stated by Chakravarty and Kar (1944 b).

Types : Likely to be present in the collections of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

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

(Fig. 51)

- 1952. *Isospora lophuriae* Ray, Shivnani, Oommen and Bhaskaran, *Proc. Indian Sci. Congr.*, p. 314.
- 1952. *Isospora parusae* Ray, Shivnani, Oommen and Bhaskaran, *Proc. zool. Soc. Calcutta*, 5 : 141.
- 1976. *Isospora parusi* emend Mandal, *Rec. zool. Surv. India*, 70 : 68.

Description : Oocyst oval to subspherical in shape, double walled of grayish-white colour with yellowish tinge. It measures 22.5-27.5 μm in length with a mean of 24.16 μm and 20.0-22.5 μm in width with a mean of 20.83 μm . The shape index is 1.1. Subspherical cytoplasm.

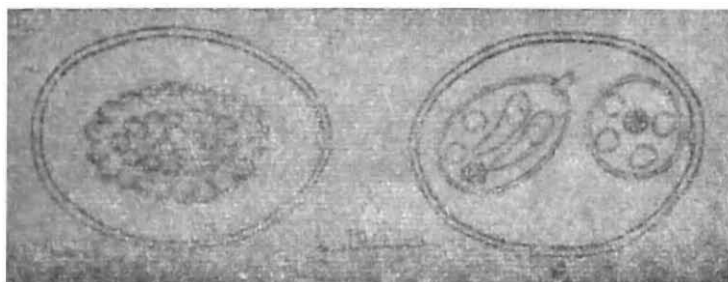


Fig. 51. A, mature and B, immature oocysts of *Isospora parusi*.

Oocystic residuum is in the form of one or two granules and micropyle present in the form of a slight depression in the endocystic wall. Sporocyst pyriform in shape tapering at the anterior end, with a steida body in the form of a plug. It measures 10.0-17.5 μm in length with a mean of 15.0 μm and 10.0 μm in width. The shape index is 1.5. Sporocystic residuum present in the form of globular mass. Sporozoites are elongated each having a nucleus at the posterior rounded end with tapering anterior end. Sporozoite measures 9.5 μm in length and 2.5 μm in width. The shape index is 3.8.

Sporulation time : 36-48 hours.

Type host : Brown crested Tit, *Parus dichrurus* (Hodgson).

Other hosts : From the Type host, Mandal (1976).

Distribution : Mukteswar, Uttar Pradesh ; Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

38. *Isospora psittaculæ* Chakravarty and Kar

(Fig. 52)

1947. *Isospora psittaculæ* Chakravarty and Kar, *Proc. R. Soc., Edinb.*, 62(B) : 225.

1960. *Eimeria psittaculidæ* (lapsus) Farr, (vide Pellerdy, 1974 *Coccidia and Coccidiosis*, Verlag Paul Parey, Berlin und Hamburg p. 344).

Description : Oocyst broadly oval and provided with double envelop,

the outer one is thinner than the inner one. It measures 28.5-32.6 μm in length with a mean of 30.5 μm and 24.4-28.4 μm in width with a mean of 25.4 μm . The shape index is 1.16. Cytoplasm with refringent globules almost fills up the oocyst. Oocystic residuum present, micropyle absent. Sporocyst somewhat oval with narrow anterior end which

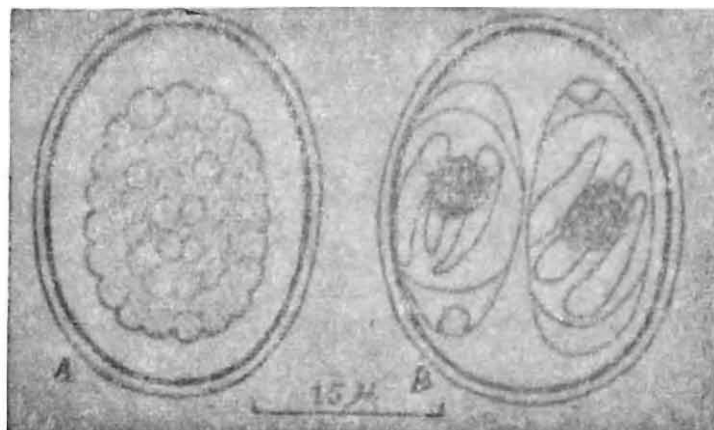


Fig. 52. A, mature and B, immature oocysts of *Isospora psittaculæ*.

is provided with a well developed knob of 2.2 μm in length. Sporocyst measures 22.0-26.4 μm in length with a mean of 24.5 μm and 12.5-14.5 μm in width with a mean of 13.5 μm . The shape index is 1.8. Sporocystic residuum present as compact mass. Sporozoite elongated in shape with pointed anterior end and rounded posterior end. It measures 11.5-15.5 μm in length with a mean of 13.5 μm and 4.4-6.4 μm at broadest width with a mean of 5.4 μm . The shape index is 2.5. Posterior end of the sporozoite is provided with a vacuole.

Sporulation time : 48-60 hours.

Type host : Large Indian Parakeet, *Psittacula eupatria nipalensis* (Hodgson).

Other hosts : Red whiskered Bulbul, *Elathea* (= *Pycnonotus*) *jocosus emeria* (Linn.)

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

39. *Isospora pycnonotae* Mandal and Chakravarty
(Fig. 53)

1964. *Isospora pycnonotae* Mandal and Chakravarty, *Proc. zool. Soc. Calcutta*, 17 : 35.
1973. *Isospora pycnonotusi* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 43 : 944.

Description : Oocyst oval, provided with double wall, the outer being thinner than the inner one. It measures 23.2-24.5 μm in length with a mean of 24.2 μm and 18.8-20.8 μm in width with a mean of 19.8 μm . The shape index is 1.2. Cytoplasm spherical, highly granular

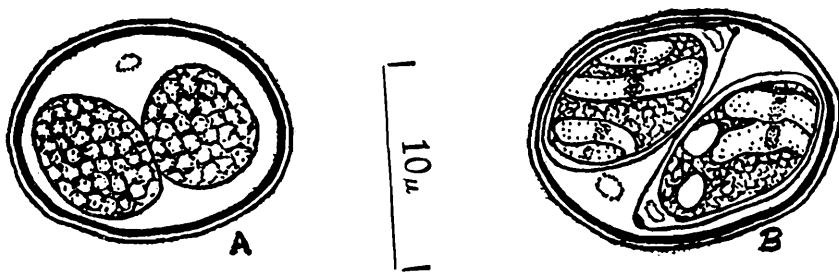


Fig. 53. A, immature and B, mature oocysts of *Isospora pycnonotae*.

containing refractile globules. Micropyle present, oocystic residuum absent. The sporocyst pyriform with pointed anterior end and rounded posterior end. The pointed end is provided with small knob and just behind the knob a transparent refractile area is observed. Sporocyst measures 18.8-20.8 μm in length with a mean of 19.8 μm and 7.8-9.8 μm in width with a mean of 8.8 μm . The shape index is 2.1. Sporocystic residuum is present as scattered mass. Sporozoite elongated with both ends bluntly pointed and nucleus is situated at the middle position. Sporozoite measures 11.1-13.1 μm in length with a mean of 12.1 μm and 2.1-3.4 μm in width with a mean of 2.8 μm . The shape index is 4-3.

Sporulation time : 41-62 hours.

Type host : Red Whiskered Bulbul, *Pycnonotus jocosus* (Linnaeus).

Other hosts : Jungle babbler, *Turdoides straitus* (Dumont.).

Distribution : Calcutta, West Bengal, Zoological Garden, Lucknow, Uttar Pradesh ; Bhatia *et al.* (1973).

Endogenous stages : Schizont round measuring 4.4 μm in diameter. The mature one produces eight to twelve merozoites, each measuring

3.3 μm long. Microgametocytes are oval each measuring 12.1 μm in length and 9 μm in width. The comma-shaped microgametes are formed each is tapering at one end. The macrogametocyte measures 6.6 μm in diameter but the mature macrogamete measures 22 μm by 15.4 μm .

Type : Lying in the collections of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

Remarks : The specific name was misspelt as '*pyncnonotae*' instead of '*pyncnonoti*' as cited by Pellerdy, 1974. Bhatia *et al.* 1973 described *I. pyncnonotusi* unaware of the fact that Mandal and Chakravarty (1964) already described *I. pyncnonotae* from the same host. The measurements and shape of the oocysts as well as sporocysts come close to each other. Therefore *I. pyncnonotusi* Bhatia *et al.*, 1973 is synonymised with *I. pyncnonotae* Mandal and Chakravarty, 1964.

40. *Isospora rajuli* Satyanarayanacharullu, Subba Rao and Christopher.

1969. *Isospora rajuli* Satyanarayanacharulu, Subba Rao and Christopher, *Indian J. Microbiol.*, 9 : 121.

Description : The oocyst subspherical to broadly ovoidal with both ends rounded, measuring 19.2-34.4 μm (mean 26.24 μm) in length and 17.4-26.6 μm (mean 21.84 μm) in width. The shape index is 0.83. The wall of oocyst is 1.5 μm , double contoured, smooth, clear and colourless. The micropyle is either inconspicuous or absent. The unsporulated oocyst shows sporont centrally placed. In a few cases the sporonts are noticed in paracentral position. They are spherical and granular each with a diameter of 12.5-25.5 μm (mean 19.2 μm). The sporont occupied two-third of the cavity leaving space on either end. The polar granules absent in the unsporulated oocyst but present in many of the sporulated ones and are compact and spherical in shape. These granules are terminal except in a few which are sub-terminal. Oocystic residuum absent. The sporocyst oval and measures 14.8-20.2 μm by 11.2-13.4 μm (mean 17.4 μm by 12.2 μm). Stieda body small, plug-like and present at the narrower end. Sporocystic residuum is present inbetween the sporozoites as a compact rounded mass. The sporozoites are slender, slightly curved and each measuring 10-14 μm by 3-5 μm (mean 12.2 μm by 4.2 μm) with a compact centrally located nucleus. The refractile globules were noticed on either side of the nucleus.

Type host : Mynah (= Common Mayna) *Acridotheres t. tristis* (Linn)

Other hosts : Unknown

Distribution : Tirupati, Andhra Pradesh.

Endogenous stages : Unknown.

Types : Not known.

**41. *Isospora scircusae* Ray, Shivnani, Oommen and Bhaskaran
(Fig. 54)**

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

1952. *Isospora cryptolophae* Ray, Shivnani, Oommen and Bhaskaran, *Proc. Indian Sci. Congr.*, p. 314.

Description : Oocyst spherical to subspherical in shape and provided with double walls of pink colour. Oocyst measures 22.5-30.0 μm in length with a mean of 24.8 μm and 20.5-25.0 μm in width with a mean of 23.28 μm . The shape index is 1.06. Micropyle and oocystic

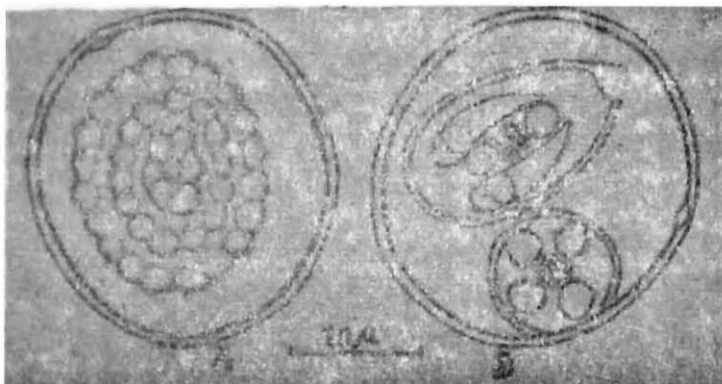


Fig. 54. A, immature and B, mature oocysts of *Isospora scircusae*.

residuum present. Sporocysts are pear-shaped each with a prominent knob at the tapering anterior end. It measures 10.0-17.5 μm in length with a mean of 14.21 μm and 8.75-11.25 μm in width with a mean of 10.31 μm . The shape index is 1.3. Sporocystic residuum present as compact mass. Sporozoites are elongated, each is provided with bluntly pointed anterior end. Sporozoite measures 8.5-9.7 μm in length with a mean of 8.8 μm and 2.2-4.3 μm in width with a mean of 3.3 μm . The shape index is 2.7. Nucleus is situated at the rounded posterior end.

Sporulation time : 48 hours.

Type host : Grey headed flycatcher Worbblor, *Sicercus xanthochistos* (Gray).

Other hosts : Unknown.

Distribution : Mukteswar, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

42. *Isospora sturniae* Chakravarty and Kar

(Fig. 55)

1947. *Isospora sturniae* Chakravarty and Kar, *Proc. R. Soc., Edinb.*, 62(B) : 225.

Description : Oocyst spherical or subspherical with double oocystic membrane. It measures 22.5-28.5 μm in diameter with a mean of

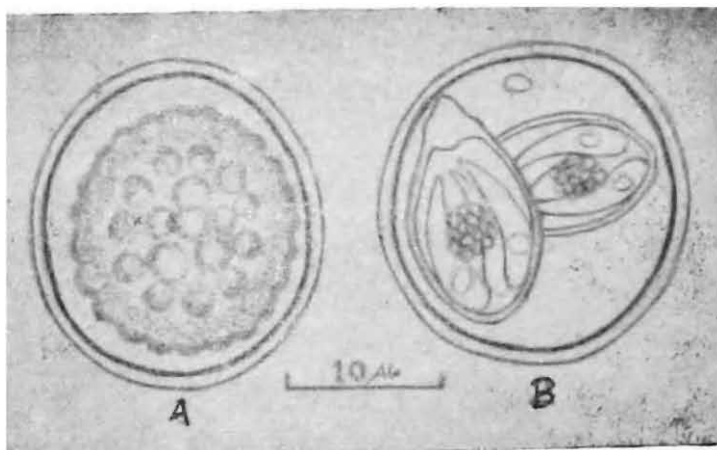


Fig. 55. A, immature and B, mature oocysts of *Isospora sturniae*.

25.5 μm . Unsporulated oocysts filled up with cytoplasm. Micropyle present, oocystic residuum absent. Sporocyst pyriform in shape with narrow anterior and broader posterior ends, the former being provided with well developed knob. It measures 17.7-19.7 μm in length with a mean of 18.7 μm and 11.4-13.4 μm in width with a mean of 12.4 μm . The shape index is 1.5. Sporocystic residuum is present as compact mass. Sporozoite elongated in shape with a centrally placed nucleus. The sporozoite measures 11.2-13.2 μm in length with a mean of 12.2 μm and 2.2-3.2 μm in width with a mean of 2.8 μm . The shape index is 4.8.

Sporulation time : 30-43 hours.

Type host : Gray headed Mayna, *Sturnia malabarica* (= *Sturnus malabaricus* (Gmelin)).

Other hosts : Unknown.

Distribution : Gaya, Bihar.

Endogenous stages : Schizont round ; the mature one produces elongated merozoite of $4.4\ \mu\text{m}$ in length and $2.2\ \mu\text{m}$ in width. The gametocytes are round. The microgametocyte on maturation gives rise to spindle-shaped microgametes each measuring $2.2\ \mu\text{m}$ in length.

Types : Not known.

43. *Isospora temenuchii* Chakravarty and Kar

(Fig. 56)

1944. *Isospora temenuchii* Chakravarty and Kar, *Proc. Indian Acad. Sci.*, 20(B) : 102.

Description : Oocyst subspherical or slightly ovoid, measuring $22.5\text{-}24.5\ \mu\text{m}$ in length with a mean of $23.5\ \mu\text{m}$ and $19.5\text{-}21.5\ \mu\text{m}$ in width with a mean of $20.5\ \mu\text{m}$. The shape index is 1.14. Oocystic

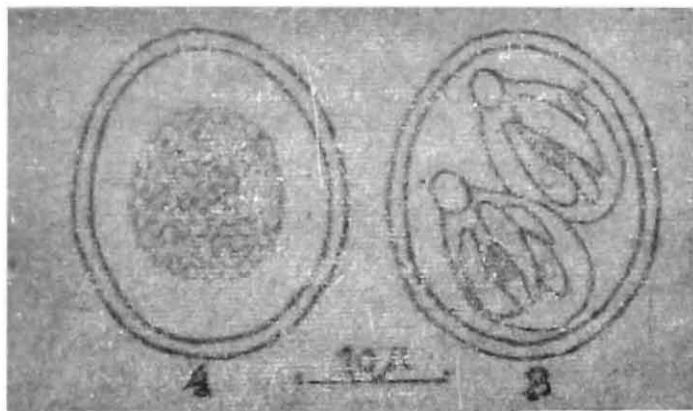


Fig. 56. A, immature and B, mature oocysts of *Isospora temenuchii*.

wall double layered of $2\ \mu\text{m}$. Micropyle present in some cases, oocystic residuum absent. Unsegmented zygote highly granular, contains several refringent globules, measures about $15.5\ \mu\text{m}$. Sporocyst elongately oval in shape, the anterior end somewhat bluntly pointed with a well developed knob. Sporocyst possesses single layer and measuring $15.5\text{-}17\ \mu\text{m}$ in length with a mean of $16.5\ \mu\text{m}$ and $10.2\text{-}11.5\ \mu\text{m}$ in width with a

mean of $10.6\ \mu\text{m}$. Sporocystic residuum compact and appears as refractile area. Sporozoite elongated in shape with the anterior end narrowing down to a blunt point while the posterior end remains round. Nucleus is placed near the centre of the body or slightly towards the rounded end of the sporozoites. Sporozoite measures $8.5\ \mu\text{m}$ by $3.3\ \mu\text{m}$.

Sporulation time : 36-48 hours.

Type host : Black headed or Brahmini Mayna, *Temenuchus* (= *Sturnus*) *pagodarum* (Gmelin).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) stated that instead of '*temenuchii*' it should be spelt as '*temenuchi*', because the genetive of *temenuchus* is '*temenuchi*'

44. *Isospora upupae* Chakravarty and Kar (Fig. 57)

1947. *Isospora upupae* Chakravarty and Kar, *Proc. R. Soc., Edinb.*, 62 (B) : 225.

Description : Oocyst spherical provided with double envelop. It

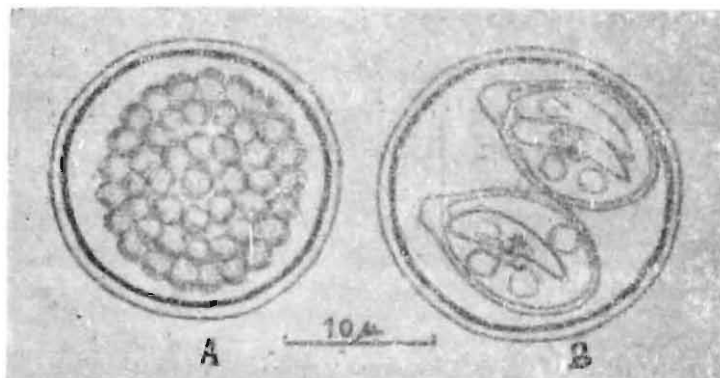


Fig. 57. A, immature and B, mature oocysts of *Isospora upupae*.

measures $24.4\text{-}28.4\ \mu\text{m}$ in diameter with a mean of $26.4\ \mu\text{m}$. Cytoplasm is rounded and contains refringent globules. Micropyle and oocystic residuum absent. Sporocyst oval, provided with blunt knob at the

pointed anterior end. It measures 15.4-19.4 μm in length with a mean of 17.4 μm and 11.3-13.5 μm in width with a mean of 12.4 μm . The shape index is 1.4. Sporocystic residuum is present as a compact irregular mass. Sporozoites are sickle-shaped, each measuring 16.00-18.00 μm in length with a mean of 17.00 μm and 2.00-3.00 μm in width with a mean of 2.4 μm . The shape index is 7.08. Nucleus is situated towards the rounded posterior end of the sporozoite.

Sporulation time : 48-62 hours.

Type host ; Hoope, *Upupa epops orientalis* Baker.

Other hosts : Drongo, *Dicrurus macrocercus* (= *D. adsimilis*) *macrocercus* (Vieillot).

Distribution : Gaya, Bihar.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) has made a comment on the occurrence of this species in both the hosts after considering the remote systematic position. The type host belongs to the order Coraciformes and the Black Drongo comes under the order Passeriformes. However, on personal discussion with one of the author (M. M. C.), the present author could not come to any conclusion about this type of host range.

45. *Isospora zosteropis* Chakravarty and Kar

(Fig. 58)

1947. *Isospora zosteropis* Chakravarty and Kar, *Proc. R. Soc., Edinb.*, 62 (B) : 225.

Description : Oocyst oval, double layered, the outer being thinner. Oocyst measures 17.5-22.5 μm in length with a mean of 19.8 μm and

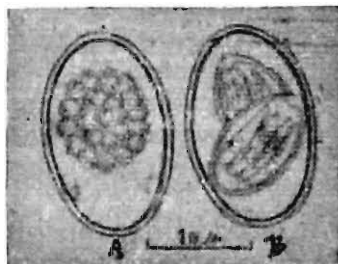


Fig. 58. A, immature and B, mature oocysts of *Isospora zosteropis*.

13.5-19.5 μm in width with a mean of 16.5 μm . The shape index is 1.2. Cytoplasm circular and provided with refringent globules. Micropyle and oocystic residuum absent. Sporocyst oval and the anterior pointed end is provided with a knob. Sporocyst measures 15.3-17.5 μm in length with a mean of 16.5 μm and 10.5-11.5 μm in width with a mean of 11.1 μm . The shape index is 1.4. Sporocystic residuum is present as compact mass. Sporozoites are club shaped each is provided with nucleus at central position, measuring 14.5-16.5 μm in length with a mean of 15.5 μm and 2.1-3.5 μm is width with a mean of 2.5 μm . The shape index is 6.2.

Sporulation time : 30-48 hours.

Type host : White eye, *Zosterops palpebrosa palpebrosa* (Temm. & Schiegal).

Other hosts : Northern Green barbet, *Thereiceryx zeylanicus caniceps* (Frankl). (= *Megalaima zeylanica caniceps* (Franklin).

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) expressed a doubt about the occurrence of the present species in Northern-green barbet, *Thereiceryx zeylanicus caniceps* (Frankl) after considering the host specificity of the parasite.

46. *Isospora* sp.

1965. *Isospora* sp. Shah and Joshi, *Indian J. Microbiol.*, 5 : 27.

Description : The oocyst subspherical or sometimes spherical and measures 16-33 μm by 15-31 μm (mean 23 μm by 20.4 μm). The wall consists of two layers ; the external one is smooth, 1 μm thick and light yellow ; the internal one is 0.5 μm thick and brownish yellow. There is no micropyle. No oocystic residuum is formed during sporulation but there are often one or two polar bodies. The thick-walled is having no micropyle. No oocystic residuum is formed during sporulation but there are often one or two polar bodies. The thick-walled sporocyst has a stieda body and sporocystic residuum. The sporozoite is narrower at one end and bear yellowish globule on the other broad end.

Host : Domestic fowl, *Gallus domesticus* (= *Gallus* sp.)

Distribution : Madhya Pradesh.

Endogenous stages : Unknown.

Remarks : From domestic fowl so far 2 species of *Isospora* viz. *I. gallinae* Scholtyseck, 1954 and *I. gallinarum* Kornieko and Glebezdin, 1963 (vide Pellerdy, 1974, p. 260) have been reported. Pellerdy (1974) expressed a doubt about the validity of both the species. He presumed that both of them are *I. lacazei* Labbe, 1893 of sparrow and have erroneously been described, pointing the continuous contact of the hens with other birds like sparrow. On the report of the occurrence of this *Isospora* sp. in domestic fowl from India, he expressed the similar view as stated above. Mandal (1980) has also variedly discussed about this *Isospora* sp.

The wide host range (vide Mandal, 1976) of *Isospora lacazei* along with the chance of contamination in addition to the variation in sizes of the oocyst and sporocyst, it is sometimes difficult to identify a *Isospora* species. It is quite possible that the present species might be *Isospora lacazei*, found due to contamination.

47. *Isospora* sp.

(Fig. 59)

1968. *Isospora* sp., Bhatia, *Indian J. Microbiol.*, 8 : 245.

Description : Oocyst spherical to subspherical, measuring 20-29.0 μm in length with a mean of 26.0 μm and 19-27.0 μm in width with a mean of 24.0 μm . It is provided with a comparatively delicate but

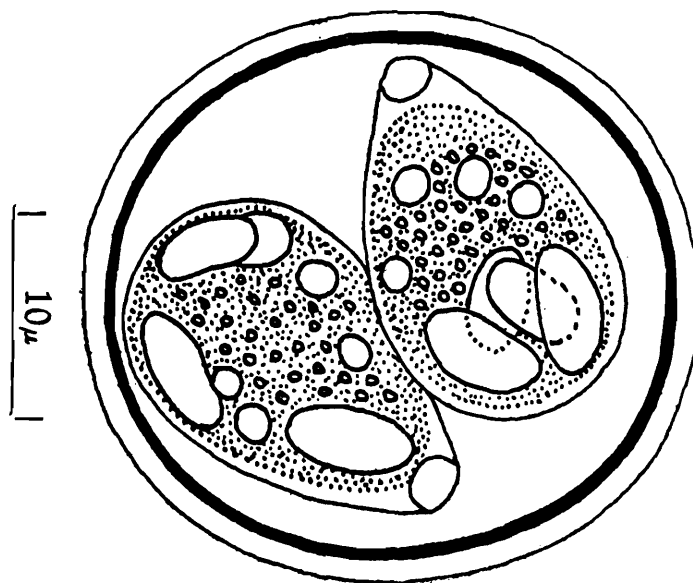


Fig. 59. Mature oocyst of *Isospora* sp.

double layered wall of 1.0-1.3 μm thickness, the outer nearly colourless or slightly pinkish and the inner of dark-blue colour. Micropyle, oocystic residuum and polar granule are absent. Sporocyst pyriform, measuring 14-20.0 μm in length with a mean of 17.3 μm and 9.0-13.0 μm width with a mean of 11.4 μm , the narrower end capped by a plug like stieda body. Spotocystic residuum present as diffuse granules. Sporozoite elongated with one end narrower, measuring 14.6 μm in length and 4.0 μm in width with two refractile globules and the larger one is situated at the broader end.

Sporulation time : 24-28 hours.

Host : Khaki Campbell duck, *Anas* sp.

Distribution : Chak Ganjaria Farm, Lucknow, Uttar Pradesh.

Remarks : Pellerdy (1969, 1974) has not mentioned any species of *Isospora* from the birds belonging to order Anseriformes. However, the occurrence of an *Isospora* species is likely to be contaminative and from the description it appears that the author was dealing with *Isospora lacazei* (Labbe, 1893) of some common passerine birds of the farm.

48. *Isospora* sp.

1947. *Isospora* sp. Misra, *Proc. Indian Acad. Sci.*, 25 (B) : 75.

Description : The oocyst round in shape, measures 14.8-17.8 μm in diameter and usually sheds in the unsporulated state. The yellowish tint oocystic wall is double-contoured, the inner layer is thicker than the outer. The sporocyst has no outer residual body, measures 10.6 μm by 7.4 μm and at the tapering end, the wall is thickened. The sporozoites are 7.5 μm long.

Sporulation time : 10-12 days.

Host : Wagtail, *Motacilla alba* (Linnaeus)

Distribution : Lucknow, Uttar Pradesh.

Remarks : Pellerdy (1974) only mentioned this species but did not comment any. An Isosporan species of a bird with such prolong sporulation time is rare. The present author has examined some Wagtails at Shillong, Meghalaya and Lucknow, Uttar Pradesh but could not come across any coccidial infection.

(D) PARASITES OF MAMMALS

*Key to the species***A. Oocyst spherical, spherical to subspherical, subspherical or spherical to ovoid****(1) Sporocyst oval/ovoid**

(i) Size of sporocyst 18-24 μm by 12-15.00 μm ...	<i>I. aurangabadensis</i>
(ii) Size of sporocyst 20-26 μm by 17-21 μm ...	<i>I. krishnamurthyi</i>
(iii) Size of sporocyst 15.5-16 μm by 10-10.5 μm ...	<i>I. tropicalis</i>

(2) Sporocyst not oval/ovoid**(a) Sporocyst ellipsoidal**

(i) Size of sporocyst 10-12 μm by 8.9 μm ...	<i>I. hoarae</i>
(ii) Size of sporocyst 7-8 μm by 5-7 μm ...	<i>I. bigemina</i>

(b) Sporocyst spherical	<i>I. canis</i>

(c) Sporocyst elliptical to cylindrical	<i>I. suis</i>

B. Oocyst not spherical, spherical to subspherical, subspherical or spherical to ovoid.**(1) Oocyst elongated or egg shaped**

(a) Micropyle present	<i>I. belli</i>

(b) Micropyle absent

(i) Size of sporocyst 9.16 μm by 7-11 μm ...	<i>I. hominis</i>
(ii) Size of sporocyst 16-21 μm by 11-16 μm ...	<i>I. ursi</i>

(2) Oocyst rhomboidal	<i>I. leonina</i>

(3) Oocyst ellipsoidal

(i) Size of sporocyst 21 μm by 15 μm ...	<i>I. felina</i>
(ii) Size of sporocyst 19-21 μm by 12-14 μm ...	<i>I. garnhami</i>
(iii) Size of sporocyst 14.4-20.16 μm by 11.52-15.54 μm ...	<i>I. pantheri</i>

(4) Oocyst ovoid to egg-shaped

(i) Size of sporocyst 20-24 μm by 18-21 μm ...	<i>I. felis</i>
(ii) Size of sporocyst 12.96-17.28 μm by 11.52-14.4 μm ...	<i>I. hippopotami</i>
(iii) Size of sporocyst 15.84-20.16 μm by 15.84-18.16 μm ...	<i>I. leopardi</i>
(iv) Size of sporocyst 11.52-15.84 μm by 11.52-15.5 μm ...	<i>I. mohini</i>

(5) Oocyst ovoid**(a) Sporocyst ellipsoidal**

(i) Size of sporocyst 19-21 μm by 11.12 μm ...	<i>I. buriatica</i>
(ii) Size of sporocyst 16-18 μm by 11-14 μm ...	<i>I. levinei</i>

(b) Sporocyst not ellipsoidal

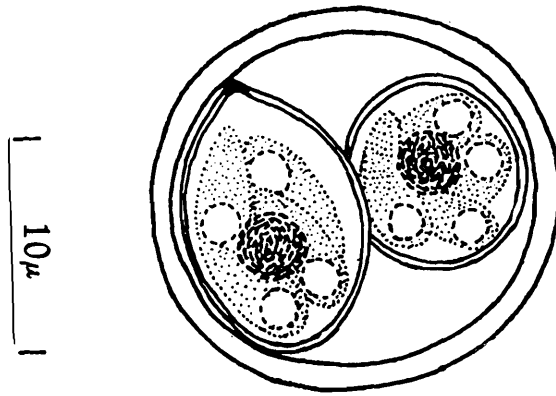
(i) Size of sporocyst 17-19 μm by 12-14 μm ...	<i>I. dubeyi</i>
(ii) Size of sporocyst 11 μm by 9.5 μm ...	<i>I. nandankanani</i>
(iii) Size of sporocyst 22.5 μm by 18 μm ...	<i>I. pardusi</i>
(iv) Size of sporocyst 12-14 μm ...	<i>I. rivolta</i>

49. *Isospora aurangabadensis* Kshirsagar

(Fig. 60)

1980. *Isospora aurangabadensis* Kshirsagar, *Arch. Protistenk.*, 123 : 267.

Description : Oocyst spherical or subspherical in shape, measuring 32.0-44.0 μm in length with a mean of 35.46 μm and 32.0-40.0 μm in width with a mean of 33.96 μm . The length/width ratio is 1.0-1.12 with a mean of 1.04. The single layered oocystic wall is 1.5-2.0 μm

Fig. 60. Mature oocyst of *Isospora aurangabadensis*.

thick and yellowish brown is colour. The polar granule is present but the oocystic residuum is absent. The oocyst contains two sporocysts, each provided with four sporozoites. The sporocysts are oval, globose or elongated in shape each measuring 18.0-24.0 μm in length with a mean of 19.86 μm and 12.0-15.2 μm in width with a mean of 12.96 μm . The length/width ratio of the sporocyst is 1.50-1.76 with a mean of 1.54. A small stieda body is present. The sporocystic residuum is present in the form of small ovoid granular mass near the centre of the sporocyst. The sporozoites are short and stumpy with one end broad and the other slightly narrow and possess a large refractile body at the broader end.

Sporulation time : 48-72 hours.

Type host : Rat, *Rattus rattus rattus*.

Other hosts : Unknown.

Distribution : Aurangabad, Maharashtra.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The subspecies like *R. r. rattus* is not found within Indian limit.

50. *Isospora belli* Wenyon

1891. *Coccidium bigeminum* var. *hominis* Railliet and Lucet, *Bull. Soc. zool. Fr.*, 16 : 246.
1917. *Isospora bigemina* var. *hominis*, *Isospora hominis* Fantham, *Med. J. S. Africa*, 13 : 33.
1922. *Isospora hominis*, Dobell, *Coccidiosis* In Byameo & Archibld, RG (Eds. *Practice of Medicine in the Tropics*, London) II : pp. 1496.
1923. *Isospora belli* Wenyon, *Ann. trop. Med. Parasit.*, 17 : 231.
1926. *Lucetina belli* Henry and Leblois, *Annals. Parasit. hump. comp.*, 4 : 22.

Description : The oocyst elongated, egg-shaped with one end more constricted than the other, forming neck, measuring 25-33 μm in length (mean 29 μm) and 12.5-16 μm in width (mean 14.25 μm). It is transparent and colourless with a wall consisting of two layers, the outer thick and procellanous, the inner thin and membranous. At the narrow end there is an indication of a micropyle. In fresh stools unripe oocysts are found with cytoplasmic contents contracted into a spherical body in each with highly refractile granules, and a single nucleus seen as a clear pale area. The cytoplasm divides into two sporoblasts, which become elongated and covered with wall. Sporocyst measures 12-14 μm and 7-9 μm having four sporozoites and a large spherical residual body. Sporozoites are elongated each is rounded at the anterior end and tapering at the posterior.

Sporulation time : 1-4 days.

Type host : Man, *Homo sapiens* Linnaeus.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal ; Bombay, Maharashtra.

Endogenous stages : Unknown.

Types : Not known.

Remarks : As mentioned by Bhatia (1938), four instances of this infection in man in Bombay has been reported by Garg (1917). Knowles (1924, 28) also reported the same in man. The authors like DasGupta (1934), Mukherjee and Ray (1956) and Ray, Mukherjee and Chakrabarty (1959) reported this species from man while working at the School of Tropical Medicine, Calcutta, West Bengal.

51. *Isospora bigemina* (Stiles)

1878. *Cytospermium villorum intestinalium canis* Rivolta (nomen nudum) *Gior. Anat. Fisiol. Patol. Anim. Pisa.*, 4 : 220.
1879. *Coccidium rivolta* Grassi (partim), *Gaz. Med. Ital.*, 39 : 8, 445.
1886. *Coccidium rivoltae* Leuckart (partim), *The parasites of man* English translation, London, p. 325.
1891. *Coccidium bigeminum* Stiles (partim), *Bull. Soc. zool.*, Fr., 16 : 163.
1891. *Coccidium bigeminum* var. *canis* Railliet and Lucet, *Bull. Soc. zool.* Fr., 16 : 246.
1891. *Coccidium bigeminum* var. *cati* Railliet and Lucet, *Bull. Soc. zool.* Pr., 16 : 246.
1906. *Isospora bigemina* Luhe, *Handbuch der Tropenkrankheiten* 3, Anhang : Coccidi, p.
1922. *Isospora cati* Marotel (partim) (vide Pellerdy, 1974, *Coccidia* and *Coccidiosis*, Verlag Paul Parey, Berlin und Hamburg, p. 632).
1926. *Lucetina bigemina* Henry and Leplois, *Annals Parasit. hump. comp.*, 4 : 22.
1933. *Isospora bigemina* Gousseff (lapsus), *Arch. Tierernahr.*, 66 : 424.

Description : The large oocyst, measuring 18-20 μm in length and 14-16 μm in width, is found in the dog only ; where as the smaller ones 10-16 μm long and 7.5-10 μm broad, is found in the dog and the cat alike. The oocysts are spherical to ovoidal in shape. Micropyle is not visible. Sporocyst broadly ellipsoid, measuring 7-8 μm by 5-7 μm without any stieda body ; sporocystic residuum granular. Sporozoite are sausage-shaped and so arranged that their longitudinal axes lie parallal to each other.

Sporulation time : 4 days.

Type host : Domestic dog, *Canis familiaris* Linn. (= *Canis* sp.)

Other hosts : From the Type host and Domestic cat, *Felis domestica* Linn. (= *Felis* sp.) and Pup, white Alsatian, *Canis* sp., (Patnaik, 1963 and Rao, 1968).

Distribution : Bhubaneswar, Orissa and Bombay, Maharashtra.

Endogenous stages : Schizonts in the epithelial cells give rive to 8 merozoites in each sometimes subepithelially upto 12 nos. The gametocytes are found epi and subepithelially also.

Types : Not known.

Remarks : Morphologically the oocysts of *Isospora bigemina* and *Toxoplasma gondii* are very similar. The proper distinction between the two is almost impossible as stated by Pellerdy (1974). Some authors regarded the toxoplasma as vegetative stages of the coccidium. Scholtyseck and Piekarski (1965), Scholtyseck, Kepka and Piekarski (1970), Colley and Zaman (1970), Sheffield (1970) have also suggested the coccidial nature of toxoplasma. Moreover, the ultrastructure of

Toxoplasma zoites differ little from that of eimerian merozoites and the zoites of *Sarcocystis*, *Besnoitia* and *Frenkelia* (M—organism). The details about the cystforming coccidia may be had from Tardos and Laarman (1982).

52. *Isospora buriatica* Yakimoff and Matschoulsky
(Fig. 61)

1940. *Isospora buriatica* Yakimoff and Matschoulsky, *Schweiz. Arch. Tierernahr.*, 82 : 16.

Description : Oocyst ovoid, measuring 29-33 μm by 22-25 μm with a mean of 31 μm by 25 μm their length/width index ranged from 1.23-1.28. Oocystic wall 1-2 μm thick, composed of two layers, the outer

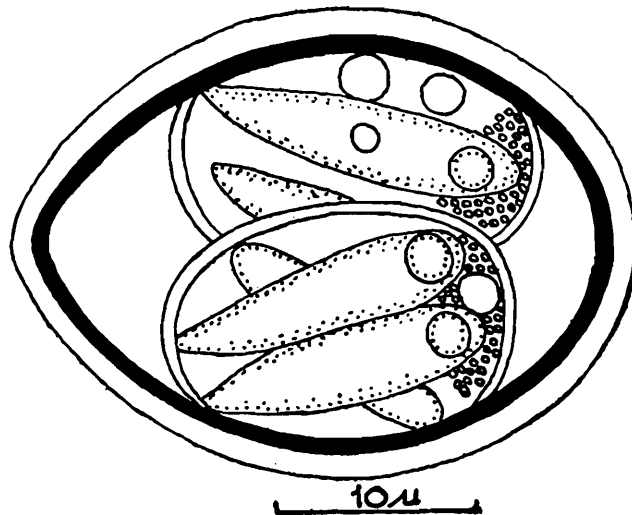


Fig. 61. Mature oocyst of *Isospora buriatica*.

thicker and of yellowish colour. Sporont was nearly as wide as the oocyst. Micropyle, polar cap, polar granule and oocystic residuum absent. Sporocyst ellipsoidal and double layered, measuring 19-21 μm by 11-12 μm with a mean of 19 μm by 12 μm . Sporocystic residuum present. Sporozoite measuring 14-15 μm by 3-4 μm with a central nucleus and a large globule at the posterior end.

Sporulation time : 2 days.

Type host : Corsac fox, *Vulpes corsac* (Linnaeus),

Other hosts : Bengal fox, *Vulpes bengaiensis* Shaw, (Dubey, 1963)

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

53. *Isospora canis* Nemeseri

1959. *Isospora canis* Nemeseri, *Allatori. Lapok.*, 14 : 91 ; Mandal, 1976. *Rec. zool. Surv. India*, 70 : 39.

1965. *Isospora canis* Ray and Banik, *Proc. Indian Sci. Congr.*, p. 466.

Description : Oocyst subspherical measuring 36-40 μm in length with a mean of 38 μm and 32 μm in width. The wall of the oocyst is thick. Micropyle and oocystic residuum absent. Sporocyst spherical in shape measuring 20 μm in length and 16 μm in width. Steida body absent, sporocystic residuum present as a large granular mass. Sporozoites are bean-shaped each measuring 11.5 μm in length.

Sporulation time : 15-20 hours.

Type host : Domestic dog, *Canis familiaris* Linn. (= *Canis* sp.)

Other hosts : From the Type host.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Mandal (1976) has synonymised *Isospora canis* Ray and Banik with *I. canis* Nemeseri. Although the question of homonymy cannot also be ignored.

54. *Isospora dubeyi* Patnaik and Ray

1965. *Isospora dubeyi* Patnaik and Ray, *Indian J. Anim. Hlth.*, 4 : 33.

1963. *Isospora knowlesi* Dubey and Pande, *Indian J. Microbiol.*, 3 : 49.

1964. *Isospora pellerdyi* Dubey and Pande, *Indian J. Microbiol.*, 4 : 29.

Description : Oocyst is ovoid in shape, measuring 27-30 μm by 20-25 μm with a mean of 28 by 23 μm ; the length-width index ranging from 1.17-1.22. Oocystic wall 1-2 μm thick composed of two layers. The outer thicker and of yellowish orange in colour and the inner darker with a shining inner contour. Sporont nearly as wide as the oocyst. Micropyle, polar cap, polar granule and oocystic residuum absent. Sporocyst measures 17-19 μm by 12-14 μm with a mean of 15 μm by 11 μm . Stieda body absent. Sporocystic residuum present. Sporozoite elongated with one end pointed, measuring 13-15 μm by 2-3 μm .

Sporulation time : 1 to 2 days.

Type host : Indian Grey Mongoose, *Herpestes mungo* (= *Herpestes edwardsii* Geoff.).

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

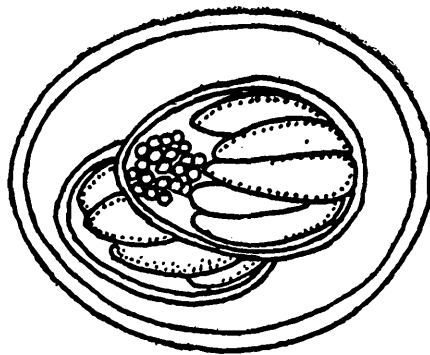
Types : Not known.

55. *Isospora felina* Patnaik and Acharjyo

(Fig. 62)

1971. *Isospora felina* Patnaik and Acharjyo, *Orissa vet. J.*, 6 : 133.

Description : The oocysts are thin walled colourless, ellipsoidal to globular in shape, and their micropyle indistinct, each measuring $25\ \mu\text{m}$ by $20\ \mu\text{m}$ and contains the eccentric spherical sporont at the bottom.



| 10 μ |

Fig. 62. Mature oocyst of *Isospora felina*.

The oval sporocyst measures $15\ \mu\text{m}$ by $21\ \mu\text{m}$ leaving behind no oocystic residuum. The sporocyst contains four elongate to oval sporozoites each measuring $10\ \mu\text{m}$ by $3\ \mu\text{m}$ and a granular residual body at the end.

Sporulation time : 48 hours.

Type host : Leopard cat, *Felis bengalensis* Keer.

Other hosts : Unknown.

Distribution : Nandankanan Zoological Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Though there is little difference between the oocysts of *I. felina* and *I. nandankananensis* described from Leopard cat but at present it is very difficult to treat them as one species.

56. *Isospora felis* (Wasielewsky)

(Fig. 63)

1904. *Diplospora bigemina* Wasielewsky (partim), *Studien und Mikrophotogramme zur Kenntnis der Pathogenen Protozoen* Leipzig, p.
 1914. *Isospora bigemina* Swellengrebel, *Arch. Protistenk.*, 32 : 379.
 1921. *Isospora cati* Marotel (partim), *Bull. Soc. Sci. vet. Med. Comp. Lyon*, p. 86.
 1923. *Isospora felis* Wenyon, *Ann. trop. Med. Parasit.*, 17 : 231.
 1926. *Lucetina felis* Henry and Leblois, *Annals Parasit. hump. comp.*, 4 : 22.
 1934. *Isospora* sp. (Type 'B') *Isospora* sp. Knowels and Das Gupta, *Indian Med. Gaz.*, 69 : 387.

Description : Oocysts are ovoid to egg-shaped, each is tapering at one end. The ovoid form measures 39-48 μm by 26-37 μm (mean 43.5 μm by 31.5 μm) and the another one measuring 35-45 μm by 23-35

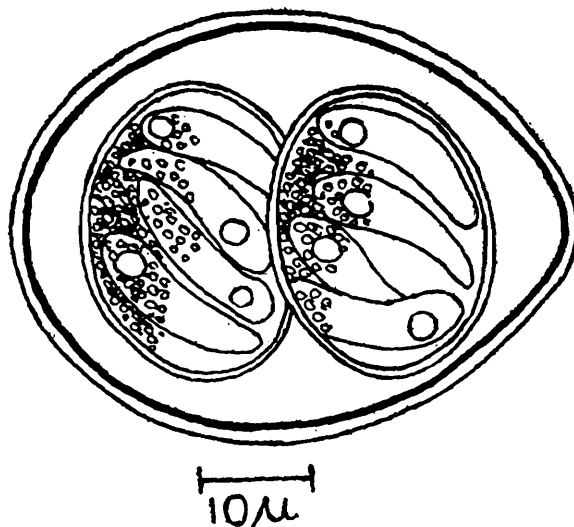


Fig. 63. Mature oocyst of *Isospora felis*.

μm (mean 40 μm by 29 μm). The oocystic wall is smooth and pinkish in colour. No micropyle is present. Sporocysts are elongated each measuring 20-24 μm by 18-21 μm (mean 22 μm by 19.5 μm). Sporozoites are comma-shaped. The sporocystic residuum is present as large-sized granules.

Sporulation time : 48 hours.

Type host : Domestic cat, *Felis catus* (= *F. domestica* Linn, (= *Felis* sp.).

Other hosts : From the Type host, White Tiger, *Panthera* sp., Alsatian pup., *Canis* sp., Rao and Hirigaudar (1952), Alwar and Lalitha (1958), Rao (1968), Bhatia (1970) and Bhatia, Chauhan, Arora and Agarwal (1973).

Distribution : Calcutta, West Bengal ; Bombay, Maharashtra ; Madras, Tamil Nadu ; Lucknow, Uttar Pradesh.

Endogenous stages : Shah (1971) studied with the pure strain of *I. felis* and found that the first generation schizont measures 4-6.2 μm produces 8-16 merozoites. Each schizont finally attains 11-30 μm by 10-23 μm . The first generation merozoite are banana-shaped each measuring 11-15 μm by 3-5 μm , tapering at one end. The second generation schizonts appear after 4-5 days and each produce 2-10 merozoites. Each of the third generation schizonts measures 14-36 μm by 13-22 μm in size and produce about 70 merozoites. Microgametocyte measures 24-72 μm by 18-32 μm produces many microgametes and a residuum, each microgamete measures 5-7 μm by 8 μm with a single flagellum. The macrogametocyte measures 16-22 μm by 8-17 μm when mature, with a large nucleus and plastic granules.

Types : Not known.

57. *Isospora garnhami* Bray

(Fig. 64)

1954. *Isospora garnhami*, Bray, *Ann. trop. Med. Parasit.*, 48 : 405.

Description : The oocyst occurs in two sizes, large and small. The larger forms were ellipsoidal with rounded ends each measuring 27-34 μm by 23-27 μm (mean 34 μm by 27 μm), their length-width index ranges from 1.17-1.25. Oocyst wall 1-2 μm thick, composed of two layers, the outer thicker, light yellowish green to pale yellow and inner darker with shining inner contour buckling on application of pressure to rupture the oocysts. Sporont is centrally placed measuring 17-19 μm in diameter. Micropyle, polar cap, polar granule and oocystic residuum absent. Oocystic shape, after sporulation seen to vary depending upon the position of the larger size sporocysts. Sporocyst ellipsoidal, measuring 19-21 μm by 12-14 μm (mean 21 μm by 14 μm). Sporocystic residuum present. Stieda body absent. Sporozoite sausage-shaped with one end narrower, filling up the entire cavity of sporocyst and lying somewhat twisted and each having a prominent globule at the broader

end. Smaller forms of the oocysts are spherical each measuring $19-22\ \mu\text{m}$ by $16-19\ \mu\text{m}$ with the sporocyst $14-17\ \mu\text{m}$ by $8-11\ \mu\text{m}$ in dimensions.

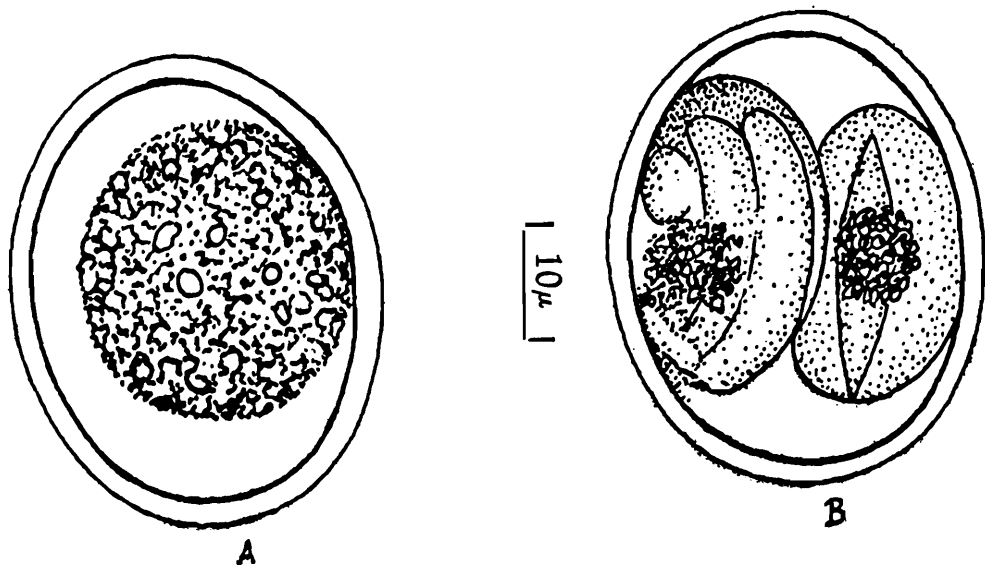


Fig. 64. A, immature and B, mature oocysts of *Isospora garnhami*.

Sporulation time : 24 hours.

Type host : Mongoose, *Halogale undulata rufula* (= *Halogale pervula undulata* Peters).

Other hosts : Indian grey Mongoose, *Herpestes mungo* (= *Herpestis edwardsii* Geoff.), Dubey and Pandey (1963).

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Young gametocytes are found in the terminal ileal portion and in the large intestine at the epithelial cells of the villi. The microgametocyte measure $23\ \mu\text{m}$ by $22\ \mu\text{m}$ produce about 400 microgametes with a residuum. The macrogamete measures $24\ \mu\text{m}$ by $22\ \mu\text{m}$ (Bray, 1954).

Types : Not known.

58. *Isospora hippopotami* Agarwal, Ahluwalia, Bhatia and Chauhan (Fig. 65)

1981. *Isospora hippopotami* Agarwal, Ahluwalia, Bhatia and Chauhan, *Indian J. Anim. Sci.*, 51 : 125.

Description : Oocysts are ovoid to broadly ellipsoidal in shape each measuring 30.24-36.00 μm in length and 21.60-27-36 μm in breadth with a mean of 32.40 μm by 24.48 μm . The oocystic wall is bilayered, measuring 1.5 μm in thick, the outer layer is light yellowish green. The length-width ratio of the oocyst is 1.4-1.5 with a mean of 1.33. Micropyle, polar cap, oocystic residuum and polar granules

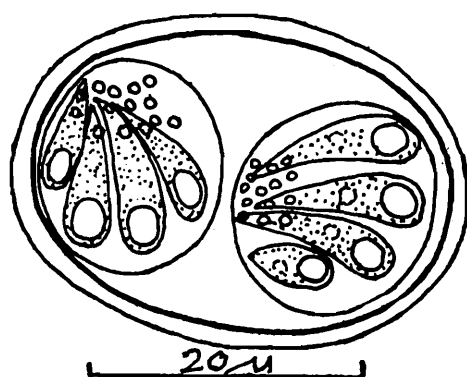


Fig. 65. Mature oocyst of *Isospora hippopotami*.

are absent. Sporocyst subspherical to ovoid in shape with an entire wall without stieda body. It measures 12.96-17.28 μm in length and 11.52-14.4 μm in breadth with a mean of 15.12 μm by 13.68 μm . Sporocystic residuum present as clumps of few coarse dark granules. Sporozoites are 4 in number and pear shaped each measuring 7.4-11.5 μm in length and 2.8-5.04 μm in breadth with a mean of 9.36 μm by 3.60 μm lay parallel to each other with one end narrow and pointed and the other end broad carrying a larger refractile globule.

Type host : Hippopotamus, *Hippopotamus amphibius* Linn.

Other hosts : Unknown.

Distribution : Zoological garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

59. *Isospora hoarei* Bray

(Fig. 66)

1954. *Isospora hoarei* Bray, *Ann. trop. Med. Parasit.* 48 : 405.

Description : The oocysts are yellowish tinged, spherical to sub-spherical, rarely ellipsoidal in shape and had no perceptible micropyle.

Oocyst measures $19.32-20.93\ \mu\text{m}$ by $16.32\ \mu\text{m}-18.25\ \mu\text{m}$ with a mean of $19\ \mu\text{m}$ by $17.55\ \mu\text{m}$. The length/width ratio varied from 1-1.2 with a

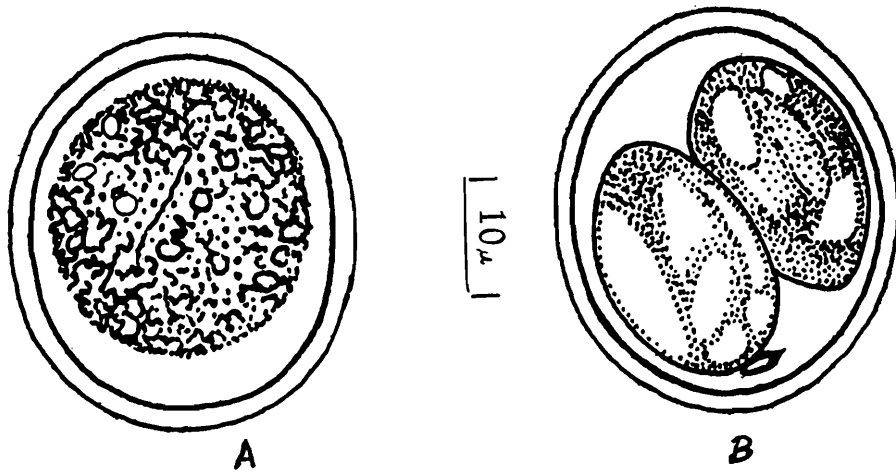


Fig. 66. A, immature and B, mature oocysts of *Isospora hoarei*.

mean of 1.12. The sporant was of $9.5-11.5\ \mu\text{m}$ in diameter. Sporulated in 2-3 days into two sporocysts and contain no oocystic residuum. The tetrozoic ellipsoidal, thin walled sporocyst measures $10-12\ \mu\text{m}$ by $8-9\ \mu\text{m}$ and contained a globular sporocystic residual mass. The sporozoites are banana or sausage-shaped.

Type host : Mongoose, *Helogale undulata rufula* (= *Halagale permla undulata* Peter).

Other hosts : Indian grey Mongoose, *Herpestis edwardsii* Geoff., (Dubey and Pande, 1963 and Pathaik and Ray, 1965).

Distribution : Mathura, Uttar Pradesh ; Orissa.

Endogenous stages : Unknown.

Types : Not known.

60. *Isospora hominis* (Railliet and Lucet)

(Fig. 67)

1860. *Psorospermium* sp. Virchow, *Archs. Path. Anat.*, 18 : 523.

1878. *Cytospermium hominis* Rivolta, *Gior Anat. Fisiol. Patol. Anim. Pisa*, 4 : 220, *nomen nudum*.

1878. *Eimeria hominis* Rivolta, *Gior. Anat. Fisiol. Patol. Anim. Pisa*, 4 : 220, *Lapsus*.

1891. *Coccidium bigeminus* var. *hominis* Railliet and Lucet. *Bull. Soc. Zool. France*, 16 : 246.

1923. *Isospora belli* Wenyon, *Ann. Trop. Med. Parasit.*, 17 : 231, Pro Parte.
 1923. *Isospora hominis* Wenyon, *Ann. trop. Med. Parasit.*, 17 : 231.
 1926. *Lucetina hominis* Henry and Leblois, *Ann. Parasit. hump. comp.*, 4 : 22.

Description : Oocysts are elongated in shape each measuring 22-32 μm in length and 10-15 μm in width. They are transparent, colourless bodies, each with a thin outer and a thick inner membrane.

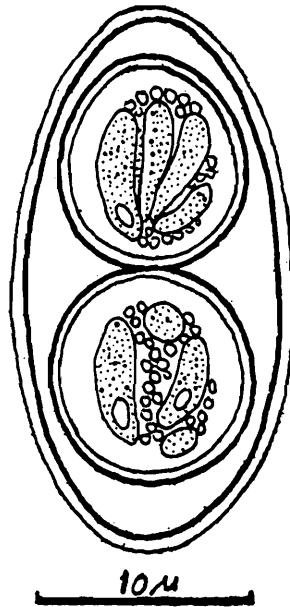


Fig. 67. Mature oocyst of *Isospora hominis*.

Micropyle and oocystic residuum absent. Sporocysts are oval shaped each measuring 9-16 μm in length and 7-11 μm in width. A large sporocystic residual mass is always present. Sporozoites are elongated in shape each with one end rounded and the other pointed.

Sporulation time : 96 hours.

Type host : Man, *Homo sapiens* Linn.

Other hosts : From the Type host.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The authors like Ray, Mukherjee and Chakravarty (1959) and Haldar and Chakravarty (1969) reported this species from India. With the advancement of knowledge on coccidia and subsequent description of certain genera like *Sarcocystis*, *Besnoitia*, *Frenkelia* etc. the human coccidia have also been reviewed. As a result, *Isospora hominis* has now been treated as *Sarcocystis hominis* and *S. suis hominis*.

The authors like Zaman (1968) Tardos and Laarman (1976), Dubey (1976) and long (1982) have contributed much on the subject.

61. *Isospora krishnamurthyi* Kashirsagar

(Fig 68)

1980. *Isospora krishnamurthyi* Kashirsagar, *Arch. Protistenk.*, 123 : 267.

Description : Oocyst spherical or slightly ovoid in shape, measuring 36.0-48.0 μm in length with a mean of 42.40 μm and 35.2-40 μm in width with a mean of 37.10 μm . The length width ratio is 1.0-1.28

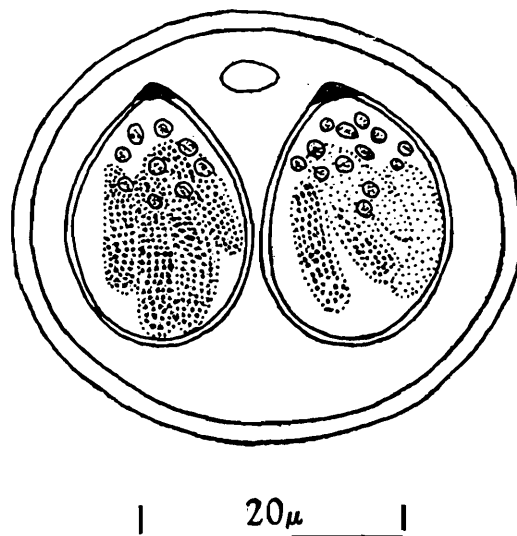


Fig. 68. Mature oocyst of *Isospora krishnamurthyi*.

with a mean of 1.14. The single layered oocystic wall measuring 1.8 μm thick and pale yellowish in colour. A prominent polar granule is always present but the oocystic residuum is absent. Elongated or ovoid sporocysts are two in number, each possesses a conspicuous stieda body. The sporocyst measures 20.8-26.0 μm in length with a mean of 23.64 μm and 17.6-21.5 μm in width with a mean of 19.25 μm . The length/width ratio of the sporocyst is 1.16-1.36 with a mean of 1.23. Sporocystic residuum is present in the form of coarse granules. Each sporocyst contains four sporozoites. The sporozoites are elongated in shape and without any refractile body.

Sporulation time : Six hours.

Type host : Rat, *Rattus rattus rattus*.

Other hosts : Unknown.

Distribution : Aurangabad, Maharashtra.

Endogenous stages : Unknown.

Types : Not known.

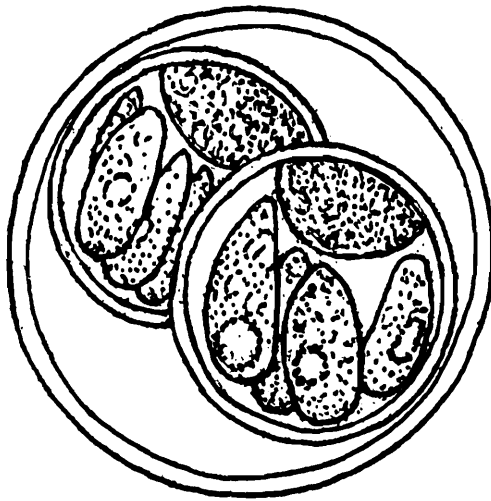
Remarks : There is no subspecies like '*rattus*'; found in our country.

62. *Isospora leonina* Mandal and Ray

(Fig. 69)

1960. *Isospora leonina* Mandal and Ray, *Bull, Calcutta Sch. trop. Med. Hyg.*, 8 : 107.

Description : Oocyst rhomboidal in shape measuring 30-32 μm in length with a mean of 31.8 μm and 28.00-31.00 μm in width with a mean



| 10 μ |

Fig. 69. Mature oocyst of *Isospora leonia*.

of 28.2. μm . Micropyle and oocystic residuum absent. Sporocyst spherical, measuring 16-20 μm in length and 13.5-15 μm in width. Sporocystic residual mass coarsely granular. Sporozoite sausage shaped measuring 9.5 μm in length.

Sporulation time : 5 days.

Type host : Lion, *Panthera leo* (Linn.).

Other hosts : From the type hosts ; Patnaik and Acharjya, (1970).

Distribution : Zoological Garden, Calcutta, West Bengal and Nandankanan Zoological garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

63. ***Isospora leopardi*** Agarwal, Ahluwalia, Bhatia and Chauhan

(Fig. 70)

1981. *Isospora leopardi* Agarwal, Ahluwalia, Bhatia and Chauhan, *Indian J. Anim. Sci.*, 51 : 125.

Description : Oocysts are nearly egg shaped each measuring 38.88-44.64 μm in length and 23.04-27.36 μm in breadth with a mean of 41.04 μm by 25.20 μm . Bilayered oocystic wall is smooth, measuring 1.5 μm thick, the outer wall is light yellowish and inner one is dark brown in colour. The length/width ratio is 1.55-1.75 with a mean of

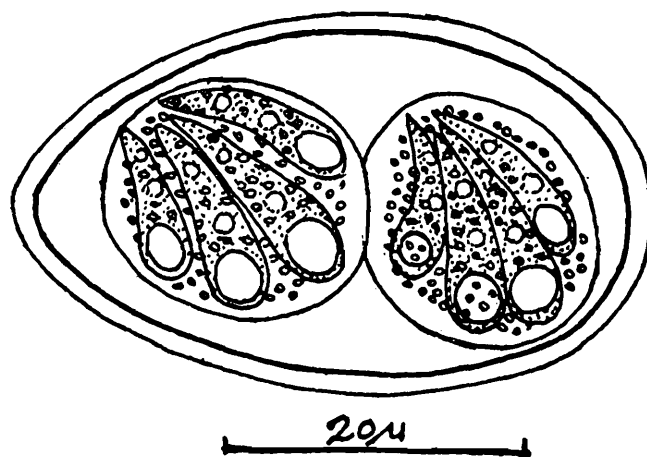


Fig. 70. Mature oocyst of *Isospora leopardi*.

1.64. Micropyle, polar cap, oocystic residuum and polar granules are absent. Sporocysts are ovoid in shape each measuring 15.44-20.16 μm in length and 15.84-18.72 μm in breadth with a mean of 18.00 μm by 17.28 μm . Sporocystic residuum is present as scattered granules. Sporozoite elongated with one end broader and the other end pointed ; measures 11.52-15.84 μm in length and 3.6-5.04 μm in breadth with a mean of 12.96 μm by 4.32 μm . The broader end of the sporozoite is provided with a large refractile globule.

Type host : Clouded leopard, *Neofelis nebulosa* (Linn.).

Other hosts : Unknown.

Distribution : Zoological garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

64. *Isospora levinei* Dubey

(Fig. 71)

1963. *Isospora levinei* Dubey, *Indian J. Microbiol.*, 3 : 121.

Description : Oocyst ovoid, measuring 23-29 μm by 22-26 μm with a mean of 27 μm by 25 μm , length/width ratio ranged from 1.05-1.06. Oocystic wall 1-2 μm in thickness, composed of two layers, outer smooth, thicker, yellowish green and inner dark with a shining inner

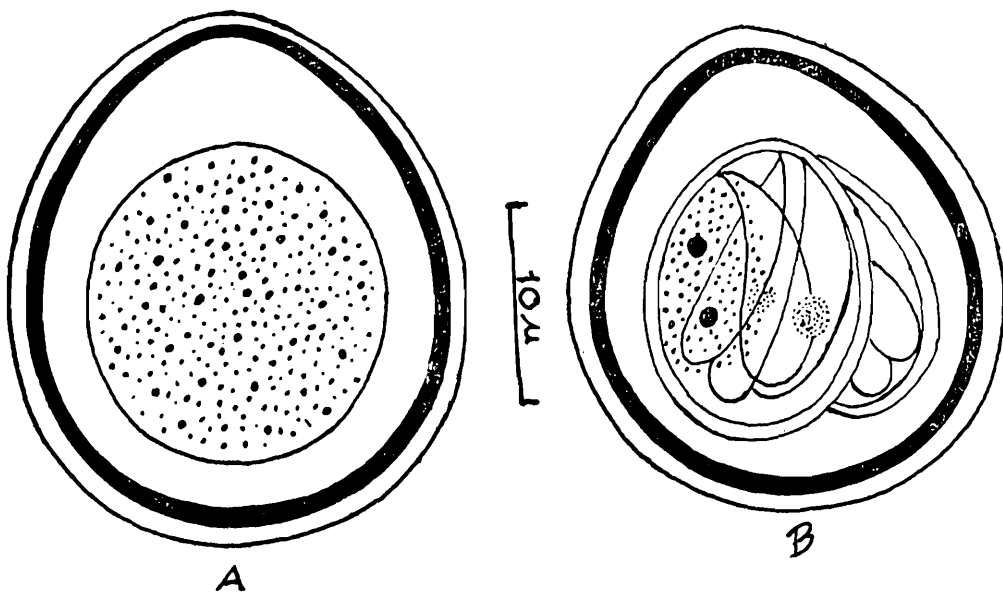


Fig. 71. A, immature and B, mature oocysts of *Isospora levinei*.

contour. Sporocyst ellipsoidal, situated centrally, 13-16 μm in diameter. Division into two double-walled sporoblasts was accomplished after a few hours of collection (Dubey, 1963). It measures 16-18 μm by 11-14 μm , with a mean of 18 μm by 14 μm . Sporocystic residuum present as dark granular bodies. A few refractile bodies are also seen in the sporocystic residuum. Sporozoite is pointed at one end and rounded on other, measuring 10-14 μm by 3-4 μm .

Sporulation time : 24 hours.

Type host : Striped Hyaena, *Hayana striata* [= *Hyaena hyaena hyaena* (Linn.)].

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Likely to be present in the Collection of Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

65. *Isospora mohini* Agarwal, Ahluwalia, Bhatia and Chauhan
(Fig. 72)

1981. *Isospora mohini* Agarwal, Ahluwalia, Bhatia and Chauhan, *Indian J. Anim. Sci.*, 51 : 125.

Description : Oocyst ovoid to broadly ellipsoidal in shape measuring $18.72\ \mu\text{m}$ - $27.36\ \mu\text{m}$ in length and $14.40\ \mu\text{m}$ - $20.16\ \mu\text{m}$ in breadth with a mean of $23.04\ \mu\text{m}$ by $17.28\ \mu\text{m}$. The oocystic wall is double layered and $1.5\ \mu\text{m}$ thick, the outer layer is yellowish green while the inner one is dark brown in colour. The length-width ratio of the oocyst is 1.53-1.86 with a mean of 1.65. Oocystic residuum, micropyle,

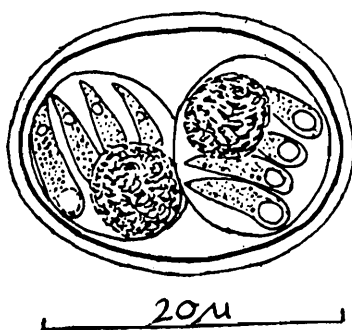


Fig. 72. Mature oocyst of *Isospora mohini*.

polar cap and polar granules are absent. Sporocysts are ovoid, each measuring $11.52\ \mu\text{m}$ - $15.84\ \mu\text{m}$ in length and 11.52 - $15.54\ \mu\text{m}$ in breadth with a mean of $17.14\ \mu\text{m}$ by $14.4\ \mu\text{m}$. Sporocystic residuum is present in the form of clumps of coarse granules. Sporocyst contains four sporozoites each measures 7.92 - $10.8\ \mu\text{m}$ in length and 1.8 - $3.24\ \mu\text{m}$ in width with a mean of $9.36\ \mu\text{m}$ by $2.16\ \mu\text{m}$. Sporozoites are banana-shaped each is provided with one broader end having a large refractile globule and the other end is pointed.

Type host : Lion, *Panthera (Leo) leo* [= *Panthera leo* (Linnaeus)]

Other hosts : Unknown.

Distribution : Zoological garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not kdown.

66. ***Isospora nandankanani*** Patnaik and Acharjyo
(Fig. 73)

1971. *Isospora bengalensis* Patnaik and Acharjyo, *Orissa vet. J.*, 6 : 133.

1977. *Isospora nandankanani* Patnaik and Acharjyo, *Orissa vet. J.*, 11 : 47.

Description : The oocyst colourless, relatively large and oval in shape. The micropyle is inperceptible. It measures 30 μ m by 40 μ m with subglobular sporont. The oocyst sporulates into two oval sporocysts

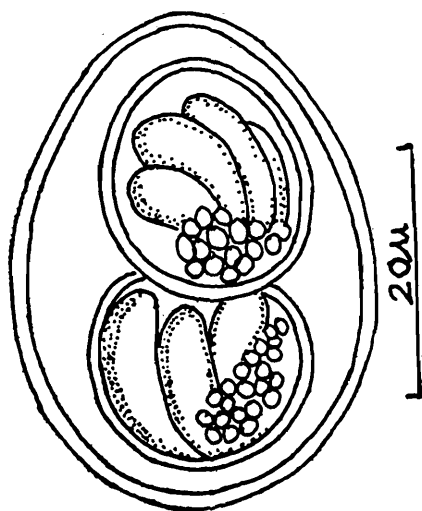


Fig. 73. Mature oocyst of *Isospora nandankanani*.

leaving behind no oocystic residuum. The sporocyst measures 11 μ m by 9.5 μ m and contained four banana shaped sporozoites and a globular sporocystic mass consisting of granular bodies. The sporozoite measures 8.5 μ m by 2.75 μ m.

Sporulation time : 72 hours.

Type host : Leopard Cat, *Felis bengalensis* Keer.

Other hosts : Unknown.

Distribution : Nandankanan Zoological garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The specific name should be *nandankanonensis* instead of *nandankanani*,

67. ***Isospora pantheri*** Agarwal, Ahluwalia, Bhatia and Chauhan
(Fig. 74)

1981. *Isospora pantheri* Agarwal, Ahluwalia, Bhatia and Chauhan, *Indian J. Anim. Sci.*, 51 : 125.

Description : Oocyst ellipsoidal measuring 33.12-40.32 μm in length and 20.92-25.92 μm in breadth with a mean of 36.72 μm by 22.32 μm . light yellowish while the inner one is dark brown. The length width ratio of the oocyst is 1.53-1.86 with a mean of 1.65. The micropyle, polar cap, oocystic residuum and polar granules are absent. The

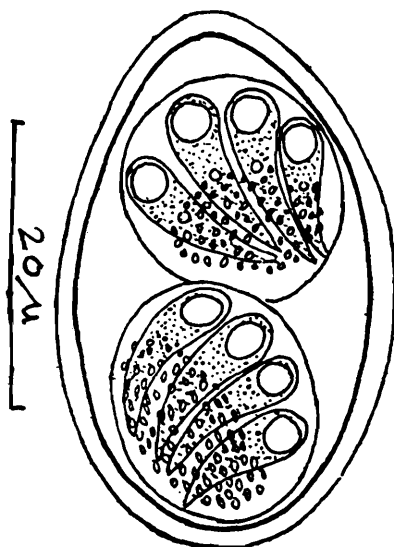


Fig. 74. Mature oocyst of *Isospora pantheri*.

sporocysts are ovoid in shape each measuring 14.0-20.16 μm in length and 11.52-15.54 μm in breadth with a mean of 17.28 μm by 14.4 μm . Sporocystic residuum is present in the form of clumps of coarse granules. Sporocyst contains four banana-shaped sporozoites, measures 11.52-14.40 μm in length and 2.88-4.32 μm in breadth with a mean of 12.24 μm by 3.60 μm . The sporozoite banana-shaped with one end broad, provided with a large prominent refractile globule and the other end is pointed.

Type host : Lion, *Panthera (Leo) leo* [= *Panthera leo* (Linn.)].

Other hosts : Unknown.

Distribution : Zoological garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

68. *Isospora pardusi* Patnaik and Acharjyo (Fig. 75)

1971. *Isospora pardusi* Patnaik and Acharjyo, *Orissa vet. J.* 6 : 133.

Description : The oocyst colourless and oval in shape with no distinct micropyle. It measures 40-49 μm in length and 30-36 μm in

breadth (mean 45 by μm 33 μm). The unsporulated oocyst contains a relatively small spherical sporont which further shrunk on sporulation and developed into two sporocysts within 72 hours. There is no

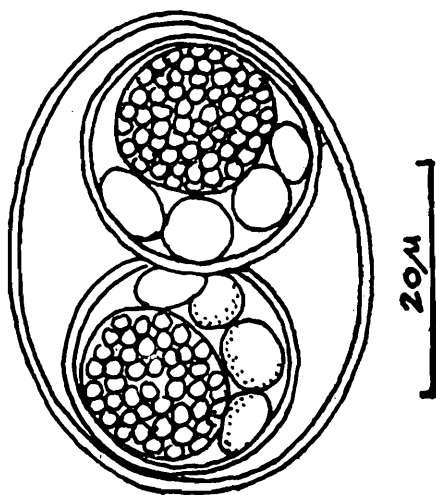


Fig. 75. Mature oocyst of *Isospora pardusi*.

oocystic residuum. The sporocyst measures 22.5 μm long and 18 μm wide and contained four elongated symmetrically arranged sporozoites and a residual mass of 18-22 μm consisting of globular bodies. Sporozoite measures 15 μm by 4.5 μm .

Type host : Leopard, *Panthera pardus* (Linnaeus).

Other hosts : Unknown.

Distribution : Nandankanan Zoological garden, Orissa.

Endogenous stages : Unknown.

Types ; Not known.

69. *Isospora rivolta* (Grassi)

- 1879. *Coccidium rivolta* Grassi (partim), *Gaz. Med. Ital.*, 39 : 445.
- 1886. *Coccidium rivoltae* Leuckart (partim), *The Parasites of Man. English Translation*, London, p. 325.
- 1891. *Coccidium bigemium* Stiles (partim), *Bull. Soc. zool. F.*, 16 : 163.
- 1904. *Diplospora bigeminum* Wesielewsky (partim), *Studien und Mikrophotogramme zur Kenntnis der Pathogenen Protozoen*, Leipzig, p. ?
- 1919. *Isospora rivaltae* Dobell, *Parasitology*, 11 : 147.
- 1923. *Isospora rivolta* Wenyon, *Ann. trop. Med. Parasit.*, 17 : 231.
- 1926. *Lucetina rivolta* Henry and Leblois, *Annals, Parasit. hump. comp.*, 4 : 22.

Description : Oocyst ovoid measuring 27-30 by 20-25 μm (mean

28 μm by 23 μm , the length-width index ranging from 1.17-1.22. Oocystic wall 1-2 μm thick composed of two layers the outer thicker and of yellowish to orange in colour and the inner darker with a shining contour. Sporont centrally placed. Sporulation completed in 24 hours. Micropyle, polar granules and oocystic residuum absent. Sporocyst ellipsoidal measuring 17-19 μm by 12-14 μm (mean 18 μm by 12 μm). Steida body absent. Sporocystic residuum present, sporozoites elongated, each with one pointed end, measuring 13-15 μm by 2-3 μm .

Sporulation time : About 24 hours.

Type host : Domestic dog, *Canis familiaris* Linn. (= *Canis* sp.),

Other hosts : Dingo, *Canis dingo* Linn. ; Domestic cat, *Felis catus*, (= *Felis domestica* Linn.) (= *Felis* sp.), Jungle cat, *Felis chaus* Guldensteadt, Knowles and Das Gupta (1931, 1934), Aiyar (1937), Rao and Hiregauder (1952), Alwar and Lalitha (1958) and Dubey and Pande (1963).

Distribution : Bombay, Maharashtra ; Madras, Tamil Nadu ; Mathura, Uttar Pradesh ; Calcutta, West Bengal.

Endogenous stages : Mahrt (1967) using a pure strain studied the life cycle and found that the stages are detectable in the posterior segment of the small intestine and few are in the caecum and colon. Schizont oval, 17-24 μm by 12-15 μm in size, produces 4-20 merozoites but usually 4-8 ; each measures 10.5-13.4 μm by 2.3-3 μm , The microgametocyte measures 13.4 μm by 8.7 μm having 50-70 nuclei which are transformed into microgametes. Biflagellate microgamete measures 5.8-6.4 μm by 6 μm with flagellum about 11-14 μm long. Macrogametocyte measures 4-5 μm in diameter with many granules.

Types : Not known.

70. *Isospora suis* Biester and Murray

(Fig. 76)

1934. *Isospora suis* Biester and Murray, *J. Am. vet. med. Ass.*, 85 : 207.

Description : Oocyst subspherical measuring 20-24 μm in length and 18-21 μm in width with a mean of 22 μm by 19.5 μm . The shape index is 1.1. The oocystic wall is double layered,

thickness $1.5\ \mu\text{m}$, light yellow in colour with a brown shade. No micropyle is visible. Two sporonts are usually round in shape, each

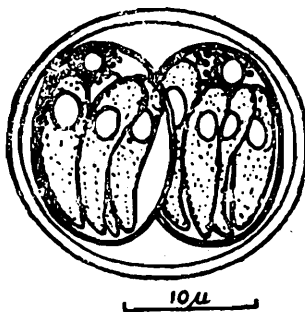


Fig. 76. Mature oocyst of *Isospora suis*.

measuring $16.5\ \mu\text{m}$ in diameter and occupies the central position of the oocyst. Oocystic residuum absent. Sporocysts are elliptical to cylindrical in shape, each measuring $16-18.6\ \mu\text{m}$ in length and $10-12\ \mu\text{m}$ in width with a mean of $18\ \mu\text{m}$ by $11\ \mu\text{m}$. The sporocystic wall is very distinct and $0.66\ \mu\text{m}$ in thickness. Sporozoites are four in number in each sporocyst.

Sporulation time : 74-95 hours.

Dimension of the oocyst reported by other authors are as follows : $19-25\ \mu\text{m}$ by $16-21\ \mu\text{m}$ (Boch, Pezenburg and Rosenfeld, 1961) ; $17-22\ \mu\text{m}$ by $17-19\ \mu\text{m}$ with the mean $19.5\ \mu\text{m}$ by $17.5\ \mu\text{m}$ (Vetterling, 1965).

Type host : Domestic pig, *Sus scrofa* (Linn.) (= *Sus sq.*).

Other hosts : From the Type host, and Wild boar, *Sus scrofa scrofa* Linn, Gill, 1960 ; Patnaik, 1963 ; Mishra, 1967 ; Upadhyay and Ahluwalia 1977 and Upadhyay, Ahluwalia and Asthana, 1977.

Distribution : Orissa and Uttar Pradesh.

Endogenous stages : Little is known about the endogenous developmental stages. This coccidium prefers jejunum and ileum. The discharge of oocysts takes place after 6-8 days from the date of inoculation.

Types : Not known.

Remarks : Pellerdy (1974) expressed a doubt about the validity of *I. suis* and of opinion that this *Isospora* resembles to that of *I. lacazei* (Labbe) found in Sparrow. Mandal (1980) stated that some cross in-

fection experiments are needed for further clarification of this species.

71. *Isospora tropicalis* Mukherjee and Krassner

1965. *Isospora tropicalis* Mukherjee and Krassner, *Proc. zool. Soc, Calcutta*, 18 : 35.

Description : Oocyst spherical measuring $16\ \mu\text{m}$ in diameter. The wall is thin and tightly stretched over the sporocyst. Micropyle and oocystic residuum absent. Sporocyst oval measuring $15.5\text{-}16\ \mu\text{m}$ in length and $10.00\text{-}10.5\ \mu\text{m}$ in width. The sporocystic residuum present as a granular mass. The sporozoites are banana-shaped each measuring $8\text{-}10\ \mu\text{m}$ by $3.2\text{-}4\ \mu\text{m}$.

Sporulation time : Not known.

Type host : Asiatic Jackle, *Canis aureus* Linn.

Other hosts : Unknown.

Distribution : Bandipore, Hooghly dist., West Bengal.

Endogenous stages : Little is known about the endogenous stages. Both epithelial and subepithelial tissues of the small intestine are found infected as stated by the describer.

Types : Likely to be present in the Protozoology Laboratory, School of Tropical Medicine, Calcutta.

72. *Isospora ursi* Agarwal, Ahluwalia, Bhatia and Chauhan (Fig. 77)

1981. *Isospora ursi* Agarwal, Ahluwalia, Bhatia and Chauhan, *Indian J. Anim. Sci.*, 51 : 125.

Description : Oocysts are more or less egg shaped each measuring $34.56\text{-}43.20\ \mu\text{m}$ in length and $20.16\text{-}30.0\ \mu\text{m}$ in breadth with a mean of $37.44\ \mu\text{m}$ by $24.48\ \mu\text{m}$. The oocystic wall is bilayered measuring $1.5\ \mu\text{m}$ in thickness. The outer wall is yellowish green and the inner one is dark brown in colour. The length/width ratio of the oocyst is $1.40\text{-}1.73$ with a mean of 1.54 . The micropyle, polar cap, oocystic residuum and polar granule are absent. The sporocysts are broadly ellipsoidal in shape each measuring $15.84\text{-}21.60\ \mu\text{m}$ in length and $10.08\text{-}15.84\ \mu\text{m}$ in breadth with a mean of $18.72\ \mu\text{m}$ by $12.96\ \mu\text{m}$. There is no stieda body within the sporocyst. Sporocystic residuum is present in the form of clumps of dark granules or sometimes spread over the sporozoites. The sporocyst is provided with 4 elongated

sporozoites each measures 11.52-14.40 μm in length and 2.88-4.32 μm in breadth with a mean of 12.9 μm by 3.60 μm and having a broader

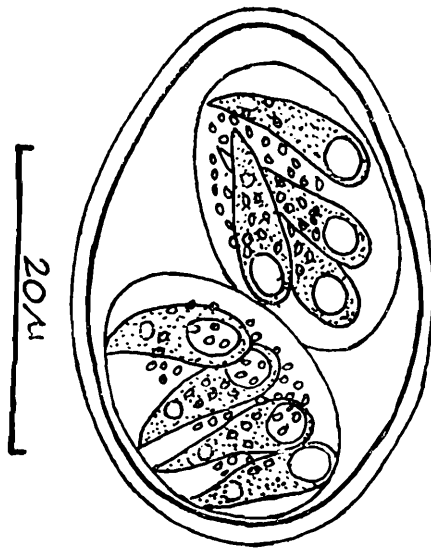


Fig. 77. Mature oocyst of *Isospora ursi*.

end carrying a refractile globule and the other tapering. The sporozoites lay parallel within the sporocyst.

Type host : Sloth bear, *Melursus ursinus* Linn.

Other hosts : Unknown.

Distribution : Zoological garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

73. *Isospora* sp.

1970. *Isospora* sp. Pande Bhatia, Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Description : The oocysts are ovoid in shape, each measuring 23-33 μm by 20-28 μm with a mean of 26 μm by 22 μm . The length-width ratio of the oocyst is 1.06-1.4 with a mean of 1.2. The oocystic wall is 1.3 μm thick, double-contoured, with an outer straw-coloured and the inner brown layers. Micropyle and polar cap absent. Oocystic residuum and polar granule absent. Sporocyst ellipsoidal, single-layered, 16-18 μm by 11-13 μm in size with a mean of 17 μm by 12 μm . Sporocystic residuum present as a large mass of dark and coarse granules. Sporozoite banana-shaped, 12-15 μm by 3.25-4.9 μm in size

with a mean of $13\ \mu\text{m}$ by $3.6\ \mu\text{m}$, with one end broader and the other pointed, the former carrying a prominent refractile globule with a centrally placed small nucleus.

Host : Lion, *Panthera leo* (Linn.)

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Remarks : It is very difficult at this stage to comment about the specific diagnosis of this parasite.

74. *Isospora* sp.

1926. *Isospora* sp. Cooper and Gulati, *Mem. Dep. Agric. India vet. ser.*, 3 : 191.

Description : Oocyst usually subspherical, occasionally spherical, measuring $21\text{--}33\ \mu\text{m}$ in length and $20\text{--}32\ \mu\text{m}$ in width with a mean of $27\ \mu\text{m}$ by $25\ \mu\text{m}$. Oocysts wall smooth, colourless, pale-leavender or pale-yellowish, composed of a single layer about $1\ \mu\text{m}$ thick, sometimes apparently lined by a thin membrane. Micropyle and oocystic residuum absent. Several irregular, refractile polar granules present. Sporocyst lemon-shaped, quite thick-walled, $14\text{--}20$ by $10\text{--}12\ \mu\text{m}$ in size with a mean of $17\ \mu\text{m}$ by $11\ \mu\text{m}$. Sporocystic stieda body is button-shaped with a dependant globular, hyaline mass (substieda body) protruding into the interior of the sporocyst. Sporocystic residuum finely granular. Sporozoite appears sausage-shaped, not arranged in any particular order within the sporocyst. Sporocystic residuum and sporozoites enclosed in a membrane, forming more or less of a ball within sporocyst.

Sporulation time : 24 hours.

Host : Domestic cattle, *Bos taurus* (= *Bos* sp.)

Distribution : Dhupatul, Kocklai, Assam ; Shillong, Meghalaya.

Endogenous stages : Unknown.

Remarks : The report of an *Isospora* sp. from domestic cattle is vividly explained by Levine and Mohan, 1960 and Mandal, 1965b. *Isospora* sp. of Cooper and Gulati is also indistinguishable from that of *Isospora lacazei* of sparrow. The description of *Isospora* sp. as stated by Cooper and Gulati is too meager, "Oocysts were quite rounded and within twenty four hours two fully formed sporoblasts were seen in all cases". This detail description of the oocysts of *Isospora* sp. of cattle is mainly based on Levine and Mohan (1960) and Mandal, (1965b).

75. *Isospora* sp.

1972 *Isospora* sp. Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim Sci.*, 42 : 625.

Description : Oocysts are subspherical in shape, each measuring 19.5-25 μm in length and 17-20 μm in width ; lined by an outer light yellowish-brown and an inner blue layer. Micropyle and polar cap absent. Oocystic residuum and polar granule absent. Sporocyst almond-shaped, measuring 13-16 μm in length and 9-11 μm in width, with a small stieda body at the narrower pole. Sporocystic residuum present as dark granules. The sporozoites, though could not be differentiated, carried two refractile globules in each.

Host : Bonnet monkey, *Macaca radiata* Geoffrey.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Remarks : The present species has got resemblance with *Isospora scorzal* Arcay-Peraza (1967) described from Uakari Monkey, *Cacajó rubicundus*. Moreover, the contamination due to *Isospora lacazei* Labbe cannot also be ignored. However, it is very difficult at this stage to comment further for the specific identity of the parasite.

76. *Isospora* sp.

1968 *Isospora* sp. Shrivastava and Shah, *Indian J. vet.*, 45 : 204.

Description : Oocysts are subspherical in shape, each measuring 25-26 μm by 25 μm in diameter with a mean of 25.5 μm by 25 μm . The wall composed of two layers, 1.2 μm in total thickness ; outer layer smooth, yellowish to pale brown, the inner layer dark brownish-yellow. Micropyle and micropylar cap absent. Polar granule and oocystic residuum absent. Sporocysts lemon-shaped. Stieda body present, with dependent hyaline mass extending into the anterior of the sporozoite more or less sausage-shaped, with a clear large globule at broad end ; having no definite arrangement within the sporocyst. Sporocystic residuum present as fine granules scattered throughout.

Host : Domestic pig, *Sus scrofa domestica* [= *Sus* sp.]

Distribution : Jabalpur, Madhya Pradesh.

Endogenous stages : Unknown.

Remarks : It is very likely that the describer was dealing with the *Isospora lacazei* commonly found in sparrow.

IV. Genus **Dorisa** Levine, 1980

1930. *Dorisiella* Ray (Partim), *Parasitology*, 22 : 471.

Type species : *scololepidis* Ray.

1980. *Dorisa* Lavine, *J. Parasit.*, 66 : 11.

Type species : *hoarei* (Yakimoff and Gouseiff, 1935).

Oocyst with two sporocysts, each having eight sporozoites ; occurring in vertebrate hosts.

Type host : *Elaphe quatuorlineata sauromates*. Reptilia : Ophidia. From birds, six species and from mammals, one species have been reported so far.

(A) PARASITES OF BIRDS

Key to the species

1. Oocyst spherical
 - (A) Oocystic residuum present *D. passeris*
 - (B) Oocystic residuum absent
 - (a) Sporocyst ellipsoidal *D. chakravartyi*
2. Oocyst oval
 - (A) Oocystic residuum present
 - (a) Sporocyst oval *D. vagabundae*
 - (b) Sporocyst vial-shaped *D. mandali*
 - (B) Oocystic residuum absent *D. aethiopsaris*

77. **Dorisa aethiopsaris** (Chakravarty and Kar)

(Fig. 78)

1947. *Dorisiella aethiopsaris* Chakravarty and Kar, *Proc. R. Soc., Edinb.*, 62(B) : 225.

Description : Oocyst subspherical or oval, double walled of equal thickness. The spherical form measures 28.5-30.5 μm in length with a mean of 29.5 μm and 24.4-25.4 μm in width with a mean of 25.4 μm . The shape index is 1.16. Oval form measures 33.5-38.5 μm in length with a mean of 35.8 μm and 24.5-26.4 μm in width with a mean of 25.4 μm . The shape index is 1.4. Cytoplasm spherical and centrally placed with numerous refractile globules. Micropyle and oocystic residuum absent. Sporocyst oval, with a well developed knob at the anterior pointed end. It measures 19.5-22.5 μm in length with a mean of 20.9 μm and 11.2-13.2 μm in width with a mean of 12.2 μm . The shape index is 1.5. Sporocystic residuum present as compact mass.

Sporozoite is elongated in shape with pointed anterior end and rounded posterior. Nucleus is centrally placed. Sporozoite measures $12.2-14.2\ \mu\text{m}$

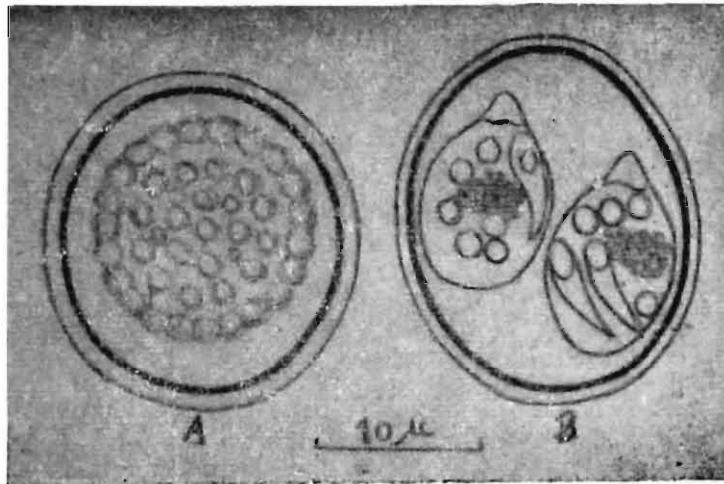


Fig. 78. A, immature and B, mature oocysts of *Dorisa aethiopsaris*.

in length with a mean of $13.2\ \mu\text{m}$ and $1.5-2.5\ \mu\text{m}$ in width with a mean of $2.1\ \mu\text{m}$. The shape index is 6.2.

Sporulation time : 48-62 hours.

Type host : Jungle Mayna, *Aethiopsar* (= *Acredotheres*) *fuscus fuscus* (Wagler).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Schizonts are spherical each measuring $8.8\ \mu\text{m}$ in diameter. The mature one possesses eight to sixteen nuclei and is found in the epithelial layer of the small intestine. The microgametocyte measures $11-13.2\ \mu\text{m}$ in diameter. The microgametes are comma-shaped and each bears a single short flagellum. The macrogametes are spherical each measuring $11\ \mu\text{m}$ in diameter having a granular cytoplasm and a distinct eccentric karyosome inside the nucleus.

Types : Likely to be present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

78. *Dorisa chakravartyi* (Ray and Sarkar)

1967. *Dorisiella chakravartyi* Ray and Sarkar, *Proc. Indian Sci. Congr.* p. 488.

1974. *Dorisiella chakravartyi* Ray and Sarkar, emend., Pellerdy, *Coccidia and Coccidiosis*, Verlag Paul Parey, Berlin und Hamburg, p. 368.

Description : Oocyst spherical, measuring 27.5-30.00 μm with a mean of 28.45 μm . Double layered, the outer being transparent and the inner one dark black in transmitted light. Oocystic residuum and micropyle absent. Sporocyst ellipsoidal, measuring 22.5 μm in length and 15.0-17.5 μm in width. The narrow end is provided with stieda and substiedal body. Sporocystic residuum is present as scattered mass. Sporozoite elongated, club-shaped measuring 13.2 μm in length and 3.6 μm in width. Each sporozoite has a large vacuole at its broader pole and small one at the narrower pole, while the nucleus is placed just below the large vacuole.

Sporulation time : 3-4 days.

Type host : White throated Munia, *Lonchura malabarica* (Linn.) and Spotted Munia, *L. punctulata* (Linn.).

Other hosts : From the type host, Sarkar (1968).

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

79. *Dorisa hareni* (Chakravarty and Kar)
(Fig. 79)

1944. *Dorisiella hareni* Chakravarty and Kar, *Proc. Indian Acad. Sci.*, 20(B) : 102.

Description : Oocyst spherical, measuring 18.5-22.5 μm in diameter with a mean of 20.5 μm having double envelop, the outer being

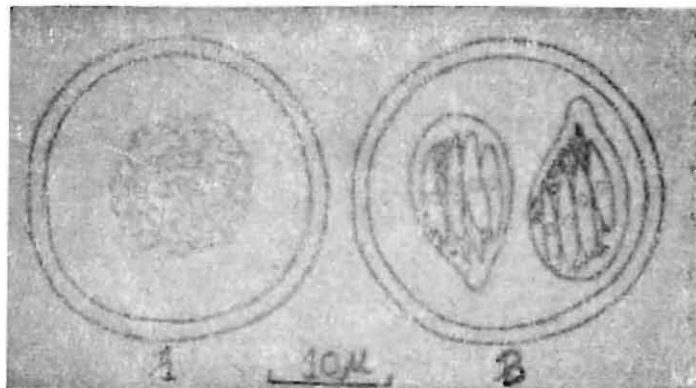


Fig. 79. A. immature and B. mature oocysts of *Dorisa hareni*.

thinner than inner one. The cytoplasm measuring 18.2 μm in diameter and coarsely granular with several refringent globules. Micropyle and

oocystic residuum absent. Sporocyst single layered and pyriform in shape with anterior pointed and posterior rounded ends, the anterior end being provided with small ill-differentiated knob. Sporocyst measures $14.5-18.5\ \mu\text{m}$ in length with a mean of $16.5\ \mu\text{m}$ and $9.5-10.5\ \mu\text{m}$ in width with a mean of $9.9\ \mu\text{m}$. The shape index is $1.5\ \mu\text{m}$. Residuum present. Sporozoite club-shaped with bluntly pointed anterior end. Sporozoite measures $8.2\ \mu\text{m}$ by $2.5\ \mu\text{m}$, nucleus is situated at the rounded posterior end.

Sporulation time : 72-96 hours.

Type host : Black headed Munia, *Munia* (= *Lonchura*) *malacca malacca* Linn.

Other hosts : (i) Chestnet-bellied Munia (= Nepal Black headed Munia), *Munia atricapilla* (= *Lonchura malacca rubroniger* (Hodgson) (ii) Red Munia, *Amandava amandava* (= *Estrilda amandava* (Linn.), (iii) White throated Munia, *Uroloncha* (= *Lonchura*) *malabarica* (Linn.) (iv) Spotted Munia, *Uroloncha* (= *Lonchura*) *puntulata* (Linn.).

Endogenous stages : The detail life-cycle can be had from Bhattacharya and Chakravarty (1975). Trophozoite spherical, measuring $5.6\ \mu\text{m}$ with a clear cytoplasm and a distinct nucleus. Chakravarty and Kar (1944) found trophozoite of $4.0\ \mu\text{m}$ in diameter also. The schizonts are found in the epithelial cells of the small intestine. The mature one measuring $19.50\ \mu\text{m}$ by $16.35\ \mu\text{m}$ and contains 16 or more chromatin granules. Bhattacharjee and Chakravarty (1975) have observed first generation schizont in fair number on inoculation after 48 hours. The merozoite measures $9.2\ \mu\text{m}$ by $3.4\ \mu\text{m}$ with a central nucleus and uniformly granular cytoplasm. The second generation schizonts are observed on the 3rd day after inoculation and the mature one measured $11.19\ \mu\text{m}$ by $7.72\ \mu\text{m}$. The large schizont produces nearly 50 merozoites and the smaller one contains 14 to 16 merozoites. The second generation merozoites are smaller each measuring $7.5\ \mu\text{m}$ by $2.5\ \mu\text{m}$ with a nucleus at the middle. The mature microgametocyte measures $14.8\ \mu\text{m}$ by $10.6\ \mu\text{m}$ and the earliest one measures $11.3\ \mu\text{m}$ by $7.1\ \mu\text{m}$. The nucleus divided upto 50 approximately. The microgametes are comma-shaped. The macrogametocytes are spherical in shape, each measuring $16.6\ \mu\text{m}$ by $12.8\ \mu\text{m}$, gives rise to macrogamete measuring $19.5\ \mu\text{m}$ by $14.8\ \mu\text{m}$. The cytoplasm appears dense with food materials, having eosinophilic granules inside.

The fertilized one can be distinguished from other stages by the nature of the cytoplasm which appears as "powdery mass" (vide Chakravarty and Kar, 1944).

Types : Not known.

Remarks : The describer could not observe any flagellated microgamete which is something unusual.

80. *Dorisa mandali* (Ray and Sarkar)

1967. *Dorisiella mandali* Ray and Sarkar, *Proc. Indian Sci. Congr.*, p. 448.

Description : Oocyst oval in shape measuring 27.5-33.7 μm in length and 25.0-30.0 μm in breadth (average 30.73 μm by 26.7 μm). Oocystic wall 1.8-2.00 μm thick, outer wall transparent greenish yellow in colour with a thin yellow inner membrane. Oocystic residuum present as a few scattered minute refractile granules ; having no micropyle. Two vial-shaped sporocysts each is provided with prominent pluglike "stieda body" at the pointed anterior end. Sporocystic residuum comprises of compact refractile granules. Sporozoite measures 12.2 μm by 4.5 μm . Nucleus is placed just below the vacuole.

Sporulation time : 4-5 days at 31°C.

Type host : Indian white eye, *Zosterops palpebrosa* (Temm.).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

81. *Dorisa passeris* (Ray and Sarkar)

1967. *Dorisiella passeris* Ray and Sarkar, *Proc. Indian Sci. Congr.*, p. 448.

Description : Oocyst spherical, 30-32.5 μm in diameter (average 31.17 μm) wall 1.8-2 μm thick, colour of the outer transparent wall is pale yellowish green, while the inner one is dark-black in transmitted light. Oocystic residuum present in the form of a few scattered granules, micropyle absent. Two vial shaped sporocysts each measures 20.2 μm in length and 14-16.0 μm in breadth (average 22.5 μm by 15.2 μm). Sporocystic residuum centrally situated as a compact granular mass. Sporozoites are curved, sausage-like in appearance and each measures 9.7 μm by 3.0 μm having both the ends blunt. The vacuoles are seen at both ends with the nucleus in the centre.

Sporulation time : 6-8 days.

Type host : House Sparrow, *Passer domesticus* (Linn.)

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stage : Unknown.

Types : Not known.

82. *Dorisa vagabundae* (Mandal and Chakravarty)
(Fig. 80)

1963. *Dorisiella vagabundae* Mandal and Chakravarty, *Proc. zool. Soc., Calcutta*, 16 : 147.

Description : Oocyst oval, double walled, outer thinner ; micropyle seen in early stage ; cytoplasm globular and refractile, oocystic residuum

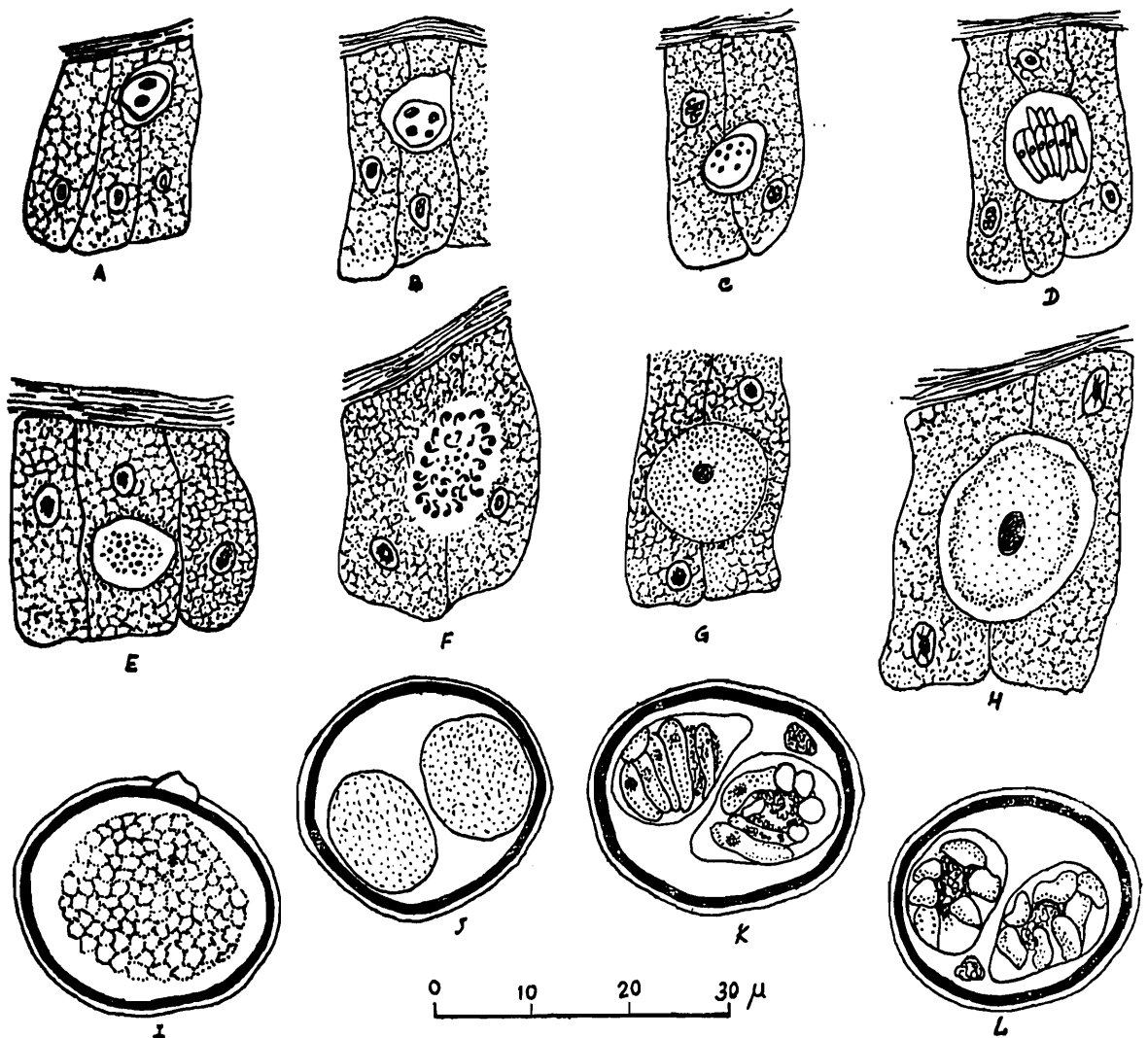


Fig. 80. Life cycle of *Dorisa vagabundae* from *Crypsirina vagabunda* :

A. Binucleated schizont. B. Quadrinucleated schizont. C. and D. Merozoites inside the intestinal epithelium. E. Microgametocyte. F. Microgametes. G. Macrogamete. H. Fertilized macrogamete. I. Immature oocyst. J. Oocyst with two sporoblasts. K. and L. Fully developed oocysts.

present. Fully developed oocyst measures 24.0-26.4 by 22.0 μm . Fully developed sporocyst having one pointed end with a less prominent stieda body and rounded posterior end. Sporocyst measures 17.6-19.8 μm by 12.1 μm . Sporozoite club-shaped, pointed at one end, nucleus is situated at the rounded posterior end ; cytoplasmic striations are found on the sporozoite and their arrangement is irregular.

Sporulation time : 60-72 hours. Mandal (1966a) studied the sporulation and the viability of oocyst of this species by using some physical and chemical agents.

Type host : Indian Tree-pie, *Crypsirina vagabunda* (Latham).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : In the intestinal submucosa the schizonts (figs 80 A and B) are mainly found and less often within the villi. The mature schizont measures 5.5 μm in diameter. The merozoites (figs 80 C and D) are irregularly arranged each measuring 6.6 μm in length and 1.1 μm in width with a nucleus at the rounded posterior end. The microgametocytes (fig 80 E) are circular in shape each measuring 3.2 μm in diameter. The comma-shaped microgametes (fig 80 F) are found in peripheral rows inside the microgametocytes. The macrogametes (fig 80 G) are found with prominent nuclei and uniformly granular cytoplasm which ultimately become coarsely granular.

Types : Present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

(B) PARASITE OF MAMMAL

83. *Dorisa harpia* (Sinha and Das Gupta)

(Fig. 81)

1878. *Dorisiella harpia* Sinha and Das Gupta, *Proceedings Asian Congr. Parasit.*, p. 188 ; 1979, Sinha, *Indian J. Parasit.*, 3 : 173-175.

Description : Oocysts are subspherical to ellipsoidal in shape each measuring 21.5-24.2 μm in length and 17-19 μm in width with a mean of 22.6 μm by 17.8 μm . The oocystic wall is smooth and double layered measuring 0.5 μm in thickness. The cytoplasm is coarsely granular. No oocystic residuum or micropyle are seen but one or two refractile bodies are found inside the oocyst. Sporocyst two in number, each provided with eight sporozoites. The sporocyst measures 16.8 μm .

by $10.8\ \mu\text{m}$ with the compact sporocystic residuum. The sporozoite is elongated in shape and measures $8.4\ \mu\text{m}$ by $3.2\ \mu\text{m}$.

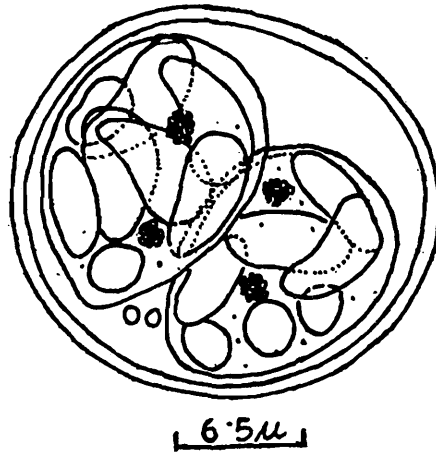


Fig. 81. Mature oocyst of *Dorisa harpia*.

Sporulation time : 120-144 hours at room temperature.

Type host : Hairry winged Bat, *Harpiocephalus harpia lasyurus* (Hodgson).

Other hosts : Unknown.

Distribution : Darjeeling, West Bengal.

Endogenous stages : The trophozoite is oval in shape measuring $6.6\ \mu\text{m}$ by $5.5\ \mu\text{m}$ with a thin outer covering. The schizont is spherical measuring $5.5\ \mu\text{m}$ in diameter cotaining 12-14 nuclei. The macrogametocyte is subspherical measuring $7.9\ \mu\text{m}$ by $6.8\ \mu\text{m}$ with a centrally placed nucleus while the microgametocyte is round to subspherical measuring $6.8\ \mu\text{m}$ by $5.5\ \mu\text{m}$, provided with several small microgametes arranged along the periphery. The macrogamete measures $15.5\ \mu\text{m}$ by $14.0\ \mu\text{m}$.

Types : Not known.

Remarks : Mainly based on the description of Sinha (1979).

V. Genus *Sivatoshella* Ray and Sarkar, 1967

1967. *Sivatoshella* Ray and Sarkar, *Proc. Indian Sci. Congr.*, p. 448.

Type species : *lonchurae* Ray and Sarkar.

Oocyst having two sporocysts each with sixteen sporozoites (heccaidecazoic).

Type host : *Lonchura punctulata* Aves : Passeriformes.

Monotypically represented within the Indian subcontinent, reported only from bird.

84. *Sivatoshella lonchurae* Ray and Sarkar

1967. *Sivatoshella lonchurae* Ray and Sarkar, *Proc. Indian Sci. Congr.*, p. 448.

Description : Oocysts spherical in shape each measures 36.0-38.0 μm in diameter with a mean of 37.62 μm . Oocystic wall consists of 4 layers of 3.6 μm in thickness. Oocystic residuum and micropyle absent. Sporocyst pear-shaped measuring 28.00-29.00 μm in length and 18.0 μm in width. A stieda body along with a substiedal body are present at the narrow pole. Sporozoites are broad, comma-shaped each is provided with a large vacuole at the broader end. Sporocystic residuum present as small refractile globules. Sixteen sporozoites are invariably arranged at the periphery of this individual mass.

Sporulation time : 24-48 hours.

Type host : Spotted Munia, *Lonchura punctulata* (Linn.).

Other hosts : White throated Munia, *L. malabarica* (Linn.)

Distribution : Calcutta, West Bengal.

Endogenous stages : The merozoites are broadly sickle-shaped, each measuring 5 μm by 2 μm in size with a distinct nucleus at the middle. The schizonts are found in the anterior part of the duodenum each measuring 24-26 μm in diameter and the mature one contains nearly 100 merozoites. The macro and micro gametocytes are found in the posterior part of the duodenum and sometimes to the anterior part of the small intestine. Microgametocytes produce microgametes each measuring 5-7 μm in length. The macrogametocyte measuring 30-35 μm in diameter. The macrogametes with large peripheral globules are seen in the preparation each is provided with a distinct karyosome at the middle.

Types : Not known.

Remarks : The description of this parasites is made mainly on the basis of Ray and Sarkar (1968).

VI. Genus *Eimeria* Schneider, 1875

1870. *Gregarina* Eimer (partim), *Ueber die ei-und kugelformigen sogenannten Psorspermien der Wirbeltiere* Wurzburg, p. 4. Type species : *Falciformis* Eimer.

1875. *Eimeria* Schneider, *Archs. zool. exp. gen.*, 4, 45. Type species : *falciformis* Schneider.
1878. *Psorospermium* Rivolta (partim), *Gior Anat. Fisiol. Patol. Anim. Pisa.*, 4 : 220. Type species : ?
1879. *Coccidium* Leuckart (partim), *Die Parasiten de. Menschen*, I. Leipzig, p. 254. Type species : ?
1881. *Orthospora* Schneider, *Archs. Zool. exp. gen.*, 9 : 389. Type species : ?
1883. *Globidium* Flesch (partim), *Zool. Anz.*, 6 : 396. Type species ?
1889. *Karyophagus* Steinhaus *Virehow's Arch.*, 115 : 1976. Type species : *salalaman-darae* Steinhaus.
1891. *Cytophagus* Steinhaus, *Zentbl. Bkt. . Abt. Orig.*, 9 : 50. Type species : *tritonis* Steinhaus.
1894. *Pfeifferia* Labbe, *C. r. hebd Seanc. Acad. Sci.*, Paris, 119 : 537. Type species : ?
1894. *Acystis* Labbe, *Archs. Zool. exp. gen.*, 2 : 55, Type species : ?
1895. *Bananella* Labbe, *Arch. Zool. exp. gen.*, 3 : 15 : Type species : *lacazei* Labbe.
1896. *Crytallospora* Labbe, *Ibid*, 4 : 554. Type species : ? ; 1899, Sporozoa. In *Das Tierreich*, Berlin, p. 63. Type species : ?
1896. *Goussia* Labbe, *Archs Zool. exp. gen.*, 4 : 551. Type species : ?
1899. *Pfeifferalla* Labbe, *Sporozoa*. In *Das Tierreich*, Berlin, p. 57. Type species : ?
1902. *Paracoccidium* Laveran and Mesnil, *C. Seanc. Soc. Biol.*, Paris, 54 : 857. Type species : ?
1922. *Jarrina* Leger and Hesse, *C. r. hebd Seanc Acad. Sci.*, Paris, 174 : 74. Type species : *paludosa* Leger and Hesse.

Oocyst having four sporocysts, each is provided with two sporozoites.

Type host : *Mus musculus* Rodentia : Muridae.

Represented both from invertebrate and vertebrate hosts ; centepede (one species), fish (six species), amphibian (three species), reptile (18 species), bird (52 species) and mammal (92 species). In addition, one *Eimeria* sp. from insect, eight from fish and one each from bird and mammal have also been reported.

PARASITES OF INVERTEBRATE

(A) PARASITE OF CENTIPEDE

85. *Eimeria mecistophori* Narasimhamurti

(Fig. 82)

1976. *Eimeria mecistophori* Narasimhamurti, *Proc. Indian Acad. Sci.*, 48(4) : 141.

Description : The oocysts are spherical in shape each measuring 26-0.28 μm in diameter. They are bilayered and without any polar thickenings. A small quantity of residual cytoplasm is left in the centre of each oocyst after sporulation. The oocyst contains four

spherical sporocysts each measuring $14.0\ \mu\text{m}$ by $10.0\ \mu\text{m}$ in diameter. The sporocyst is provided with two sporozoites which are elongated and

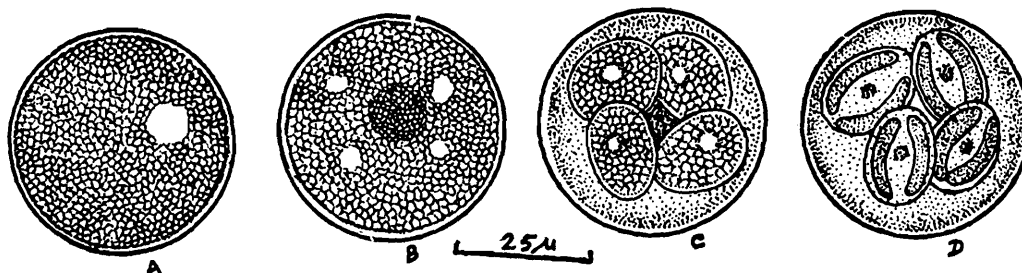


Fig. 82. A, B and C, immature and D. mature oocysts of *Eimeria mecistophori*.

cylindrical. It has an anterior round and posterior bluntly pointed ends, measuring $10.0\text{-}12.0\ \mu\text{m}$ in length $2.5\text{-}3.0\ \mu\text{m}$ in width.

Type host : Centipede, *Mecistocephalus punctiform*.

Other hosts : Unknown.

Distribution : Waltair, Andhra Pradesh.

Endogenous stages : The merozoites observed in the epithelial cells of the gut each measuring 10.0 by $3.0\ \mu\text{m}$. One end of the merozoite is broadly rounded and the other tapering gradually. The nucleus is situated towards the broader end having a distinct membrane with a number of chromatin granules and the endosome is placed centrally. The schizont measuring $14.0\ \mu\text{m}$ by $8.0\ \mu\text{m}$ developed from the merozoite initially possesses 14-16 nuclei having finely alveolated cytoplasm with scattered refringent granules. The number of nuclei was counted upto 45 in fully developed schizont. Each nucleus is having a clear membrane with a number of chromatin granules. The merozoites were detected as finger-shaped lobes radiating from the residual mass of central cytoplasm. Each merozoite measures $6.5\text{-}7.0\ \mu\text{m}$ in length and $2.5\text{-}3.0\ \mu\text{m}$ in width.

The author further studied the merozoites developed into the gametocytes in the subepithelial layer, surrounded by a sheath of connective tissue of the host. It has been possible by the author to distinguish the merozoites developing into the male and female gametocytes by their size and amount of reserve food material present in the cytoplasm. The female gametocyte contains a large quantity of paraglycogen, which in some cases may fill the entire cytoplasm whereas the males are smaller and show a comparatively smaller quantities of reserve food material in the cytoplasm.

The merozoites which transform into the micro (male) gametocytes attain a maximum size, each measuring $38.0\ \mu\text{m}$ by $18.0\ \mu\text{m}$. When fully grown it becomes round or oval in shape. The single nucleus repeatedly divides forming a large number of daughter nuclei. The nuclei in the earlier stages appear as rings of chromatin while in the later stages they are crescent-shaped. The microgametes are found on the surface as deeply staining comma-shaped bodies each measuring $6.0\text{-}7.0\ \mu\text{m}$ by $1.0\text{-}1.5\ \mu\text{m}$. They are intensive feulgen positive. The cytoplasm forms a thin film surrounding the male gametes and a large quantity of cytoplasm remains unused which ultimately disintegrates.

The anterior end of the microgamete is slightly curved and the posterior end is provided with a flagellum measuring $8.0\text{-}10.0\ \mu\text{m}$ in length. A second flagellum was also detected by the author a little behind the curved anterior end which trails backwards. The metozoite forming macro (female) gametocyte measures $50.0\ \mu\text{m}$ by $22.0\ \mu\text{m}$ having finely alveolated cytoplasm which is larger than the alveolus of microgamete. When matured the macrogametocyte becomes spherical and measures $30.0\text{-}32.0\ \mu\text{m}$ in diameter having cytoplasm completely packed with paraglycogen bodies. While attaining maturity the nucleus of the macrogametocyte breaks down into smaller bodies and the nuclear membrane is found to disintegrate. The fertilised macrogamete is distinguishable from the unfertilised one due to the presence of outer membrane in the former which subsequently becomes the oocystic membrane.

Types : Lying in the collection of Dept. of Zoology, Andhra University, Waltair.

Remarks : As already stated, except zygote, rest of the stages in the life-cycle of a coccidium are haploid. While describing this species the author could be able to differentiate the merozoites forming micro and macro gametocytes. The author further discussed about the misconception of the formation of polar bodies by the macrogamete and concluded that no such phenomenon occurs in this particular parasite.

(B) PARASITE OF INSECTS

86. *Eimeria* sp.

1898. *Eimeria* sp. Ross, *Trans. S. Indian Brch. Br. med. Ass.*, 7 : 143.

Description : The oocysts are oval in shape, each measuring $8\ \mu\text{m}$

in length and 4 μm in width and possesses a vacuole (?) surrounded by a faint granulation.

Type host : Mosquito, *Culex* sp.

Distribution : Ootacamund, Madras, Tamil Nadu.

Remarks : Bhatia (1938) remarks that Ross could not come across this parasite afterward. From the literature it reveals that he reported in 1906 once more while mentioning 'notes on the parasites of mosquitoes in India between 1895 and 1899.' Pellerdy (1974) questioned the validity of this *Eimeria* sp.

PARASITES OF VERTEBRATE

(C) PARASITES OF FISHES

Key to the species

(A) Oocyst spherical or round.

(1) Sporocyst elliptical

(i) With long protuberance at one end ...	...	<i>E. harpodoni</i>

(2) Sporocyst not elliptical

(a) Sporocyst pyriform

(i) Wall of sporocyst provided with warts ...	...	<i>E. zygaenae</i>
(ii) Wall of the sporocyst not provided with warts ...	...	<i>E. glossogobii</i>

(B) Oocyst not spherical

(1) Sporocyst oval

(i) With sausage-shaped sporozoites of 10.1 μm in length ...	...	<i>E. southwelli</i>
(ii) With elongated sporozoites of 5.5 μm in length ...	...	<i>E. notopteri</i>

(2) Sporocyst not oval

(a) Sporocyst ellipsoidal

(i) With elongated sporozoites of 4.5-5 μm in length	...	<i>E. ambassi</i>

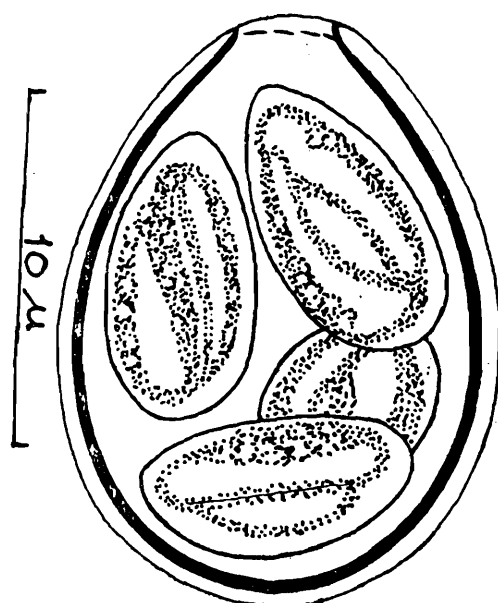
Remarks : Dykova and Lom (1981) while reviewing fish coccidia recognised two genera as valid viz., *Gaussia* Labbe with type species, *G. cluperum* (Thelohan, 1894) having tetrasporocystic, dizoic sporocyst, devoid of any stieda body and wall consists of two prominent valves join along a meridional suture ; and *Epieimeria* with type species *E. anguillae* (Leger and Hollande, 1922) characterised by the tetrasporocystic, dizoic sporocyst having a stieda body. However, the present author treated all these fish parasites under the genus *Eimeria*, though the proposition made by Dykova and Lom (1981) is thought provoking.

87. *Eimeria ambassi* Patnaik and Acharya

(Fig. 83)

1972. *Eimeria ambassi* Patnaik and Acharya, *Indian J. Microbiol.*, 12 : 53.

Description : Oocyst oval or somewhat pyriform in shape measuring 15.0-17.5 μm in length with a mean of 16.0 μm and 10.0-12.5 μm in width with a mean of 11.25 μm . Oocystic wall double layered, colourless

Fig. 83. Mature oocyst of *Eimeria ambassi*.

of 1.5 μm in thickness. Micropyle measures 2.5 μm without any polar cap. The outer layer is relatively thinner than the thick inner layer. The sporont completely fills up the entire space. Oocystic residuum absent. Sporocyst some what ellipsoidal measures 5-7 μm in length with a mean of 5 μm and 3.3-7.5 μm in width with a mean of 3.5 μm . Sporozoite measures 4.5-5 μm in length and 1.75 μm in width. Sporocystis residuum appears as a granular mass.

Sporulation time : 36 hours.

Type host : Minnow Barb, *Barbus ambassi* [= *Puntius ambassis* (Day)].

Other hosts : Unknown.

Distribution : Bhubaneswar, Orissa.

Endogenous stages : Unknown.

Types : Not known.

88. *Eimeria harpodoni* Setna and Bana

(Fig. 84)

1933. *Eimeria* sp. Setna, *Curr. Sci.*, 2 : 97.1935. *Eimeria harpodoni* Setna and Bana, *Jl. R. microsc. Soc.*, 55 : 165.

Description : Oocyst spherical with two transparent membrane, the outer one is thinner than the thick inner one, 12.3-17.5 μm in diameter with a mean of 14.02 μm . Cytoplasm granular with centrally placed nucleus. Cytoplasmic mass measures 8.5-10.5 μm in diameter

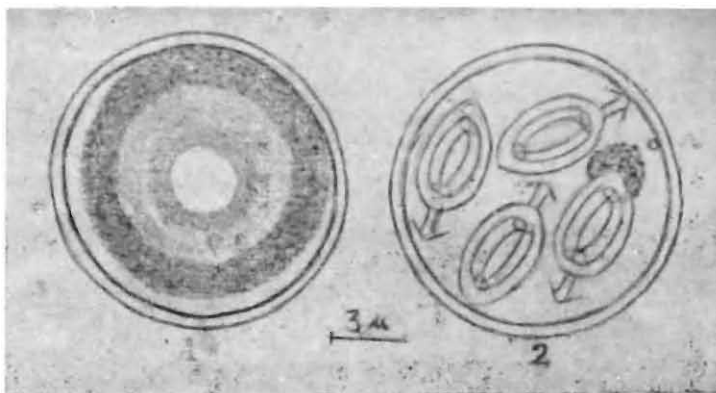


Fig. 84. A, immature and B, mature oocysts of *Eimeria harpodoni*.

with a mean of 9.5 μm . Four rounded sporoblasts each 3.5-4.4 μm in diameter are seen without any micropyle. Thin granular oocystic residuum clearly visible after the complete development of the oocyst. Sporocyst elliptical in shape with a long protuberance at one end. At the edge of this protuberance or neck there is a broad inverted V-shaped appendage. Sporocyst measures 8.5-10.8 μm in length with a mean of 9.7 μm and 3.6-5.7 μm in breadth with a mean of 4.8 μm , shape index is 2.02. Sporocystic residual compact mass present at one end of the sporocyst. Elongated sporozoite is slightly curved at middle region with one pointed end. Sporozoite 7.3 μm in length. Nucleus is situated at broader end of the sporozoite.

Sporulation time : 24-36 hours.

Type host : Bombay duck, *Harpodon nehereus* (Ham.).

Other hosts : Reported from the type host, Mandal (1976).

Distribution : Bombay, Maharashtra ; Port Canning, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Oocysts with two sporocysts instead of regular four are common as stated by the describer, However, Mandal (1976) did not come across any oocyst of such anomalous development.

89. *Eimeria glossogobii* Mukherjee and Haldar
(Fig. 85)

1980. *Eimeria glossogobii* Mukherjee and Haldar, *Acta Protozool.*, 30 : 181.

Description : Oocyst spherical, with a very delicate and smooth wall having faintly yellowish tinge, measuring 7.1-12.2 μm by 7.1-11.0 μm in diameter with a mean 10.0 μm by 10.2 μm . Sporocyst four in

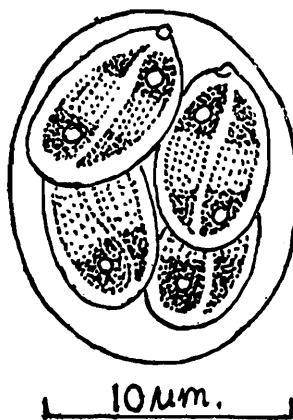


Fig. 85. Mature oocysts of *Eimeria glossogobii*.

number, pyriform to oval in shape measuring 3.0-9.1 μm in length and 2.0-5.1 μm in breadth with a mean of 7.2 μm and 3.9 μm respectively. Stieda body is present as a small knob at the pointed end of each sporocyst. Oocystic and sporocystic residium absent. Sporozoites sickle shaped but the authors could not be definite about the the position of the nucleus.

Habitat : Small intestine.

Type host : Bar eyed Goby, *Glossogobius giuris* (Hamilton).

Other hosts : Unknown.

Distribution : Kalyani, West Bengal.

Endogenous stages : Unknown.

Types : Lying in the collection of Protozoology Laboratory, Kalyani University, Kalyani.

Remarks : The absence of sporocystic residuum is interesting in this species. However, the inclusion of present species under genus *Goussia* Labbe due to its thin wall and sporulation inside the intestine is substantiated by the work of Dykova and Lom (1981). The specific name should be *glossogabia* instead of *E. glossogobii* as per International Code of Zoological Nomenclature.

90. *Eimeria notopteri* Chakravarty and Kar

(Fig 86)

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

Description : Oocyst irregular in shape measuring 23.5-25.2 μm in length with a mean of 24.3 μm and 21.4-22.5 μm in width with a mean of 22.2 μm . Oocystic wall double layered of equal thickness. Zygotic mass is centrally placed measuring 20.4-21.1 μm in diameter. Sporoblasts four in number each measuring 5.8 in diameter. Neither any micropyle nor any oocystic residuum are seen after complete

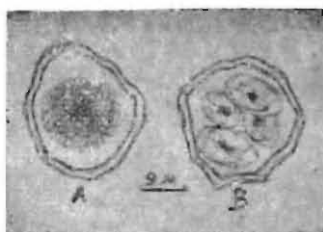


Fig. 86. A, immature and B, mature oocysts of *Eimeria notopteri*.

development of the oocyst. Sporocyst oval, with both ends bluntly pointed, measuring 10.5-11.5 μm in length with a mean of 11.00 μm and 5.5-7.3 μm in width with a mean of 6.8 μm . The shape index is 1.5. Sporocystic residuum absent. Sporozoite is elongated in shape with one pointed and the other rounded ends. It measures 5.5 μm in length and the nucleus is situated at the middle.

Sporulation time : 48-50 hours.

Type host : Feather back, *Notopterus notopterus* (Pallas).

Other hosts : From the type host, and Chital, *Notopterus chitala* (Gunther), Mandal (1976).

Distribution : Calcutta market, West Bengal ; Shillong market, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

91. *Eimeria southwelli* Halawani
(Fig. 87)

1930. *Eimeria southwelli* Halawani, *Ann. trop. Med. Parasit.*, 24 : 1 ; *Trans. R. Soc. trop. Med. Hyg.*, 23 : 326.

Description : Immature oocyst pear-shaped the mature oocyst cylindrical or sausage-shaped provided with a single outer transparent wall, measuring 1-3 μm in thickness. Oocyst measures 30.5-53.4 μm in length with a mean of 39.5 μm and 10.5-15.4 μm in width with a mean of 13.1 μm . The shape index is 3.02. The cytoplasmic mass appears

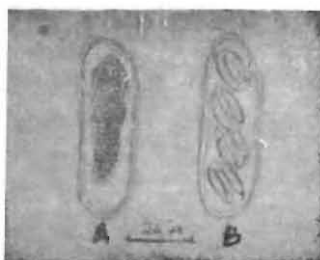


Fig. 87. A, immature and B, mature oocysts of *Eimeria southwelli*.

as refractile globules. Sporoblasts four in number, each measures 10.5-13.5 μm in length with a mean of 10.6 μm . The shape index is 1.9. The sporocysts are oval in shape each measures 10-12 μm in length and 6.5 μm in width. Sporocystic residuum absent but present at immature stage. Sporozoite sausage shaped with one pointed end. It measures 10.1 μm in length and arranged irregularly.

Sporulation time : 48 hours.

Type host : Eagle Ray (Devil fish), *Aetobatis narinari* [= *Aetobatus flagellum* (Schn.)].

Other hosts : Light Tip Shark, *Scoliodon sorrakowah* (Cuvier), Mandal (1976).

Distribution : Indian Ocean ; Sunderban, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : An interesting feature of *E. southwelli* is its occurrence in the embryo as noted by the describer. He further observed the invasion of sporozoites to the liver.

92. *Eimeria zygaenae* Mandal and Chakravarty

(Fig. 88)

1965. *Eimeria zygaenae* Mandal and Chakravarty, *Sci. Cult.*, 31 : 381.

Description : Perfectly round oocyst, measures 12.1-14.3 μm in diameter with a mean of 13.2 μm , having two transparent oocystic envelop, one is thinner than the inner one. Highly refractile cytoplasm completely fills up the oocyst. Sporoblast 4 in number. No oocystic residuum and micropyle seen after complete development of the oocyst. Sporocyst pyriform in shape, anterior end bluntly pointed

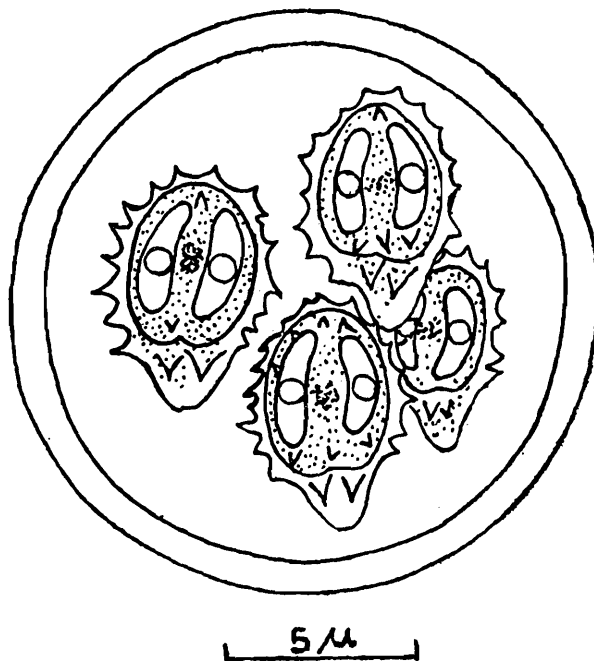


Fig. 88. Mature oocyst of *Eimeria zygaenae*.

and the posterior end rounded. Wall of the sporocyst warty and yellowish in colour, sporocyst measures 7.7-8.9 μm in length with a

mean of $8.8\ \mu\text{m}$ and $4.5\text{-}6.6\ \mu\text{m}$ in width with a mean of $5.5\ \mu\text{m}$. Shape index is 1.6. Sporocystic residuum present as globular mass. Sporozoite elongated in shape, measuring $6.6\ \mu\text{m}$ in length with a centrally placed nucleus.

Sporulation time : 72-80 hours.

Type host : Hammer headed shark, *Zygaena blochii* Cuvier [= *Sphyrna blochii* (Cuvier)].

Other hosts : From the type host, Mandal (1976).

Distribution : Digba shore ; Sunderban, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

93. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Protozoa : Sporozoa, Taylor and Francis, London, p. 197).

Description : All that is known about this coccidium is that it was reported from Bombay in the intestine of *Plotosus canius*.

Host : Canine cat-fish eel, *Plotosus canius* Hamilton-Buchman.

Distribution : Bombay, Maharashtra.

Remarks : Bhatia (1938) mentioned this species without any description.

94. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Protozoa : Sporozoa, Taylor and Francis, London, p. 196).

Description : Oocyst spherical in shape measuring $15\text{-}18\ \mu\text{m}$ in diameter. Residual body is absent. Sporocyst ovoid, frequently with a knob at one end. The sporocyst $8.7\ \mu\text{m}$ in length and $5.3\ \mu\text{m}$ in width. Sporocystic residuum is absent.

Host : Taper-tail anchovy, *Coilia dussumieri*, Valenteiennes.

Distribution : Bombay, Maharashtra.

Remarks : Could not be possible to trace the original description. Bhatia (1938) reported the present species.

95. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Protozoa, Sporozoa, Taylor and Francis, London, p. 197).

Description : Oocyst spherical in shape, measuring 11 μm in diameter. Residual body is absent. Sporocyst ovoid, measuring 4.2 μm in length and 3 μm width. Sporocystic residuum absent.

Host : Six barred reefcod, *Epinephelus diacanthus* (Valentiennes).

Distribution : Bombay, Maharashtra.

Remarks : This species is only mentioned by Bhatia (1938).

96. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Taylor and Francis, London, p. 196).

Description : Oocyst spherical in shape measuring 12 μm in diameter. Residual body absent. Sporocyst broadly ovoid, measuring 7.6 μm in length and 6.1 μm in width. Sporocystic residuum absent.

Host : Mus ached anchovy, *Engraulis mystax* (Bloch and Schneider).

Distribution : Bombay, Maharashtra.

Remarks : This species is only mentioned by Bhatia (1938).

97. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Protozoa : Sporozoa, Taylor and Francis, London, p. 196).

Description : Oocyst spherical in shape, measuring 8.4 μm in diameter. Residual body in absent. Sporocyst ovoid, with one end more pointed than the other, measuring 4 μm in length and 2.5 μm in width. Sporocystic residuum absent.

Host : Silver whiting, *Sillago sihama* (Forsk.)

Distribution : Unknown.

Remarks : Bhatia (1938) mentioned this species but could not be possible to trace the original description.

98. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Protozoa : Sporozoa, Taylor and Francis, London, p. 195).

Description : Oocyst spherical in shape, measuring $10.6\ \mu\text{m}$ in diameter. Residual body absent. Sporocyst ovoid in shape, measuring $5.3\ \mu\text{m}$ in length and $3\ \mu\text{m}$ in width. There is a small rounded knob-like thickening at one end of the sporocyst. Sporocystic residuum absent.

Host : Small headed ribbon fish, *Trichiurus savala* Cuvier.

Distribution : Bombay, Maharashtra.

Remarks : Bhatia (1938) only mentioned this species.

99. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Protozoa : Sporozoa, Taylor and Francis, London, p. 195).

Description : Oocyst spherical in shape, measuring $7.6\ \mu\text{m}$ in diameter. Residual body occasionally present. Sporocyst ovoid and small in size, with one pole slightly narrower than the other, measuring $3.6\ \mu\text{m}$ in length and $2.4\ \mu\text{m}$ in width.

Host : Frog fish, *Batrachus grunniens* (Linnaeus).

Other hosts : Unknown.

Distribution : Bombay, Maharashtra.

Remarks : This species is only mentioned by Bhatia (1938).

100. *Eimeria* sp.

1935. *Eimeria* sp. Setna and Bana (vide Bhatia, 1938, *The Fauna of British India including Ceylon and Burma*, Taylor and Francis, London, p. 196).

Description : Oocyst spherical in shape, measuring $10\ \mu\text{m}$ in diameter. Residual body absent. Sporocyst ovoid in shape, measuring $5.5\ \mu\text{m}$ in length and $3.1\ \mu\text{m}$ in width. The sporocystic residuum is present in the form of two darkly staining globules.

Host : Greasy reef-cod, *Epinephelus tauvina* (Forsk.)

Other hosts : Unknown.

Distribution : Bombay, Maharashtra.

Remarks : All the *Eimeria* sp. reported from fish are ill-described. Therefore a thorough reassessment of these parasites mentioned / described is badly needed.

(D) PARASITES OF AMPHIBIA

Key to the species

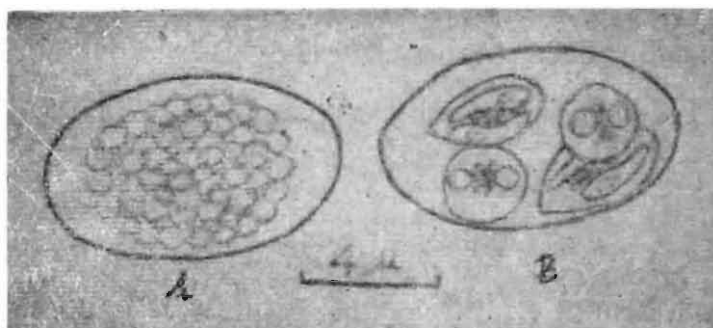
- A. Oocyst spherical
 - (i) Measuring 8.5-11.0 μm *E. laminata*
- B. Oocyst not spherical
 - (1) Oocyst without residuum and sporocyst naviculoid ... *E. himalayana*
 - (2) Oocyst with residuum and sporocyst spindle-shaped ... *E. cyanophlyctis*

101. *Eimeria cyanophlyctis* Chakravarty and Kar

(Fig. 89)

1944. *Eimeria cyanophlyctis* Chakravarty and Kar, *Proc. Indian Sci. Congr.*, p. 104.

Description : Both immature and mature oocysts are oval or sub-spherical in shape. In some of the former, clear spherical globules are present. The single layered oocystic membrane is very thin and transparent. An oocystic residuum in the form of an irregular mass containing a globule is present. Micropyle absent. Oocyst measures 15.5-20.2 μm . in length with a mean of 17.9 μm and 15.5-18.3 μm in

Fig. 89. A, immature and B, mature oocyst of *Eimeria cyanophlyctis*.

width with a mean of 16.7 μm . The shape index is 1.07. Sporocyst spindle-shaped also single layered tapering at one end ; measuring 10.5-12.5 μm in length, with a mean of 11.5 μm and 4.5-6.5 μm in width with a mean of 5.5 μm . The shape index is 2.09. Sporocystic residuum scattered. Sporozoite elongated with pointed anterior end and highly granular cytoplasm having refringent globules. The nucleus is situated at the broader end of the sporozoite.

Sporulation time : 60-75 hours.

Type host : Skipping Frog, *Rana cyanophlyctis* Schneider.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The original description of the species was difficient as stated by Pellerdy (1974), though Chakravarty and Kar (1952) described this species in detail. However, Mandal (1976) has redescrbed the species after examining the topotype, on which the present description is based.

102. *Eimeria himalayana* Ray and Misra

(Fig. 90)

1942. *Eimeria himalayanum* Ray and Misra, *Proc. Indian Sci. Congr.*, p. 169 ; 1943, *Proc. natn. Inst. Sci. India*, 9 : 265.

1976. *Eimeri himalayana* Ray and Misra (emend), Pellerdy, *Coccidia and Coccidiosis*, Verlag Paul Parey, Berlin and Hamburg, p. 87.

Description : Oocyst rounded-oval, with two thin oocystic wall, without micropyle ; residuum absent. Oocyst measures 7.5-10.5 μm in diameter with a mean of 9.2. μm . Sporocyst naviculoid, measures 4.5-6.5 μm in length with a mean of 5.5 μm and 2.5-3.5 μm in width

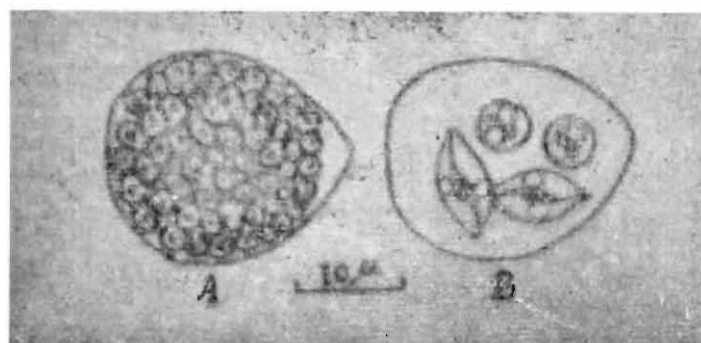


Fig. 90. A, immature and B, mature oocyst of *Eimeria himalayana*.

with a mean of 2.9 μm with globular residuum. Sporozoite club-shaped ; with centrally placed nucleus and siderophilous structure at one of the poles. Sporozoite measures 3.8-4.5 μm in length.

Type host : Himalayan Toad, *Bufo himalayanus* Boulenger.

Other hosts : Unknown.

Distribution : Mukteswar, Uttar Pradesh.

Endogenous stages : Two types of schizonts are found in the intestine and regarded as macro and micro schizonts. Thirty two macro-merozoites each measuring $4.3\ \mu\text{m}$ by $0.6\ \mu\text{m}$ in size develop from the macro-schizonts. The micro-schizonts produce 16 to 32 slender-merozoites each measuring 4-6 by $0.4\ \mu\text{m}$. In the intestinal epithelium the gametocytes are developed. Microgamete measures $2.6\ \mu\text{m}$ by $0.8\ \mu\text{m}$ and macrogamete measures $7-12\ \mu\text{m}$ by $6-10\ \mu\text{m}$.

Types : Not known.

Remarks : Pellerdy (1974) emended the specific name as *himalayana* instead of *himalayanum*. Ray and Misra (1943) described this species in detail.

103. *Eimeria laminata* Ray

(Fig. 91)

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

Description : Oocyst spherical, measures $8.5-11.0\ \mu\text{m}$ in diameter with a mean of $9.8\ \mu\text{m}$. Oocystic wall double layered, outer one thicker than the inner one, with oocystic residuum. Cytoplasm round, contains highly refringent, refractile globules. Sporocyst spindle-

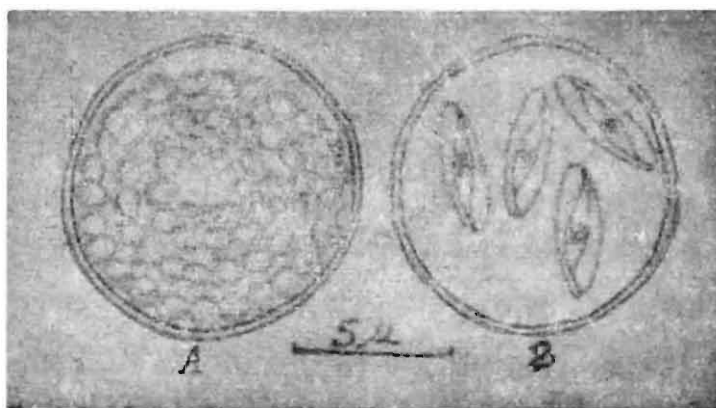


Fig. 91. A, immature and B, mature oocyst of *Eimeria laminata*.

shaped pointed at both ends and without any knob. Sporocyst measures $5.2-6.5\ \mu\text{m}$ in length and $3.0\ \mu\text{m}$ in width. The shape index

is 1.96. Sporocystic residuum present. Sporozoite elongated bodies pointed at one end, with a nucleus at the middle.

Sporulation time : 60-72 hours.

Type host : Indian common Toad, *Bufo melanostictus* Schneider.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stage : Both macro and micro schizonts are observed in the intestine by Ray (1935). He further noted the development of the parasite not only within the epithelial cells of intestine but also upon them.

Types : Not known.

Remarks : Sporulation of the oocyst is completed within the host-organism as observed by the describer. The present author observed the sporulated oocyst in the intestinal lumen which was also noted by Ray (1935).

(E) PARASITES OF REPTILES

Key to the species

A. Oocyst spherical

1. Sporocyst oval or ellipsoidal

(a) Size of oocyst 13.00-15.00 μm	...	...	<i>E. bongaonensis</i>
(b) Size of oocyst, 16.00-18.00 μm	...	...	<i>E. legeri</i>
(c) Size of oocyst 20.00-22.00 μm	...	...	<i>E. kermoganti</i>

2. Sporocysts pyriform or spindle-shaped

(a) Oocyst without residuum	...	...	<i>E. koormae</i>
(b) Oocyst with residuum			
(i) Size of oocyst 20 μm or above	...	...	<i>E. stolatae</i>
(ii) Size of oocyst below 20 μm	...	...	<i>E. trionyxae</i>

B. Oocyst not spherical

1. Oocyst triangular	...	...	<i>E. triangularis</i>
2. Oocyst lemon-shaped	...	...	<i>E. hemidactyli</i>
3. Oocyst elliptical ellipsoidal			
(a) Sporocyst ovoid	...	...	<i>E. flaviviridis</i>
(b) Sporocyst neviculoid	...	...	<i>E. fibrilosa</i>
4. Oocyst irregular	...	...	<i>E. irregularis</i>
5. Oocyst oval, cylindrical, subspherical or almond-shaped.			
(a) Oocyst with residuum			
(i) Size of oocyst 36.00 μm $\times$ 18.00 μm	...		<i>E. gupti</i>
(ii) Size of oocyst 29.00-31.00 μm $\times$ 22.5-24.5 μm			<i>E. piscatoris</i>
(iii) Size of oocyst 23-27 μm $\times$ 17-18 μm	...		<i>E. najae</i>

(b) Oocyst without residuum

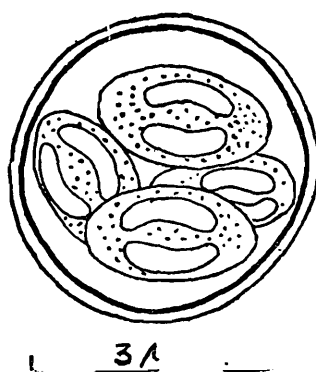
(i) Sporocyst ovoid	...	...	<i>E. knowlesi</i>
(ii) Sporocyst spherical	...	...	<i>E. minetti</i>
(iii) Sporocyst pyriform	...	...	<i>E. innominata</i>
(iv) Sporocyst ellipsoidal	...	...	<i>E. varani</i>

104. *Eimeria bongaonensis* Sinha and Sinha

(Fig. 92)

1978. *Eimeria bongaonensis* Sinha and Sinha, *Indian J. Zootomy.*, 19 : 61.

Description : Oocysts are circular in shape each measuring 13-15 μm in diameter with a mean of 13.8 μm . Usually the greenish oocystic wall is smooth and bilayered with a uniform thickness of 0.2 μm . The space between the two walls is 0.5 μm . Micropyle, oocystic residuum

Fig. 92. Mature oocyst of *Eimeria bongaonensis*.

and polar granule are absent. The four sporocysts are ellipsoidal, each measuring 8.4-9.3 μm in length and 5.1-5.7 μm in width with a mean of 8.8 μm by 5.2 μm . The sporocysts are without stieda body and contain scattered residue. Each of the sporocyst has two sporozoites each measuring 3.9-4.3 μm in length and 1.4-1.9 μm in width with a mean of 4.08 μm by 1.7 μm .

Sporulation time : 24-30 hours.

Type host : Takhak or Indian Gekko, *Gekko gekko* (Linn.).

Other hosts : Not known.

Distribution : Bongaon, West Bengal.

Endogenous stages : Not known.

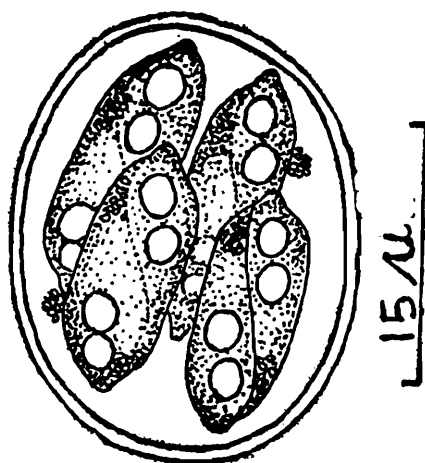
Types : Lying with the collection of the describer.

105. *Eimeria fibrilosa* Mandal

(Fig. 93)

1976. *Eimeria fibrilosa* Mandal, *Acta Protozool.*, 15 : 405.

Description : The oocyst ellipsoidal in shape measuring 25-27 μm in length with a mean of 25.5 μm and 13.5-22.5 μm in width with a mean of 11.0 μm . The length-width ratio (shape index) is 1.36. It is provided with double-layered wall of 0.75 μm in thickness, the outer being thinner than the inner one. No micropyle is visible on the oocystic wall. The cytoplasm of the oocyst is coarsely granular and almost spherical in shape, measuring 9-10 μm in diameter. During the course of development, four rounded sporoblasts each of 5-6 μm in diameter are formed. A cytoplasmic prolongation from both sides of the sporoblast comes out with a definite wall to form the naviculoid sporocyst. A clear shiny stieda body at both ends of the sporocyst is visible and appears like a glume of the paddy. On careful examination, fine fibril of 6 μm in length is observed attached to each end of sporocyst. The oocystic residuum appears as refractile globular

Fig. 93. Mature oocyst of *Eimeria fibrilosa*.

mass. Sporocyst measures 10-15 μm in length with a mean of 12.5 μm and 5-6 μm in width with a mean of 5.5 μm . The shape index 2.09. The cytoplasm of sporocyst appears as beaded refractile mass. Two bean-shaped sporozoites along with refractile bodies situated at both ends of each sporozoites were noticed. The sporozoite measures 10.5-14.4 μm by 7.5-8.5 μm with a mean of 12.2 μm by 8 μm . The length-width ratio being 1.56. After sporulation the sporocystic residuum appears like a beaded mass and takes the position at both ends of the sporocyst. On examination of the oocyst after few days from 2.5%

potassium dichromate solution, it is seen that four refractile globules of the sporozoite become very prominent.

Though the elliptical form of the oocyst is very common simultaneously some subspherical to round forms each of $13.5\ \mu\text{m}$ to $19.5\ \mu\text{m}$ in diameter with a mean of $16.5\ \mu\text{m}$ have also been observed.

Sporulation time : 50-72 hours at room temperature 30°C - 35°C .

Type host : Common water snake, *Enhydryn enhydryn* (Schneider).

Other hosts : Unknown.

Seat of infection : Intestine.

Distribution : Chakdah, Nadia, West Bengal.

Endogenous stages : Unknown.

Types : Present in the collection of the Zoological Survey of India, Calcutta, Registration No. Pt. 1841.

106. *Eimeria flaviviridis* Setna and Bana

(Fig. 94)

1933. *Eimeria* sp. Setna and Bana, *Curr. Sci.*, 2 : 97 ; Ray and Das Gupta, 1935, *Proc. Indian Sci. Congr.*, p. 315.

1935. *Eimeria* (species B) Knowles and Das Gupta, *Indian J. med. Res.*, 22 : 701.

1935. *Eimeria flaviviridis* Setna and Bana, *Jl. R. microsc Soc.*, 55 : 256.

Description : Oocyst elliptical, colourless, measuring 18.5 - $35.4\ \mu\text{m}$ in length with a mean of $25.5\ \mu\text{m}$ and 10.5 - $15.5\ \mu\text{m}$ in width with a mean of $12.5\ \mu\text{m}$. The shape index is 2. Micropyle and oocystic

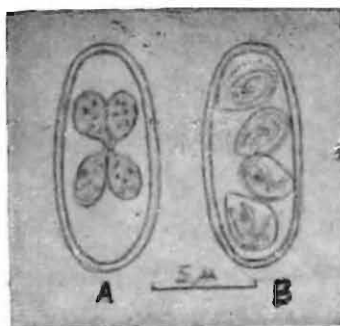


Fig. 94. A, immature and B, mature oocysts of *Eimeria flaviviridis*.

residuum absent. The ovoid sporocyst measures 6.5 - $9.4\ \mu\text{m}$ in length with a mean of $8.3\ \mu\text{m}$ and 5.3 - $8.3\ \mu\text{m}$ in width with a mean of $6.9\ \mu\text{m}$. The shape index is 1.2. Granular sporocystic residuum present in the

middle region. Sporozoites are elongated in shape with a bent in each at mid region. They overlap each other inside the sporocyst at one end. Sporozoite measure $9.5\ \mu\text{m}$ in length and $1\ \mu\text{m}$ in width with a nucleus situated close to the anterior end.

Sporulation time : 3-4 days.

Type host : House Lizard, *Hemidactylus flaviviridis* (Ruppell)

Other hosts : From the Type host, Mandal (1976).

Distribution : Bombay, Maharashtra ; Barasat, West Bengal.

Endogenous stages : The schizonts are round each measuring $12\ \mu\text{m}$ in diameter or sometimes irregular. The immature one measures $21\ \mu\text{m}$ by $15\ \mu\text{m}$. Each mature schizont contains 16 to 140 elongated merozoites, each measuring $8-10\ \mu\text{m}$ by $1.3-1.5\ \mu\text{m}$. Microgametocytes are ovoid in shape each measuring 17 by $16\ \mu\text{m}$, produces many microgametes after maturation. The authors could not observe any flagellum on the microgamete. The authors examined the endogenous stages within the endocystic epithelial cells. The host cells are found to be destroyed and hypertrophied. They have also observed detached disintegrating cells inside the lumen.

Types : Not known.

Remarks : Setna and Bana (1935) noted that almost all the gekkos in Bombay area are infected with this parasite. Mandal (1976) could not come across such massive rate of infection while collecting the topotypes.

107. *Eimeria qupti* Bhatia

1936. *Eimeria cylindrica* Ray and Das Gupta, *Proc. Indian Sci. Congr.*, p. 345 (non. *E. cylindrica* Wilson, 1931, *Va. Agr. Exp. Sta. Tech. Bull.*, 42 : 1.

1938. *Eimeria qupti* Bhatia, *The Fauna of British India including Ceylon and Burma, Protozoa*, p. 386.

Description : Oocyst cylindrical, measuring $36\ \mu\text{m}$ by $18\ \mu\text{m}$. Oocystic residuum present.

Type host : Checkered keelback (Water snake), *Natrix piscator* (Schneid.).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Type : Not known.

Remarks : Mandal (1976) warned regarding the validity of such incompletely described species and more so due to the non-availability of the topotype. The description is based on Bhatia (1938).

108. *Eimeria hemidactyli* Knowles and Das Gupta

1935. *Eimeria hemidactyli* Knowles and Das Gupta, *Indian J. med. Res.*, 22 : 701.

Distribution : The oocyst lemon-shaped with two layers of equal thickness. It measures 16.5-21.5 μm in length with a mean of 18.50 μm and 12.5-16.2 μm in width with a mean of 14.4 μm . The shape index is 1.3. Oocystic residuum and micropyle absent. Granular cytoplasm gives rise to four rounded sporoblasts. Ovoid sporocyst measures 9.5-11.3 μm in length with a mean of 10.4 μm and 7.5-8.5 μm in width with a mean of 8.00 μm . The shape index is 1.3. The sporocystic residuum is scattered inside the sporocyst. The elongated sporozoite is pointed at one end. It measures 6.5 μm in length. The nucleus is situated at the posterior end.

Sporulation time : 24-36 hours.

Type host : House Lizard, *Hemidactylus flaviviridis* (Ruppell).

Other hosts : From the type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Dark colour of the oocyst was observed by the describer from which it was inferred that the site of endogenous development was the liver or the bile ducts. Unsporulated oocysts were also observed frequently by the describer. The present author could not come across any such coloured oocyst while collecting topotype (Mandal, 1976).

109. *Eimeria irregularis* Kar

(Fig. 95)

1944. *Eimeria irregularis* Kar, *Indian vet. J.*, 29 : 231.

Description : The immature oocysts are spherical in shape and mature one irregular and without micropyle or oocystic residuum. The oocyst measures 14.6-16.5 μm in diameter with a mean of 15.5 μm . Cytoplasm measures 11.5-12.5 μm in diameter. Spindle shaped sporo-

blast measures $8.3\ \mu\text{m}$ by $4.5\ \mu\text{m}$. The sporocyst is elongately oval in shape having rounded posterior end and somewhat pointed anterior ends. At the anterior end of the sporocyst there is a little knob. A sporocyst

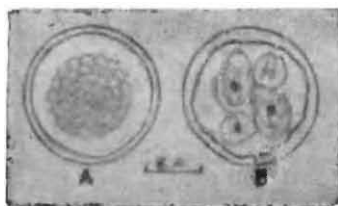


Fig. 95. A, immature and B, mature oocysts of *Eimeria irregularis*.

measures $11.5\text{--}13.5\ \mu\text{m}$ in length with a mean of $12.5\ \mu\text{m}$ and $6.5\text{--}7.5\ \mu\text{m}$ in width with a mean of $6.9\ \mu\text{m}$. Sporocystic residual mass is present. The sporozoites are sausage shaped each having both the ends rounded and measures $8.5\ \mu\text{m}$ by $2.5\ \mu\text{m}$. The spherical nucleus is placed at the centre of the body of the sporozoite.

Sporulation time : 30-45 hours.

Type host : Pond Turtle, *Lissemys punctata* (Bonnaterre).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

110. *Eimeria innominata* Kar (Fig. 96)

1944. *Eimeria innominata* Kar, *Indian vet. J.*, 29 : 231.

Description : Oocyst subspherical ; double walled, the outer is thinner than the inner one. It measures $16.5\text{--}18.8\ \mu\text{m}$ in length with

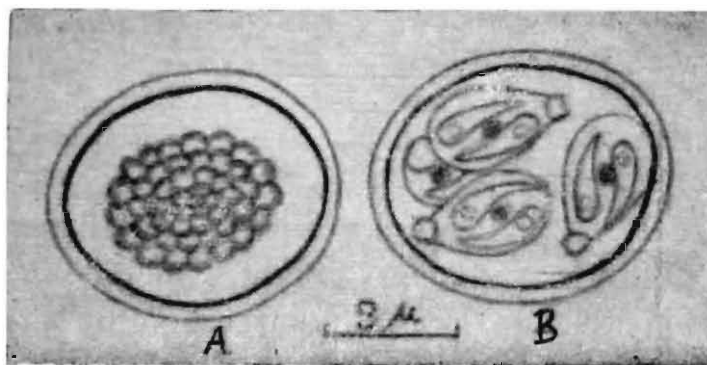


Fig. 96. A, immature and B, mature oocysts of *Eimeria innominata*.

a mean of $17.7\ \mu\text{m}$ and $11.5\text{-}14.3\ \mu\text{m}$ in width with a mean of $13.5\ \mu\text{m}$. The shape index is 1.3. Spherical cytoplasm measures $7.3\text{-}8.2\ \mu\text{m}$ in diameter and is provided with highly refringent globules. Micropyle and oocystic residuum absent. Sporocyst pyriform with an irregular shaped knob at the pointed end. Sporocyst measures $10.5\text{-}12.3\ \mu\text{m}$ in length with a mean of $11.3\ \mu\text{m}$ and $5.5\text{-}7.5\ \mu\text{m}$ in width with a mean of $6.5\ \mu\text{m}$. The shape index is 1.7. Sporocystic residual mass present. The sporozoites are elongated in shape each with one sharply pointed end and measures $6.5\text{-}7.5\ \mu\text{m}$ in length and $4.1\text{-}4.6\ \mu\text{m}$ in width with a nucleus at the centre.

Sporulation time : Unknown.

Type host : Pond turtle, *Lissemys punctata* (Bonnaterre).

Other hosts : From the Type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : This parasites is exclusively found in the liver and bile duct.

111. *Eimeria koormae* Das Gupta (Fig. 97)

1938. *Eimeria koormae* Das Gupta, *Proc. Indian Sci. Congr.*, 1955 : 1938. *Arch. Protistenk.*, 90 : 410.

Description : Spherical oocyst with two layers, the inner layer being thicker than the outer. Granular cytoplasm and micropyle

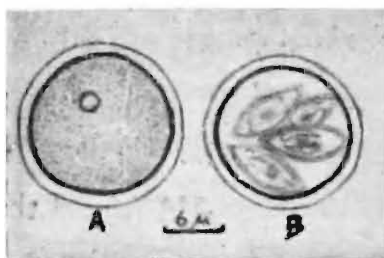


Fig. 97. A, immature and B, mature oocysts of *Eimeria koormae*.

present. The oocyst measures $13.5\text{-}15.8\ \mu\text{m}$ in diameter with a mean of $14.6\ \mu\text{m}$. Oocystic residuum absent. Spindle-shaped sporocyst with tapering at both ends, measures $9.3\text{-}11.3\ \mu\text{m}$ in length with a mean of $10.3\ \mu\text{m}$ and $3.5\text{-}5.6\ \mu\text{m}$ in width with a mean of $4.6\ \mu\text{m}$. The shape index is 2.24. Sporocystic residual mass is granular and situated

between the two sporozoites. The sporozoite elongated and has one end rounded and stouter than the other.

Sporulation time : 2-3 days.

Type host : Pond turtle, *Lysemys punctata* (Bonnaterre).

Other hosts : From the Type host, Mandal (1976).

Distribution : Jessore, Bangladesh ; Basirhat, West Bengal.

Endogenous stages : Parasites are found in the small intestine. Schizogonic stages are located within the epithelial cells and other sub-epithelially. The young schizont is round, measuring 2-2 μm . The mature one measures 4.12 μm (mean) in diameter and possesses 8 merozoites, each measuring 1.5 μm by 1.0 μm . Macrogamete spherical when fully formed measures 12.36 μm in diameter.

Types : Not known.

Remarks : Initially the specific name was misspelt as 'boormae' instead of 'koormae'.

112. *Eimeria kermoganti* (Simond)

1901. *Coccidium kermoganti* Simond, *C. r. seanc. Soc. Boil.*, 53 : 483.

1908. *Eimeria kermoganti* Braun, 1908, *Die-tierischen Parasiten des Menschen*, Wurzburg, p. ?

Description : Oocysts spherical or subspherical, measuring 20-22 μm in diameter, provided with double wall of equal thickness. Cytoplasm granular ; oocystic residuum absent. Sporocyst oval, sporocystic residual mass is situated at one end. Sporozoites comma shaped and transparent.

Sporulation time : Unknown.

Type host : Gharial, *Gavialis gangeticus* (Gmelin).

Other hosts : Unknown.

Distribution : River Ganges, India.

Endogenous stages : Simond (1901b) found the endogenous stages in the spleen.

Types : Not known.

Remarks : This description is taken from Bhatia (1938).

113. *Eimeria knowlesi* Bhatia

1935. *Eimeria* (species A) Knowles and Das Gupta, *Indian J. med. Res.*, 22 : 701,

1936. *Eimeria knowlesi* Bhatia, *Curr. Sci.*, 5 : 177,

Description : The oocyst spherical or oval, double-layered having granular cytoplasm and without any micropyle and residuum. It measures 16.5—20.5 μm in length with a mean of 18.5 μm and 14.5-18.5 μm in width with a mean of 16.5 μm . The sporocysts are ovoid in shape, each measures 9.00-11.00 μm in length with a mean of 10.00 μm and 7.5-8.5 μm in width with a mean of 7.9 μm . The sporozoite elongated with nucleus situated at posterior rounded end. The sporocystic residual mass is placed in between the sporozoites. The sporozoite measures 7.2 μm in length.

Sporulation time : 50-40 hours.

Type host : House Lizard, *Hemidactylus flaviviridis* (Ruppell).

Other hosts : From the Type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Bhatia (1938) stated that the oocysts of *E. knowlesi* are sometimes oval and come close to those of *E. flaviviridis* (= Species B of Knowles and Das Gupta, 1935). He further has made a comment that the present species might not be a distinct form. Setna and Bana (1935b) while describing *E. flaviviridis* synonymised 'Species B' of Knowles and Das Gupta, 1935, but did not mention anything about 'Species A' of the same author (= *E. knowlesi* Bhatia). However, from the diagram of both the oocysts, it appears that they are distinct from each other. Mandal (1976) on the other hand came across and marked similarity between *E. hemidactyli* Knowles and Das Gupta, 1935 and the present species in size but the oocyst of the former is lemon-shaped and that of the later is spherical or oval. At present all the three species can be kept as distinct.

114. *Eimeria legari* (Simond)

1901. *Coccidium legari* Simond, *C. r. seanc. Soc. Biol.*, 53 : 485 (non *Eimeria legari* Stankovitch, 1920, *C. r. seanc. Soc. Biol.* p. 83 : 833).
 1921. *Eimeria legari* Reichenow, *Die Coccidien Prowazek's Handbuch der Pathogenen Protozoen*, Leipzig, 3 : 950.

Description : Oocyst spherical, the cytoplasm dividing to form two sporoblasts without leaving any residuum. Oval sporocyst contains two comma-shaped sporozoites ; sporocystic residuum is granular at the begining and becomes transparent and refringent later on.

Sporulation time : Unknown.

Type host : Indian Flap-shelled Turtle, *Emyda granosa* [= *Lyssemys punctata granosa* (Schoepff.)].

Other hosts : Unknown.

Distribution : India.

Endogenous stages : The macrogametocytes develop within the liver cells. Oocysts pass into the intestine through the bile duct.

Types : Not known.

Remarks : Parasites occur in the liver. The description is mainly based on Reichenow (1929) and Bhatia (1938).

115. *Eimeria minetti* Ray, Raghavachari and Spare

1942. *Eimeria minetti* Ray, Raghavachari and Spare, *Proc. Indian Sci. Congr.*, p. 170.

1973. *Eimeria rabiti* Mandal and Nair, *Sci. Cult.*, 39 : 369.

Description : Oocyst oval, double walled, the outer being thinner. It measures 17.5-21.5 μm in length with a mean of 19.5 μm and 12.5-14.5 μm in width with a mean of 15.5 μm . The shape index is 1.2. Cytoplasm appears as globular refractile mass. Micropyle and oocystic residuum absent. Spherical sporocyst measures 7.5-9.5 μm in diameter with a mean of 8.5 μm . Sporocystic residuum granular. The sporozoites are circular in shape.

Sporulation time : 36 to 48 hours.

Type host : Skink, *Mabuya* sp.

Other hosts : Unknown.

Distribution : Mukteswar, Uttar Pradesh.

Endogenous stages : Reported to occur in the epithelial cells of the small intestine without any detail description.

Types : Not known.

Remarks : Mandal and Nair (1973) described *Eimeria rabiti* from *Gymnodactylus rabitus* (Blyth) after obtaining the specimen from Chiriatapu, Andaman Islands which is now synonymised with *Eimeria minetti* Ray, Raghavachari and Sapre, 1942 described from Skink, *Mabuya* Sp. after considering the close similarity between the two.

116. *Eimeria najae* Ray and Dás Gupta (Fig. 98)

1936. *Eimeria* sp. Ray and Das Gupta, *Proc. Indian Sci. Congr.*, p. 345.

1937. *Eimeria najai* Ray and Das Gupta, *Arch. Protistenk.*, 88 : 275.

Description : Oocyst ovoidal, double walled, outer wall being thinner. It measures 23.5-27.5 μm in length with a mean of 25.5 μm and 15.5-18.5 μm in width with a mean of 16.9 μm . The shape index is 1.5. Micropyle visible in immature oocysts. Oocystic residual mass

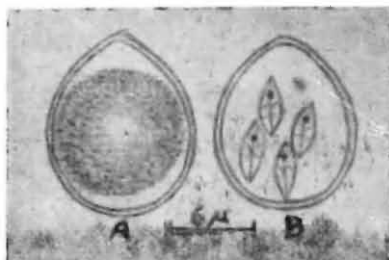


Fig. 98. A, immature and B, mature oocysts of *Eimeria najae*.

appears as compact mass. Sporocyst spindle-shaped, measures 11.5-13.5 μm in length with a mean of 12.5 μm and 5.9-7.8 μm in width with a mean of 6.9 μm . The shape index is 1.8. The sporozoite elongated, tapering at both ends. The nucleus is situated at the middle. Sporozoite measures 10.5-11.5 μm in length.

Sporulation time : 4-5 days.

Type host : Cobra, *Naja naja* Linn.

Other hosts : From the Type host, Mandal (1976).

Distribution : Sunderban, West Bengal.

Endogenous stages : The parasite is found in the intestinal epithelium. Two types of schizonts are seen by Ray and Das Gupta (1936b-37d). Both of them give rise to eight merozoites in each and measures 7 μm in length and 2 μm in breadth. According to the describer it appears that the schizont with a vacuolar cytoplasm and delicate karyosome gives rise to female gametocyte. On the other hand the schizont with hyaline cytoplasm and little nuclear chromatin material gives rise to male gametocyte. Macrogamete with temporary micropyle has been observed by the describer. The dimension of the macrogamete also correspond to those of the oocyst. The microgametocyte measures 20-24 μm in diameter and gives rise to many microgametes each of 6.1 μm in length.

Types : Not known.

117. *Eimeria piscatori* Ray and Das Gupta

1936, *Eimeria piscatori* Ray and Das Gupta, *Proc. Indian Sci. Congr.*, p. 345.

Description : Oocyst oval, measuring $29-31\ \mu\text{m}$ by $22.5-24.5\ \mu\text{m}$ with oocystic residuum. Sporocyst spindle shaped, measuring $14\ \mu\text{m}$ by $4.5\ \mu\text{m}$.

Sporulation time : Unknown,

Type host : Checkered Keelback (Water Snake), *Natrix piscator* (Schneid).

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The description is based on Bhatia (1938). Mandal (1976) examined 20 examples of water snake from the suburb of Calcutta but could not come across any parasite of this type. Species with such incomplete description may not be treated as valid.

118. *Eimeria stolatae* Ray and Das Gupta (Fig. 99)

1938. *Eimeria stolatae* Ray and Das Gupta, *Arch. Protistenk.*, 90 : 361.

Description : Oocyst spherical, provided with double envelop, the outer is thinner than the inner one. It measures $19.5-21.5\ \mu\text{m}$ in diameter with a mean of $20.5\ \mu\text{m}$. Neither micropyle nor oocystic residuum are

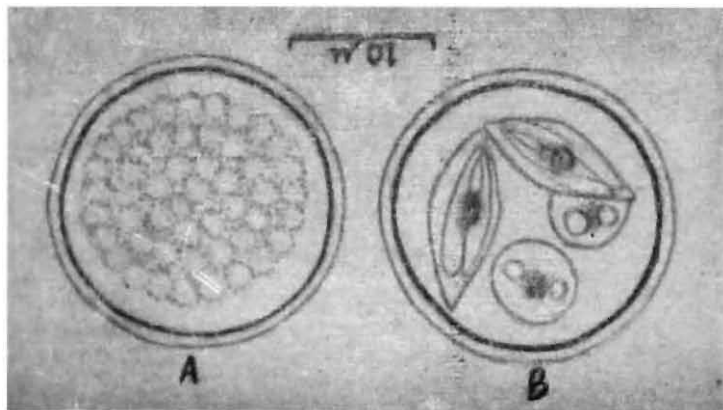


Fig. 99. A, immature and B, mature oocysts of *Eimeria stolatae*.

present. The cytoplasm is rounded with refractile globules, gives rise to four spindle-shaped sporoblasts ultimately forms the spindle shaped sporocysts, each with both ends tapering. It measures $11.5-13.4\ \mu\text{m}$ in length with a mean of $12.5\ \mu\text{m}$ and $5.5-7.5\ \mu\text{m}$ in width with a mean of $6.5\ \mu\text{m}$. The shape index is 2.0. Sporocystic residuum present in between

the elongated sporozoites by lie side by side with their broad nuclear ends facing each other. The sporozoite measures $8.5\ \mu\text{m}$ by $2.3\ \mu\text{m}$.

Sporulation time : 60-72 hours.

Type host : Striped keelback (Grass snake), *Natrix stolota* (Linnaeus).

Other hosts : From the type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : The schizonts are found in the intestinal epithelium, each measuring $8.2\ \mu\text{m}$ by $4.1\ \mu\text{m}$ in size. Mature schizont gives rise to eight irregular nuclei each of which develops into a merozoite measuring $6.1\ \mu\text{m}$. Macrogametes are round each measuring $18-20\ \mu\text{m}$ in diameter. Microgametocytes are irregular in shape. each gives rise to biflagellated microgamete measuring $6.2\ \mu\text{m}$ in length.

Types : Not known.

119. *Eimeria trionyxae* Chakravarty and Kar (Fig. 100)

1943. *Eimeria trionyxae* Chakravarty and Kar, *J. Asiat. Soc. Beng.*, 9 : 49.

Description : Oocyst spherical, double layered, the outer being thinner. It measures $14.45\ \mu\text{m}$ in diameter with a mean of $16.5\ \mu\text{m}$. The cytoplasm is spherical and placed centrally with large number of refringent globules. No micropyle is present but oocystic residuum

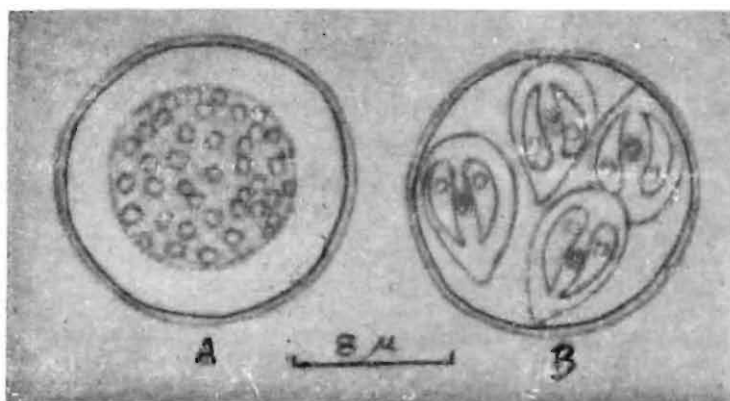


Fig. 100. A, immature and B, mature oocysts of *Eimeria trionyxae*.

present. The cytoplasm gives rise to four oval-shaped sporoblasts which are ultimately converted into pyriform sporocysts each with one end pointed and the other end round. The sporocyst measures $11.5-13.48\ \mu\text{m}$ in length with a mean of $12.5\ \mu\text{m}$ and $5.7-7.9\ \mu\text{m}$ in width

with a mean of $6.3\ \mu\text{m}$. The shape index is 2.00. Sporocystic residuum is present in between the two sporozoites-as centrally placed compact mass. The sporozoites are narrow and elongated, each measuring $9.5\text{-}10.5\ \mu\text{m}$ in length with a centrally placed nucleus.

Sporulation time : 48-60 hours.

Type host : Tortoise, *Trionyx gangeticus* Cuv.

Other hosts : From the type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : In the intestinal epithelium, the round schizont measuring $8\text{-}14\ \mu\text{m}$ in diameter is found. The merozoites are arranged in a rosette inside the mature schizont each with the pointed ends turned outwardly. It measures $4\text{-}6\ \mu\text{m}$ in length and $1.0\ \mu\text{m}$ at its broadest width.

Types : Not known.

120. *Eimeria triangularis* Chakravarty and Kar (Fig. 101)

1943. *Eimeria triangularis* Chakravarty and Kar, *J. Asiat. Soc. Beng.*, 9 : 49.

Description : Oocyst triangular with the sides arched. It measures $9.5\text{-}14.5\ \mu\text{m}$ in length with a mean of $12.5\ \mu\text{m}$. The cytoplasm is rounded measuring $9.12\text{-}11.50\ \mu\text{m}$ in diameter and provided with some refringent globules. Oocystic residuum and micropyle absent. The

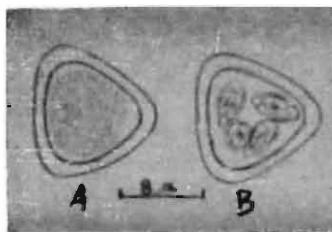


Fig. 101. A, immature and B, mature oocysts of *Eimeria triangularis*.

sporocyst oval or spindle-shaped with both the ends bluntly rounded. Sporocystic wall is very thin. Sporocyst measures $9.5\text{-}11.5\ \mu\text{m}$ in length with a mean of $10.5\ \mu\text{m}$ and $3.4\text{-}5.4\ \mu\text{m}$ in width with a mean of $4.14\ \mu\text{m}$. The shape index is 3.02. The sporozoites are elongated in shape each with tapering ends. It measures $9.5\ \mu\text{m}$ in length.

Sporulation time : 24-36 hours.

Type host : Tortoise, *Trionyx gangeticus* Cuv.

Other hosts : From the type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

121. ***Eimeria varani*** Bhatia and Chauhan
(Fig. 102)

1972. *Eimeria varani* Bhatia and Chauhan, *Indian J. Microbiol.*, 12 : 51.

Description : The oocysts are nearly almond-shaped each with tapering ends, measuring 17-21 μm in length with a mean of 19 μm and

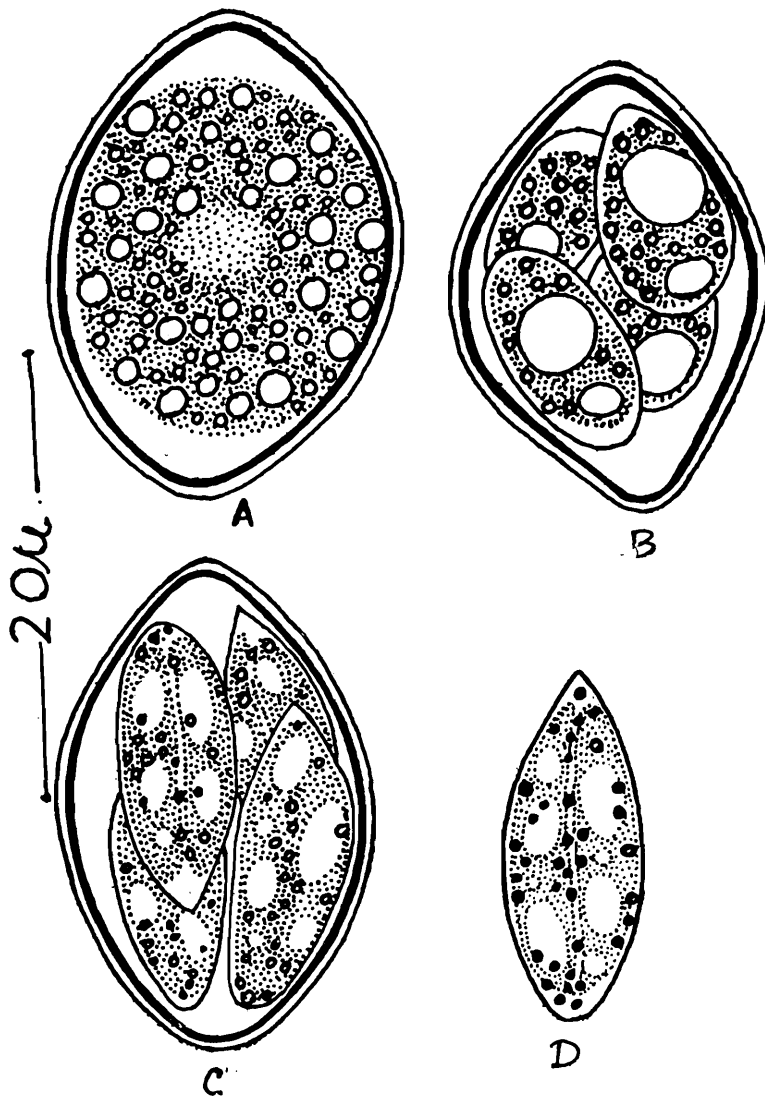


Fig. 102. A, immature, B and C, mature oocysts and D, sporocysts of *Eimeria varani*.

and 10-16 μm in width with a mean of 13 μm . The 0.8-1 μm thick oocyst wall is bilayered ; outer layer is light yellow and the inner one is light brown in colour. Micropyle, polar granules and oocystic

residuum absent. The elongated ellipsoidal sporocyst bears stieda body and measuring 11-14 μm in length with a mean of 13 μm and 5-6 μm in width with a mean of 6 μm in size. The sporocystic residuum is dispersed as coarse dark granules between the sporozoites, each measures 10.4-11.7 μm in length with a mean of 11 μm and 2.6 μm in width.

Sporulation time : 4 days.

Type host : Monitor Lizard, *Varanus monitor* [= *Varanus bengalensis* (Daudin)].

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Regarding the testudine coccidia, Bhatia (1938) included *Eimeria mitraria* (Laveran and Mesnil, 1902) from the host, *Chinemy reevissi* (Gray) as reported from Ceylon but not included here due to lack of definite information about the distribution of this species.

(F) PARASITES OF BIRDS

Key to the species

1. Oocyst kidney shaped	...	...	<i>E. sphenocercae</i>
2. Oocyst elliptical or ellipsoidal			
(A) Sporocyst pear shaped			
(i) Oocyst with micropyle	...	...	<i>E. alectorae</i>
(ii) Oocyst without micropyle	...	...	<i>E. meleagridis</i>
(B) Sporocyst not pear shaped			
(I) Sporocysts elongated ovoid			
(i) With stieda body			
(x) Polar granule one	...	...	<i>E. mayuri</i>
(y) Polar granule more than one	...	...	<i>E. adenoides</i>
(ii) Without stieda body	...	...	<i>E. gallopavonis</i>
(II) Stieda body prominent	...	...	<i>E. teetari</i>
(ii) Stieda body not prominent	...	...	<i>E. gorakhpurensis</i>
(III) Sporocyst elongated ellipsoidal	...	...	<i>E. grusi</i>
(IV) Sporocyst ellipsoidal	...	...	<i>E. lophurai</i>
3. Oocyst pyriform	...	...	<i>E. gallinagoi</i>
4. Oocyst egg-shaped			
(A) Oocystic residuum present	...	...	<i>E. pavonina</i>
(B) Oocystic residuum absent			
(i) Size of oocyst above 20 μm	...	...	<i>E. dubeyi</i>
(ii) Size of oocyst below 20 μm	...	...	<i>E. acervulina</i>

5. Oocyst oval or ovoid

(A) Oocystic residuum present

(x) Sporocyst pyriform

(a) Sporocyst large above 10.0 μm in length(i) Micropyle present *E. tenella*(ii) Micropyle absent *E. roscoviensis*(b) Sporocyst small below 10.00 μm length(i) Size of oocyst above 17.00 μm /13.00 μm *E. patnaiki*(ii) Size of oocyst below 17.00 μm /13.00 μm *E. charadrii*

(y) Sporocyst ovoid or ellipsoidal

(a) Size of oocyst large above 25 μm *E. columbae*(b) Size of oocyst small below 25 μm *E. kapotei*

(B) Oocystic residuum absent

(i) Sporocyst ovoid ellipsoidal

(a) Size of sporocyst 10-13 μm /6-8 μm *E. bezei*(b) Size of sporocyst 12 μm /5-7 μm *E. francolini*(c) Size of sporocyst 15-20 μm /8-9 μm *E. maxima*

(ii) Sporocyst not ovoid ellipsoidal

(a) Size of oocyst 17-27 μm /15-23 μm *E. dispersa*(b) Size of oocyst 16-30 μm /13-25 μm *E. bateri*(c) Size of oocyst 20-31 μm /18-25 μm *E. brunetti*(d) Size of oocyst 15.5-23.3 μm /13-6-20 μm *E. necatrix*(e) Size of oocyst 16-21 μm /13-17 μm *E. picta*

6. Oocyst spherical or subspherical

(A) Oocystic residuum present

(i) Sporocyst ellipsoidal *E. tropicalis*

(ii) Sporocyst pyriform

(a) Size of oocyst above 20 μm *E. numenni*(b) Size of oocyst below 20 μm (i) Sporocyst pyriform *E. mandali*(ii) Sporocyst bean-shaped *E. bhutanensis*

(B) Oocystic residuum absent

(I) Sporocyst oval, ovoidal or elliptical

(a) Length of sporocyst below 10 μm (i) Length of oocyst above 20 μm *E. lucknowensis*(ii) Length of oocyst below 20 μm (x) Micropyle present *E. anatis*(y) Micropyle absent *E. mitis*(b) Length of sporocyst ranging from 10 μm —13 μm (i) Length of oocyst above 25 μm *E. malaccaae*(ii) Length of oocyst below 25 μm (x) Length of sporozoite 6.5 μm *E. labbeana*(y) Length of sporozoite 9-11 μm *E. battakhi*(a) Length of sporocyst above 13.00 μm (i) Width of sporocyst above 7 μm *E. barbata*(ii) Width of sporocyst below 7 μm *E. pavonis*

(II) Sporocyst pyriform

(a) Size of oocyst large above 27 μm *E. coturnicis*

(b)	Size of oocyst below 27 μm		
(i)	Size of sporocyst below 8 μm		<i>E. gennaeuscus</i>
(ii)	Size of sporocyst above 8 μm		
(x)	Wall of oocyst provided with warts		<i>E. vanelli</i>
(y)	Wall of oocyst smooth		
(i)	Oocyst with knob at the micropyle end		<i>E. dauki</i>
(ii)	Oocyst without knob at the micropyle end		
(a)	Size of sporocyst below 12 μm in length		<i>E. columberum</i>
(b)	Size of sporocyst above 12 μm in length		<i>E. innocua</i>
(7)	Oocyst spherical to elliptical		<i>E. praecox</i>
(8)	Oocyst sub-spherical to ellipsoidal		
(A)	Size of sporocyst above 12 μm in length		<i>E. choudari</i>
(B)	Size of sporocyst below 12 μm in length		
(i)	Sporozoite with one refractile globule		<i>E. vanmurghavi</i>
(ii)	Sporozoite with many refractile globules		<i>E. meleagrimitis</i>
(9)	Oocyst ellipsoidal to ovoid		<i>E. mivati</i>
(10)	Oocyst broadly ovoid		<i>E. hagani</i>

122. *Eimeria acervulina* Tyzzer (Fig. 103)

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

Description : The oocysts are egg-shaped or oval, smooth walled and yellowish in colour each with uniformly thick wall except at anterior end where it was slightly thin. It measures 17.7-20.0 μm by



Fig. 103. Immature oocyst of *Eimeria acervulina*.

13.7-16.3 μm with a mean of 19.5 μm by 14.3 μm . Shape index 1.1-1.4 with a mean of 1.25 ; having a micropyle at the narrower end. The wall is double-contoured and has a smooth surface. No oocystic residual body is formed, but a polar granule is visible in most sporulated, and even in some unsporulated oocysts. There is no inner residual bodies.

Sporulation time : 24 hours.

Dimension of the oocysts reported by other authors are as follows :

12-23 by 9-17 μm with a mean of 16 by 13 μm (Levine, 1961) ;

17-19 by 14 μm . (Soltys, 1966) ; 13-22 by 10-16 μm with a mean of 18 by 13.5 μm (Tacla, 1967) ; 18-20 by 14-16 μm with a mean of 19.5 by 14.3 μm (Pellerdy, 1974).

Type host : Domestic fowl, *Gallus domesticus* (= *Gallus* sp.)

Other hosts : Bob white, *Colinus v. virginianus* (Linnaeus) ; California Valley Quail, *Lophoryx californicus* [= *L. californica californica* (Shaw)] ; Plumed Quail, *Oreortyx picta plumifera* [= *O. picta picta* (Douglas)] are also harbouring oocysts morphologically similar to the present species (Pellerdy, 1974).

Distribution : Uttar Pradesh, Orissa, Madhya Pradesh, Bombay, Maharashtra and Tamil Nadu.

Endogenous stages : Endogenous stages are found mainly within the epithelial cells of the anterior portion of the small intestine, particularly in the duodenal loop ; sometime they may invade the posterior segments. Four schizogonic generations have been observed in *E. acervulina* (Vetterling and Doran, 1966). First generation schizont measures 9.1-11.3 μm in diameter localizes above the nucleus of the host cell and form sixteen long merozoites each measuring 4.4-5 μm with a central residuum. Second generation schizont measures 5-5.5 μm in diameter localizes supranuclearly, produces sixteen, of 3.9-4.5 μm long merozoites without any residuum. The third one measures 3.9 μm by 5.5 μm localizes supranuclearly and produces eight merozoites each measuring 5.2-5.9 μm long, arranged around a residuum. The fourth generation schizont also lies above nucleus measures 9.1-10.3 μm with a large residuum.

Microgametocyte measures 11 μm by 9 μm gives rise to microgametes each measuring 2.2-3.3 μm in length. The macrogametocyte measures 14.5-19 μm . The prepatent period is 4 days. Further details may be had from Doran and Farr, 1965 ; Doran, Jhan and Rinaldi, 1962 ; Doran, 1966. However, the ultrastructure of macrogametes and oocysts were studied by Lee and Millard (1971). It was found that the macrogametes are devoid of microtubuli on the surface. Wall forming bodies were detected in association with golgi complex. Oocyst was composed of three layers. Jurajdova (1969) observed micropore on the surface of the gametocyte lying inside the vacuole. The macrogametocyte was provided with two layers and the microtubule was detected in the parasitophorous vacuole, older macrogametocytes were provided with glycogen in the form of rosettes. The microgamete was having three flagella of which two were free and the third one was attached to the body contour.

Excystation : The excystation of oocyst was studied *in vitro* (Doran and Farr, 1961) and *in vivo* (Farr and Doran, 1961) and found that no excystation took place in gastric or duodenal juice, pepsin and different pancreatic enzymes but due to mechanical disruption of the wall most of the oocyst released sporozoites in the bile and pancreatic juice. In the living bird no excystation took place in the crop, quite a large number of excystation took place in the gizzard but most of the sporozoites were released in the duodenum.

Pathogenecity : Tyzzer (1932) regarded this species as nonpathogenic. However, afterwards it has been proved experimentally that *E. acervulina* is pathogenic (Morehouse and Mc Guire, 1958, Horton-Smith and Long, 1963 and Gill and Lall, 1961). Pellerdy (1974) is of opinion that there might be different strain of *E. acervulina*. Long transverse ladder-like lesions are seen if the infection is medium (Tyzzer, 1929) in case of severity coalescence hides the characteristic pattern. The contents of the intestine are found pesty catarrhal and occasionally with extensive vasodilatation is marked by the reddening of the mucosa with rare epithelium desquamation.

Types : Not known.

Remarks : The distribution and further activity may be had from Ray (1945 c), Gill (1959 a,b) Patnaik (1963), Bhatia and Pande (1968 a,e), Rahman and Anantaraman (1970). Chandra and Chhabra (1972) and Mandal (1980).

123. *Eimeria adenoeides* Moore and Brown (Fig. 104)

1951. *Eimeria adenoeides* Moore and Brown, *Cornell vet.*, 41 : 124.

Description : Oocyst double contoured with smooth surface usually elliptical in shape measuring 19-31 μm in length with a mean of 26 μm and 12.6-21.0 μm in width with a mean of 16 μm . Oocystic residuum

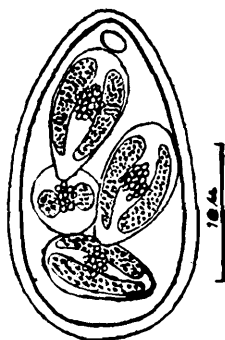


Fig. 104. Mature oocyst of *Eimeria adenoeides*.

absent but with 1 to 3 polar granules. Sporocyst elongated ovoid apparently with a stieda body.

Sporulation time : 24 hours.

Dimension of the oocysts reported by other authors are as follows :

19-31 μm by 13-21 μm with a mean of 25 μm by 16 μm (Moore and Brown, 1951) ; 18-21 μm by 14-17 μm (Svanbeav, 1957) ; 21-30 μm by 13-20 μm with a mean of 25.6 μm , by 16.2 μm (Clarkson, 1958) ; 19-32 μm by 14-18 μm with a mean of 27.2 μm by 16.6 μm (Golemansky, 1962).

Type host : Domestic Turkey, *Meleagris g. gallopavo* Linnaeus (= *Meleagris* sp.).

Other hosts : From the type host and Lady Amherst's Pheasant, *Chrysolophus amherstiae* (Lead beater).

Distribution : Lucknow, Uttar Pradesh, Orissa.

Endogenous stages : This species localizes in the tubular portion of the caecum and the terminal portion of the illeum i.e. the lower region of the small intestine the caecum and the colon (Moore and Brown, 1951 and Clarkson, 1956 and 1958). The first generation schizont measures 30 μm by 18 μm produces several hundred merozoites each measuring 4.5-7 μm by 1.5 μm . They lie below or next to the nucleus but the second generation schizont much smaller lie subnuclearly, measuring 10 μm in diameter and produce 10-24 merozoites each measuring 10 μm by 3 μm . The macrogamete measures 20 μm by 18 μm with large cytoplasmic granules, the nucleus is provided with a central Karyosome surrounded by a pale halo. The microgametocytes are roughly similar in size and the microgametes within them surrounded an irregular residual mass. Doran (1970) observed the schizogony in the bovine embryonic kidney cell cultures where schizonts found after 48 hours. This species is pathogenic to the Turkey.

Types : Not known.

Remarks : While dealing with Coccidia of Turkey at Lucknow, Uttar Pradesh, Bhatia (1968a) came across a species and described the oocyst as ellipsoidal with smooth double contoured wall, measures 20-28 $\mu\text{m} \times 14.6-17.3 \mu\text{m}$ (mean 25.6 $\mu\text{m} \times 16.4 \mu\text{m}$) (from 50 oocysts) with a length width ratio of 1.36-1.81 (mean 1.56). The 1.2 μm thick oocystic wall had the outer layer yellowish or light green and the inner with a violate or bluish hue. Oocystic residuum absent. One or two polar granules were present. Micropyle perceptible occasionally as a light area. Sporocyst 10.6-14.6 $\mu\text{m} \times 6.6 \mu\text{m}$ (mean 12.6 $\mu\text{m} \times 6.6 \mu\text{m}$)

in size, elongate-ovoid and with a narrower end. Stieda body present. Sporocystic residuum presents as scattered granules. Sporozoite of $9.3 \times 2.0 \mu\text{m}$ in size, with one end broadly rounded and the other narrower, had two refractile globules, the larger lying at the broader end and the smaller towards the narrower extremity with a small but distinct nucleus situated between the two. Scrapings from regions of the hind gut yielded oocysts inside caecal epithelial cells.

However, with this description the authors expressed a doubt of differentiating *E. adenoides* and *E. meleagridis* so also by Clarkson (1960). Mandal (1980) expressed a desire that the author might be dealing with *E. adenoides*. The further details may be had from Patnaik (1963) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

124. *Eimeria alectorae* Ray and Hiregaudar

1959. *Eimeria alectorae* Ray and Hiregaudar, *Bull. Calcutta, Sch. trop. Med. Hyg.*, 7 : 111.

Description : Oocyst ellipsoidal in shape with a few ovoidal and very few spherical forms. Oocystic wall pale yellowish-brown with fine granules near the micropyle. Micropyle conspicuous as a minute opening in the wall. Oocyst measures $23.6\text{--}26.4 \mu\text{m}$ in length and $15.6\text{--}19.5 \mu\text{m}$ in width and the shape index is 1.43. Oocyst from another bird of the same species measures $26.2\text{--}29.5 \mu\text{m}$ in length and $17.4\text{--}19.5 \mu\text{m}$ in width and the shape index is 1.50. Refractile granules present in the cytoplasm. Sporocysts are pear-shaped each measures $8\text{--}9.5 \mu\text{m}$ by $5\text{--}5.6 \mu\text{m}$, with stieda body at the pointed end. Sporozoites banana-shaped. Sporocystic residuum present.

Sporulation time : 24-48 hours.

Type host : Chukar Partridge, *Alectoris graeca* (Meisner).

Other hosts : Unknown.

Distribution : Zoological Garden, Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

125. *Eimeria anatis* Scholtyseck (Fig. 105)

1955. *Eimeria anatis* Scholtyseck, *Arch. Protistenk.*, 100 : 431.

Description : Oocyst nearly spherical or ovoid with a truncated

end and a smooth double contoured wall of $1\text{ }\mu\text{m}$ thick. It measures $15\text{--}19\text{ }\mu\text{m}$ in length with a mean of $16.9\text{ }\mu\text{m}$ and $11\text{--}15\text{ }\mu\text{m}$ in width with a mean of $14.3\text{ }\mu\text{m}$. The outer layer is colourless but the thick inner

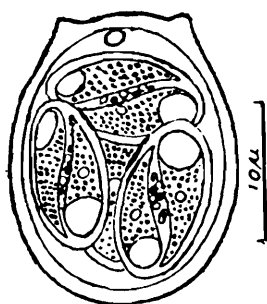


Fig. 105. Mature oocyst of *Eimeria anatis*.

layer is straw coloured. Micropyle prominent measuring $4\text{ }\mu\text{m}$ wide and thickening at their ends. Oocystic residuum absent but provided with one or two polar granules. Sporocyst ovoid with one pointed end measuring $8\text{--}10\text{ }\mu\text{m}$ in length with a mean of $9.3\text{ }\mu\text{m}$ and $5\text{--}6.6\text{ }\mu\text{m}$ in width with a mean of $6.1\text{ }\mu\text{m}$. Stieda body absent, sporocystic residuum present as loose scattered mass at the centre. Sporozoite elongated-pyriform, measuring $6\text{--}7\text{ }\mu\text{m}$ in length and $2.7\text{ }\mu\text{m}$ in width with one narrower end and the other end broadly rounded. Two refractile globules lying in different positions on the sporozoites.

Sporulation time : 3 days.

Dimension of the oocysts reported by other authors are as follows :

$14\text{--}19\text{ }\mu\text{m}$ by $11\text{--}16\text{ }\mu\text{m}$ with a mean of $16.8\text{ }\mu\text{m}$ by $14.1\text{ }\mu\text{m}$ (Kenneth *et al.* 1971 and Pellerdy, 1974).

Type host : Mallard or Domestic Duck, *Anas p. platyrhynchos* (= *Anas* sp.).

Other hosts : From the Type host, Bhatia (1968b).

Distribution : Lucknow, Uttar Pradesh.

Endogenous stages : Examination of stained duodenal and some parts of ileum revealed isolated oocysts of similar nature attached to villi epithelial cells. Other stages unknown.

Types : Not known.

126. *Eimeria barbeta* Kar

(Fig. 106)

1944. *Eimeria barbeta* Kar, *Proc. Indian Sci. Congr.*, p. 104.

Description : Oocystic oval, double walled, the outer being thinner. It measures 22.2-34.2 μm in length with a mean of 32.2 μm and 17.5-19.5 μm in width with a mean of 18.5 μm . The shape index is 1.2. Micropyle present and oocystic residuum absent. Sporocyst oval,



Fig. 106. A, immature and B, mature oocysts of *Eimeria barbata*.

with anterior portion narrower than the posterior. The anterior end is provided with a ill developed knob. Sporocyst measures 14.5-16.5 μm in length with a mean of 15.5 μm and 7.5-9.5 μm in width with a mean of 8.5 μm . The shape index is 1.8. Sporocystic residuum present as compact mass. Sporozoites are sickle shaped, each measuring 10.5-12.5 μm in length and 2.2 μm in width. The shape index is 5.2. Nucleus is placed towards the round posterior end.

Sperulation time : 48-62 hours.

Type host : Blue throated Barbet, *Cyanops asiatica asiatica* (Lath.).

Other hosts : From the Type host, Mandal (1976).

Distribution : Calcutta, West Bengal.

Endogenous stages : Both micro and macrogametocytes are spherical, each measures 11.0-13.0 μm in diameter. The microgametes are small spindle-shaped bodies, each having a flagellum. The macrogametes are spherical with a large number of irregularly scattered granules in the cytoplasm. The schizonts have also been observed and have the same shape as those of the gametocytes. The merozoites are elongated each measuring 8.8×2.2 μm with a centrally placed spherical nucleus as studied by Chakraborty and Kar (1947a).

Types : Likely to be present in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

127. *Eimeria bateri* Bhatia, Pandey and Pande
(Fig. 107)

1965. *Eimeria bateri* Bhatia, Pandey and Pande, *Indian J. Microbiol.*, 5 : 61.

Description : Oocyst ovoid measuring $16.5\text{--}29.8\text{ }\mu\text{m}$ in length and $13.5\text{ }\mu\text{m--}24.5\text{ }\mu\text{m}$ in width (mean $24.5\text{ }\mu\text{m}$ by $18.5\text{ }\mu\text{m}$). The shape

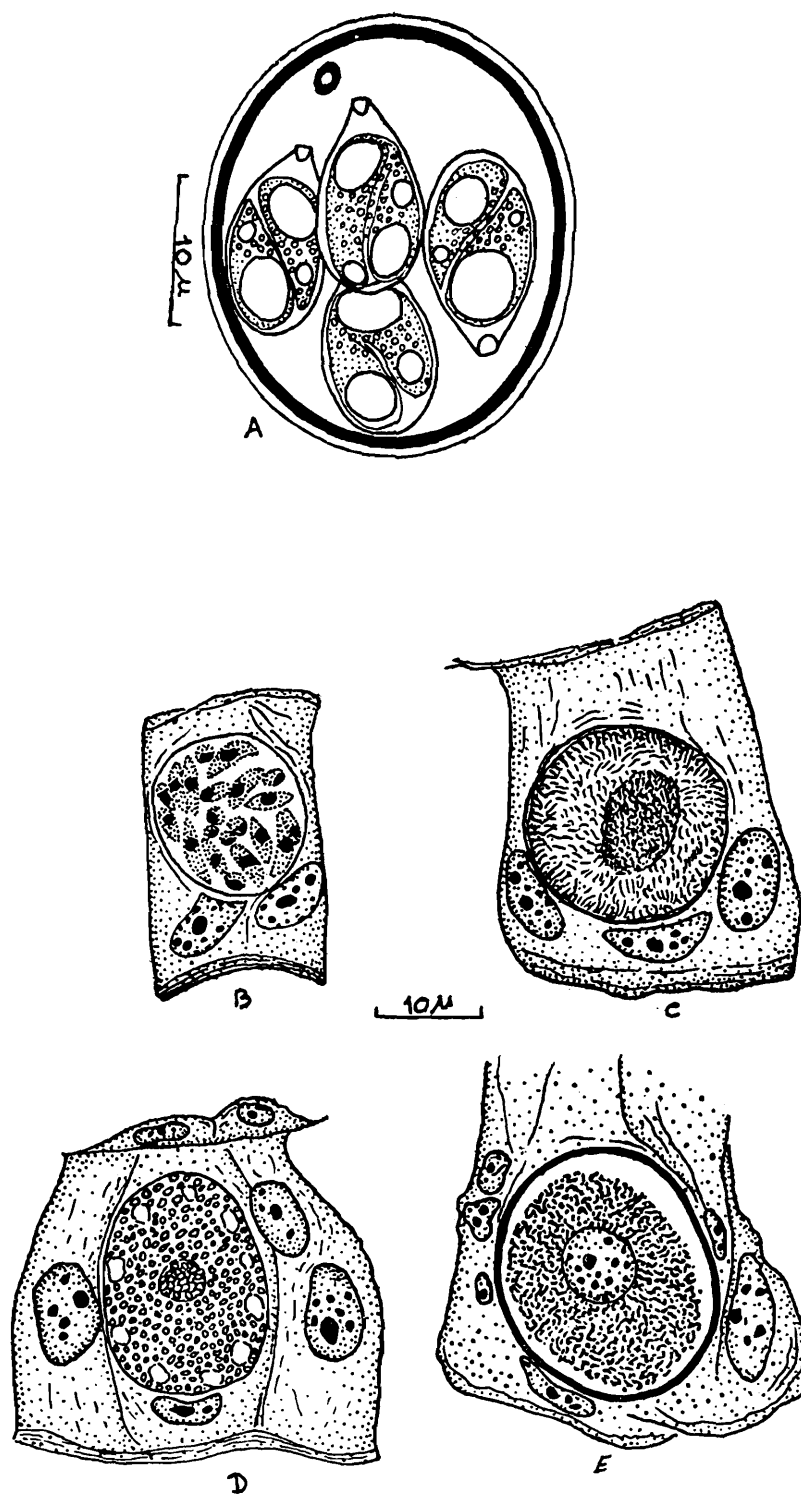


Fig. 107. A, sporulated oocyst, B, merozoite, C, microgametocyte, D, macrogamete, E, fertilized macrogamete of *Eimeria bateri*.

index is 1.25. The outer wall yellowish, inner one dark bluish. Micropyle and oocystic residuum absent. Polar granules present, sporocyst ovoidal or pyriform with prominent stieda body at narrow anterior end. It measures 8.5-13.5 μm by 5.5-8.5 μm with a mean of 12.5 μm by 7.5 μm . The shape index is 1.8. Sporocystic residuum is present as scattered granules. Sporozoites are elongated in shape each with a nucleus at posterior blunt end.

Sporulation time : 24-30 hours.

Type host : Indian Common grey quail, *Coturnix c. coturnix* (Linn.).

Other hosts : Unknown.

Distribution : Not mentioned by the describer but likely from Mathura, Uttar Pradesh.

Endogenous stages : The schizont measures 7.15-10 μm by 6.7-12.0 μm in size and produces 20-25 tapering merozoites each measuring 4.5-6 μm by 1 μm . Microgametocyte measures 12.0-20.00 μm by 19.4 μm , the mature one produces thousands of biflagellate microgametes each measuring 1.5 μm , and arranged around a prominent residual mass. Macrogamete measures 13.4-21.0 μm by 10.4-14.0 μm in size. Schizonts, microgametocytes, macrogametes, developing and mature oocysts were found in the superficial epithelial lining of the villi particularly in the lower half of the small intestine as studied by the describer.

Types : Likely to be present in the Dept. of Parasitology, Mathura Veterinary College, Uttar Pradesh.

Remarks : Norton and Pierce (1971) were able to infect Japanese quail with *E. bateri* oocysts from the Common grey quail. Shah and Johnson (1971) observed this species in Hungarian quail in the United States and failed to transmit *E. bateri* in the Domestic fowl.

128. *Eimeria battakhi* Dubey and Pande

(Fig. 108)

1963. *Eimeria battakhi* Dubey and Pande, *Curr. Sci.*, 32 : 329.

Description : Oocyst subspherical to ovoid, double walled the outer being thinner than the inner one. It measures 19-24 μm in length with a mean of 21 μm and 16-21 μm in width with a mean of 18 μm . The shape index is 1.16 μm . Cytoplasm centrally placed, coarsely granular with small refractile globules. Micropyle and oocystic

residuum absent. The sporocyst elongately ovoid, measuring 11-13 μm in length with a mean of 12 μm and 6-8 μm in width with a mean of 7 μm . The shape index is 1.7 μm . The narrower end is provided with a small knob (stieda body). Sporocystic residuum present as a compact

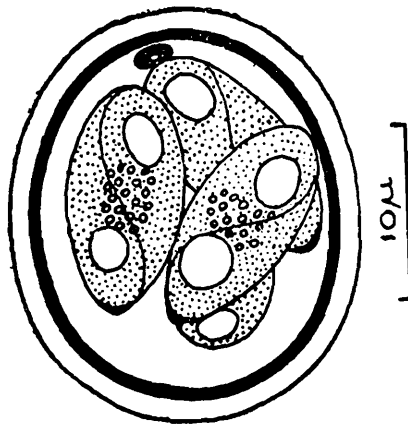


Fig. 108. Mature oocyst of *Eimeria battakhi*.

mass. The sporozoite elongated with one end broader and other narrower. It measures 9-11 μm in length with a mean of 10 μm and 2 μm in width. A clear vacuolated area is seen on the posterior rounded end in addition to the centrally placed nucleus.

Sporulation time : 24-32 hours.

Type host : Domestic duck, *Anas platyrhynchos domesticus* (= *Anas* sp.).

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

129. *Eimeria bazei* Chauhan and Bhatia

(Fig. 109)

1970. *Eimeria bazei* Chauhan and Bhatia, *Indian J. Microbiol.*, 10 : 53.

Description : The oocyst ovoid or broadly ellipsoidal in shape with prominent projection of the outer wall at the narrow micropylar end, measuring 21-28 μm by 16-20 μm (mean 23.7 μm by 16.8 μm) with a length width ratio of 1.2-1.7 (mean 1.4). Oocysts wall is smooth, 0.7 μm thick and double contoured. The outer is yellowish-green and the inner violate in colour. Prominent micropyle measures 3.9-4.5 μm

(mean $4.0\ \mu\text{m}$) broad. Oocystic residuum absent. A polar granule is present. Sporocyst ellipsoidal measuring $10.4\text{--}13.0\ \mu\text{m}$ by $6.5\text{--}7.8\ \mu\text{m}$ (mean $12.2\ \mu\text{m}$ by $7.2\ \mu\text{m}$), with a small knob like stieda body ; sporo-

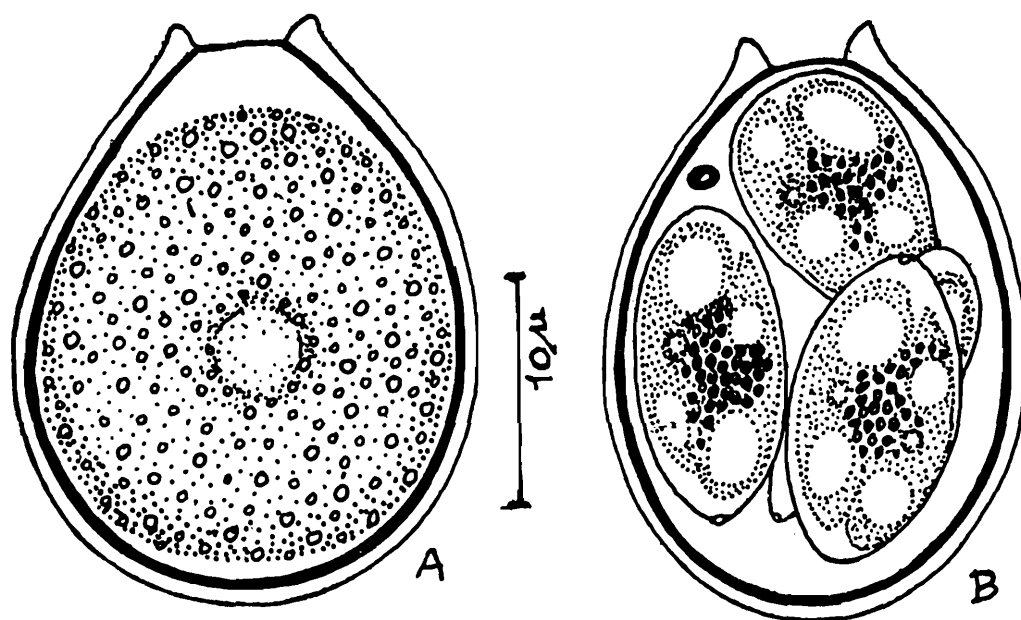


Fig. 109. A. immature and B, mature oocysts of *Eimeria bazi*.

cystic residuum is present as a mass of dark granules. Sporozoites lie head to tail, each measures $9\ \mu\text{m}$ by $2.6\ \mu\text{m}$ with two prominent refractile globules, one at each end and a nearly central nucleus.

Sporulation time : 48 hours.

Type host : Black Ibis, *Pseudobis papilosa* (Temminck).

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

130. *Eimeria bhutanensis* Ray and Hiregaudar

1959. *Eimeria bhutanensis* Ray and Hiregaudar, *Bull. Calcutta Sch. trop. Med. Hyg.*, 87 : 111.

Description : Oocysts spherical to subspherical in shape. Endocytic wall of each is thicker than the ectocystic wall and slightly yellowish in colour. Refractile granules present. Oocyst measures $15.5\text{--}16.8\ \mu\text{m}$ in length and $14.6\text{--}16.6\ \mu\text{m}$ in width. Sporocyst bean-shaped with a

stieda body at one end and having scanty residual matter. Sporocyst measures 6-7 by 3-4 μm . Sporozoites sickle-shaped.

Sporulation time : 24-36 hours.

Type host : Bhutan Peacock pheasant, *Polyplectron bicoloratum* (= *Polyplectron bicoloratum bakeri* (Linn.)).

Other hosts : Unknown.

Distribution : Zoological Garden, Calcutta, West Bengal.

Endogenous stages : Unknown.

Type : Not known.

131. *Eimeria brunetti* Levine

(Fig. 110)

1942. *Eimeria brunetti* Levine, *Cornell Vet.*, 32 : 430

Description : The oocyst oval, measures 20.7-30.3 μm in length and 18.1-24.2 μm in width with a mean of 26.8 μm by 21.7 μm resembling

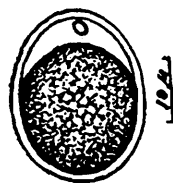


Fig. 110. Mature oocyst of *Eimeria brunetti*.

E. maxima oocysts, from which it differs by having smaller size and thin wall.

In the sporulated oocyst polar granules are present, but no residual body is formed. The oocyst obtained from this country measures 24-30 μm by 20-23 μm with sporocyst of 11-16 μm by 5-10 μm in size and are structurally similar to *E. brunetti*.

Sporulation time : 24-48 hours.

Dimension of the oocysts reported by other authors are as follows :

14-34 by 12-26 μm with the average 23 by 20 μm (Becker, Zimmermann and Pettillo, 1955), 15-30 by 12-25 μm with an average 22.2 by 18 μm (Tacla, 1967), 23-29 by 11-24 μm with an average 25.7 by 18 μm (Pohl, 1964), 23-26 μm (Roepke and Lonsing, 1968) 22-25 μm by 18-22 μm (Pellerdy, 1974).

Type host : Domestic Fowl, *Gallus* sp.

Other hosts : From the type host, Gill (1955) and Dubey and Sivastav (1965).

Distribution : Jabalpur, Madhya Pradesh and Uttar Pradesh.

Endogenous stages : The endogenous development occurs primarily in the lower part of the small intestine, the caeca, the colon and the cloaca. The gametocytes and oocysts were found in the ileum, caecum and rectum. In the stained sections macrogametocyte measuring 16.5-19.5 μm by 13.2-16.5 μm and microgametocyte of 16.5-24.7 μm by 16.5-19.5 μm with a large residual mass of 13.2 by 11.5-13.2 μm were seen. Oocyst measuring 16.5-23.1 by 13.2-16.5 μm in size was also observed. These oocysts were probably of *E. brunetti* as observed by Dubey and Srivastav (1968). Workers like Boles and Becker (1954), Pellerdy (1960) Davis (1963) and Pohl (1964) have studied the endogenous development in detail. Schizogonic process takes place in the terminal portion of the ileum and in the rectum and cloaca.

First generation schizont measures 30 by 20 μm gives rise to 200 merozoites. Second generation schizont smaller produces only 50-60 merozoites. The macrogamete measures 25 μm by 27 μm . The microgametocyte large and both the stages are found in the terminal segments.

Pathogenicity : This species is pathogenic and caused heavy mortality. The complete blockage of the large intestine with exudate inside the small intestine are frequently encountered with the infection of this parasite.

Types : Not known.

132. *Eimeria charadrii* Mandal

(Fig. 111)

1965. *Eimeria charadrii* Mandal, *Proc. zool. soc. Calcutta*, 18 : 47.

Description : Oocyst (Fig. 111 A) oval in shape with double wall, the outer wall is thinner than the inner one. Anterior end of the oocyst is drawn out as a small neck. Oocyst measures 14.3-17.6 μm in length with a mean of 15.8 μm and 11.0-12.0 μm in width with a mean of 11.5 μm . The shape index is 1.3. Highly refractile cytoplasm completely fills up the oocyst. Micropyle present at the anterior end, oocystic residuum absent. Sporocyst pyriform in shape measuring 7.8-9.8 μm in length

with a mean of $8.8\ \mu\text{m}$ and $5.5\text{-}7.6\ \mu\text{m}$ in width with a mean of $6.6\ \mu\text{m}$. The shape index is 1.3. The anterior end of the sporocyst is narrow and the posterior end round. Sporocystic residuum is present as

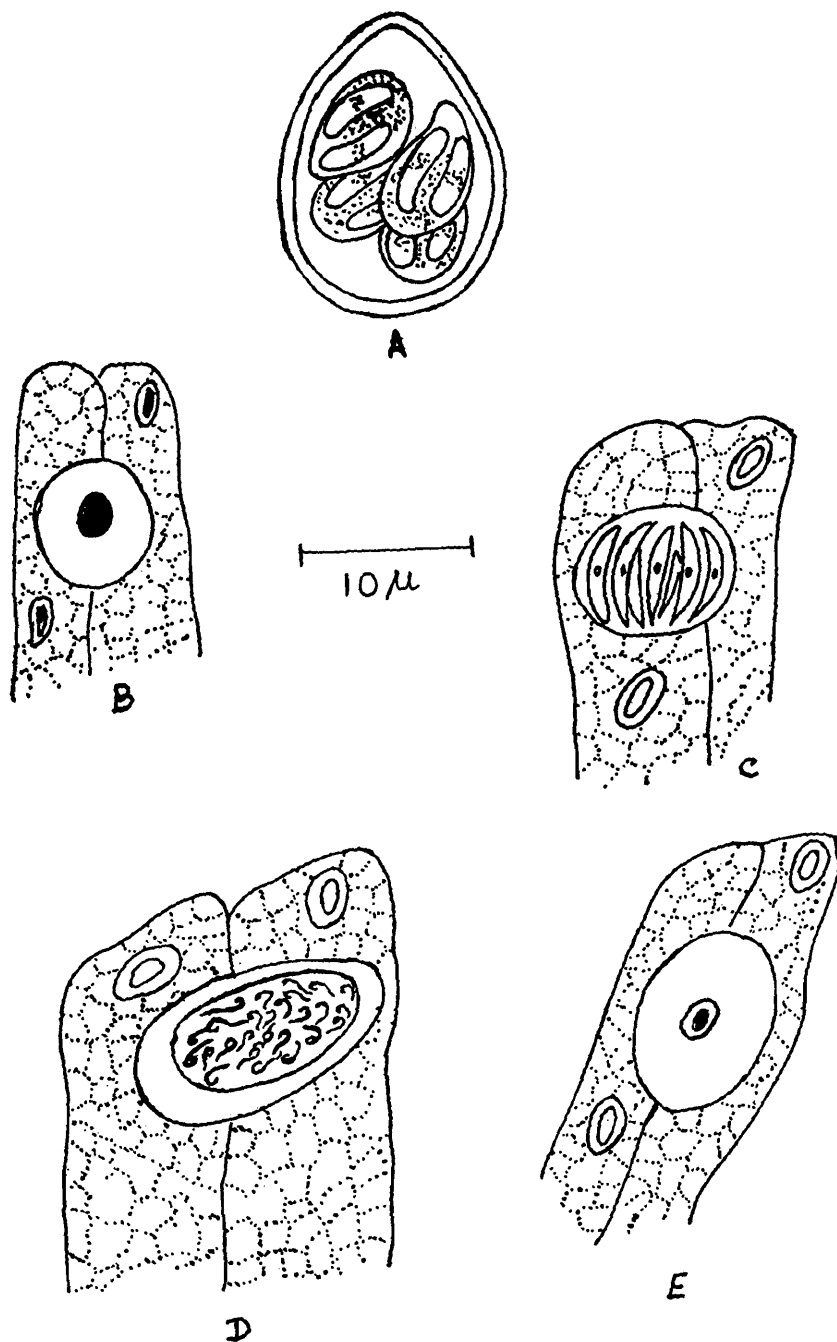


Fig. 111. A. mature oocyst, B. schizont, C. merozoites, D. microgametes and E. fertilized macrogamete of *Eimeria charadrii*.

scattered mass. Sporozoites are elongated in shape each with both ends bluntly pointed. Sporozoite measures $4.4\ \mu\text{m}$ by $2.2\ \mu\text{m}$. The shape index is 2.0. Nucleus is situated at the middle.

Sporulation time : 80-90 hours.

Type host : Sand Plover, *Charadrius asiaticus* Pallas.

Other hosts : Unknown.

Distribution : Narayantala, 24 Parganas, West Bengal.

Endogenous stages : The schizonts are spherical each measuring $8.8\ \mu\text{m}$ in diameter. The mature one (Fig. 111 B) produces $6.6\ \mu\text{m}$ long merozoite with a central nucleus (Fig. 111 C). The microgametocytes (Fig. 111 D) are oval each measuring $7.7\ \mu\text{m}$ by $5.5\ \mu\text{m}$ produces many microgametes each bears a single flagellum. The macrogamete (Fig. 111 E) measures $6.6\ \mu\text{m}$ in diameter with a central nucleus.

Types : Lying in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

133. *Eimeria choudari* Bhatia, Chauhan, Arora and Agarwal
(Fig. 112)

1972. *Eimeria choudari* Bhatia et al., *Indian J. Anim. Sci.*, 42 : 625.

Description : Subspherical to broadly ellipsoidal oocyst, measuring $16.9\text{-}22.1\ \mu\text{m}$ in length and $13.0\text{-}18.02\ \mu\text{m}$ in width (mean $19.24\ \mu\text{m}$ by $15.6\ \mu\text{m}$). The oocystic wall is $1.3\ \mu\text{m}$ thick and had an outer yellowish green and an inner bluish-brown layer. Micropyle and polar cap absent. Oocystic residuum absent. A large polar granule present. Sporocyst elongate-ellipsoidal, measures $13.0\text{-}14.3\ \mu\text{m}$ in length and $6.5\text{-}7.8\ \mu\text{m}$ in width (mean $13.6\ \mu\text{m}$ by $7.2\ \mu\text{m}$) having small nipple-like

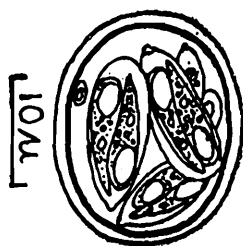


Fig. 112. Mature oocyst of *Eimeria choudari*.

stieda body at one end. Sporozoites nearly banana-shaped, each measuring $10.4\text{-}11.1\ \mu\text{m}$ in length and $2.6\text{-}3.2\ \mu\text{m}$ in width (mean $10.7\ \mu\text{m}$ by $2.9\ \mu\text{m}$) with one end tapering and the other end broad and rounded ; having a large oval refractile globule at the broader end and a small one near the centre towards the narrower extremity.

Type host : Ring Dove, *Streptopelia decaota* (Frivaldszky).

Other hosts : From the type host and Naqab-Posh pigeon and Pouter pigeon, *Columba* spp. and ? Grey Jungle fowl, *Gallus sonneratti* (Temminck).

Distribution : Zoological garden, Delhi and Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : While describing this species the authors have compared the present form with those of the species occurring in the Gallinaceous birds. The host, *Streptopelia* sp. comes under the order Columbiformes and *E. labbeana* is frequently present in this group of birds.

However, the present form is distinct from all the species described so far. Bhatia et al. (1973) reported this species from Grey Jungle-fowl, *Gallus sonneratii*, Naqab-Posh pigeon and Pouter pigeon (*Columba* spp.) from Lucknow Zoo. The occurrence of Dove coccidium in Jungle fowl warns some sort of contamination at the time of examination.

134. *Eimeria columbae* Mitra and Das Gupta

(Fig. 113)

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

Description : Oocyst subspherical, thick-walled, the outer being thinner and membranous. Oocyst measures 14.5-17.5 μm in length with a mean of 16.5 μm and 13.5-15.5 μm in width with a mean of

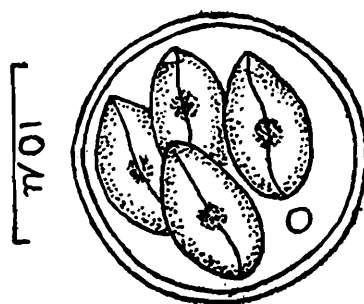


Fig. 113. Mature oocyst of *Eimeria columbae*.

14.5 μm . The shape index is 1.14. Micropyle, absent, oocystic residuum present. Sporocyst ellipsoidal, without any knob, it measures 6.5-8.5 μm in length with a mean of 7.3 μm and 3.5-5.8 μm in width with a mean of 4.6 μm . The shape index is 1.6. Sporocystic residuum

is present as scattered mass. Sporozoites are curved each with one pointed end and the other end rounded.

Sporulation time : 3-4 days.

Type host : Domestic Pigeon, *Columba intermedia* (= *Columba livia intermedia* Strickle (= *Columba* sp.).

Other hosts : From the Type host, Patnaik and Ray (1966).

Distribution : Bhubaneswar, Orissa ; Calcutta, West Bengal.

Endogenous stages : Early schizont measuring $2\ \mu\text{m}$ in diameter is round in shape and found in the intestinal epithelium. The mature schizont measures $4.1\ \mu\text{m}$ in diameter produces eight merozoites. Each merozoite measures $4.2\ \mu\text{m}$ in length and $1.8\ \mu\text{m}$ in width. Macrogametocyte measures $6.1\ \mu\text{m}$ in diameter and fully formed microgametocyte measures $10.3\ \mu\text{m}$ with biflagellated microgametes each measuring $4\ \mu\text{m}$ by $1\ \mu\text{m}$ around the central residual mass.

Types : Not known.

Remarks : A funnel-shaped area is found inside the macrogamete which recedes towards the periphery during fertilization, Das Gupta (1938d). Patnaik and Ray (1966) reported this species from Orissa for the first time.

135. *Eimeria columbarum* Nieschulz

(Fig. 114)

1935. *Eimeria columbarum* Nieschulz, Zentbl. Bakt. I. Abt. Orig., 13 : 390.

Description : Oocyst spherical/subspherical measures $19-24\ \mu\text{m}$ by $18-19\ \mu\text{m}$ with a mean of 20 by $18\ \mu\text{m}$. The double contoured oocystic wall, the outer being thinner than the thick inner one.

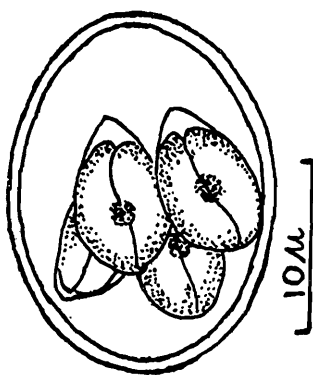


Fig. 114. Mature oocyst of *Eimeria columbarum*,

Micropyle and oocystic residuum absent. The polar granules are sometimes present. The sporocyst tapering at one end, measuring 8-11 μm by 5-6 μm .

Type host : Rock dove, *Columba livia livia*.

Other hosts : Domestic pigeon, *Columba livia intermedia* (= *Columba* sp.), Patnaik and Ray (1966b).

Distribution : Bhubaneswar, Orissa.

Endogenous stages : Unknown.

Types : Not known.

136. *Eimeria coturnicis* Chakravarty and Kar

(Fig. 115)

1947. *Eimeria coturnicis* Chakravarty and Kar, *Proc. R. Soc. Edinb.*, 62 (B) : 225.

Description : Oocyst oval, provided with double envelop. It measures 26.5-38.5 μm in length with a mean of 31.5 μm and 19.4-26.4 μm in width with a mean of 22.8 μm . The shape index

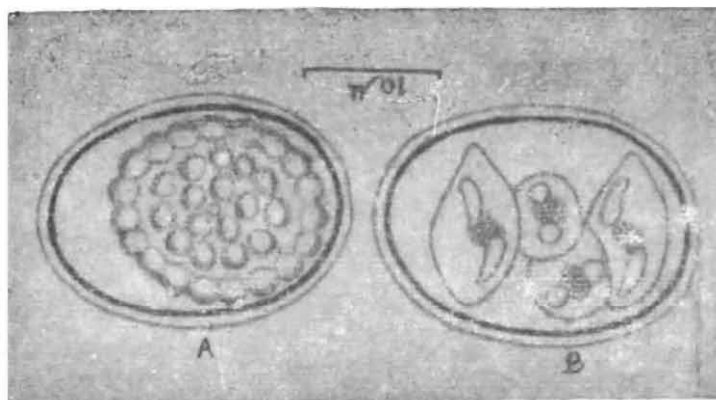


Fig. 115. A, immature and B, mature oocyst of *Eimeria coturnicis*.

is 1.3. The cytoplasm, spherical and completely filled up the oocyst. It is provided with refractile globules. Micropyle and oocystic residuum absent. The sporocyst pyriform and the anterior pointed end is provided with a knob. It measures 13.4-17.4 μm in length with a mean of 15.4 μm and 8.5-11.5 μm in width with a mean of 9.5 μm . The shape index is 1.6. The sporocystic residuum is present as a compact mass. The sporozoites are spherical or slightly oval in shape.

Sporulation time : 60-72 hours.

Type host : Common Quail, *Coturnix c. coturnix* (Linn.)

Other hosts : Unknown.

Distribution : Calcutta market, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

137. *Eimeria dauki* Bhatia and Pande

(Fig. 116)

1965. *Eimeria dauki* Bhatia and Pande, *Indian J. Microbiol.*, 5:: 65.

Description : Oocyst ovoidal, knob at narrow micropylar end and provided with double wall. It measures 14-20 μm in length with a

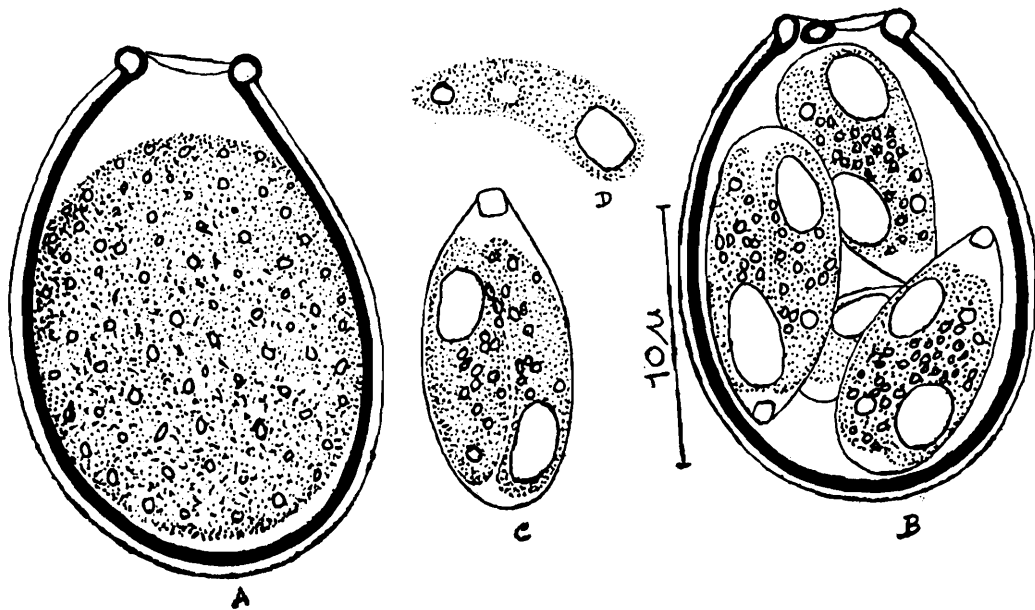


Fig. 116. A, immature B, mature oocysts and C, sporocyst and D, sporozoite of *Eimeria dauki*.

mean of 17.8 μm and 11-13.5 μm in width with a mean of 12.5 μm . The shape index is 1.4. Oocystic residuum absent. Sporocyst elongated with narrow anterior end. It measures 10.5-12.5 μm in length with a mean of 10.5 μm and 5.5-7.8 μm in width with a mean of 5.8 μm . Steida body prominent plug-like, sporocytic residuum present as dark granules. Sporozoites elongated, each measuring 8.5 μm in length and 2.5 μm in width. Nucleus is situated at the middle.

Sporulation time : 24-30 hours.

Type host : White-breasted Waterhen, *Amaurornis phoenicurus* (Pannant).

Other hosts : From the type host, Mandal (1976).

Distribution : Mathura, Uttar Pradesh ; Barasat, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

138. *Eimeria dispersa* Tyzzer

(Fig. 117)

1929. *Eimeria dispersa* Tyzzer, *Am. J. Hyg.*, 10 : 269.

Description : The oocyst is broadly oval in shape. In many cases it shows a double-contoured and in some there is only one dark wall.

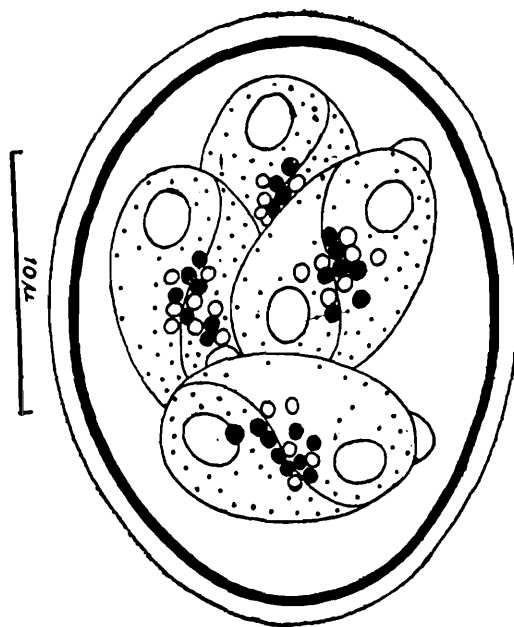


Fig. 117. Mature oocyst of *Eimeria dispersa*.

It measures 17.6-26.4 μm in length and 15.4-22.4 μm in width with a mean of 22.7 μm by 18.8 μm . The sporont fills the greater part of the oocyst. Steida body present on the sporocyst. There is no evidence of an outer residual body. Sporocystic residual bodies represented by some coarse granules.

Sporulation time : 45 hours.

Dimension of the oocysts reported by other authors are as follows :

23 by 19 μm (from Quail) and 18-26 by 15-22 μm (from Pheasant) (Tyzzer, 1929) ; 22-23 μm by 18-24 μm with a mean 26 by 21 μm (Hawkins, 1952).

Type host : Bobwhite (Quail), *Colinus virginianus virginianus*.

Other hosts : (i) Common Quail, *Coturnix coturnix coturnix* (Linn.) (ii) Domestic fowl, *Gallus* sp. (iii) Mexican Turkey, *Meliagris mexicana* Linnaeus, Chinese Ring necked Pheasant, *Phasianus colchicus torquatus* Gmelin (iv) Common Ring necked Pheasant, *Phasianus c. colchicus* Linnaeus (v) Hazel hen, *Tetrastes bonasia* Linnaeus (vi) Domestic Turkey, *Meleagris gallopavo gallopavo* Linnaeus (= *Meleagris* sp.).

Distribution : Orissa.

Endogenous stages : The development takes place in the epithelial cells of the anterior part of the small intestine mainly in the apical part of the villi. Schizonts localise in the epithelial cells of the small intestine and are of two types. First one small contains 15 merozoites, each measuring 4-6 μm by 1 μm and the large one possesses 50 merozoites. The gametocytes are found in the duodenum. Macrogametocyte measures 7-8 μm in diameter with a large Karyosome lies inside a parasitophorous vacuole. The macrogamete is 18-20 μm in diameter with cytoplasmic granules at the periphery. The microgametocyte measures 20 μm in diameter each microgamet is provided with double flagella. The prepatent period is 5 days ; in Quail it is 4 days.

Types : Not known.

Remarks : The occurrence of this species in Quail and Turkey with different prepatent periods and at different regions of the intestine are common. Pellerdy (1974) treated this species as *Species inverta*. Patnaik (1963) reported this species from Orissa.

139. *Eimeria dubeyi* Pande, Bhatia, Chauhan and Garg

(Fig. 118)

1970. *Eimeria dubeyi* Pande, Bhatia, Chauhan and Garg, *Indian J. Anim. Hlth.*, 40 : 154.

Distribution : Oocyst egg shaped, of 24-34 μm in length and 19-23 μm in width (mean 31 μm by 21.7 μm) with a length-width ratio of 1.2-1.5 (mean 1.4). Oocystic wall 1.7 μm thick and smooth, with the 1.3 μm thick light greenish-brown outer coat and the 0.4 μm thick dark yellowish-brown inner lining. A large polar granule present. Oocystic

residuum absent. Micropyle and polar cap absent. Sporocyst ellipsoidal, with narrower end of $15.6-19.5\ \mu\text{m}$ by $6.8-9.7\ \mu\text{m}$ in size

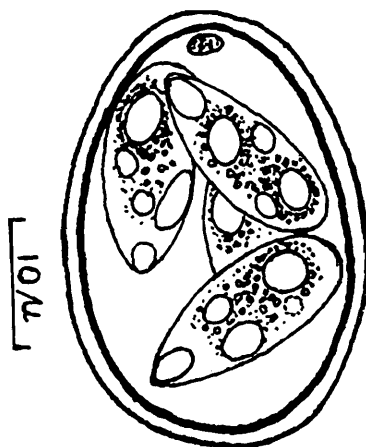


Fig. 118. Mature oocyst of *Eimeria dubeyi*.

(mean $18\ \mu\text{m}$ by $7.6\ \mu\text{m}$). Stieda body present as a prominent plug. Sporocystic residuum dispersed as dark granules. Sporozoite sausage-shaped, of $9.09-9.7\ \mu\text{m}$ by $2.6-3.2\ \mu\text{m}$ in size (mean $9.3\ \mu\text{m}$ by $2.9\ \mu\text{m}$) with two refractile globules, the larger toward the broad end and the smaller near the pointed extremity, and the nucleus lies towards the centre.

Type host : Red jungle fowl, *Gallus gallus* (Linn.)

Other hosts : Unknown.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) mentioned the striking similarity between the oocyst of the present species and of *E. maxima* from domestic fowl and warned the validity of this species. However, at present it is difficult to comment anything until or unless some cross infection experiments are being carried out. Moreover, this species was reported by Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) again from the Zoological Garden, Lucknow with certainty.

140. *Eimeria francolini* Swarup and Chauhan

1976. *Eimeria francolini* Swarup and Chauhan, *Sci. Cult.*, 42 : 166.

Description : Oocysts are ovoid in shape each measuring $18.6-20\ \mu\text{m}$ in length and $16-18.6\ \mu\text{m}$ in width with the mean of

19.7 μm by 17.5 μm . The length-width ratio is 1.07-1.15 ; mean 1.09. The oocystic wall is bilayered, the outer layer is yellowish green and the inner is bluish brown. Micropyle, polar cap and oocystic residuum absent. Sporocysts are ellipsoidal in shape each measuring 12 μm in length and 5.3-6.7 μm in width with a mean of 12 μm by 6.1 μm . Each sporocyst bears a small knob like stieda body. Sporocystic residuum present as a clump of coarse granules. Sporozoites elongated, with one end broad and the other tapering, carrying two refractile globules at either ends.

Type host : Black partridge, *Francolinus francolinus* (Linnaeus).

Other hosts : Unknown.

Distribution : Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Not known.

141. *Eimeria gallinagoi* Mandal

(Fig. 119)

1965. *Eimeria gallinagoi* Mandal, *Proc. zool. Soc. Calcutta*, 18 : 47.

Description : Oocyst pyriform, double walled with uniform thickness and yellowish in colour. It measures 19.8-20.9 μm in length with

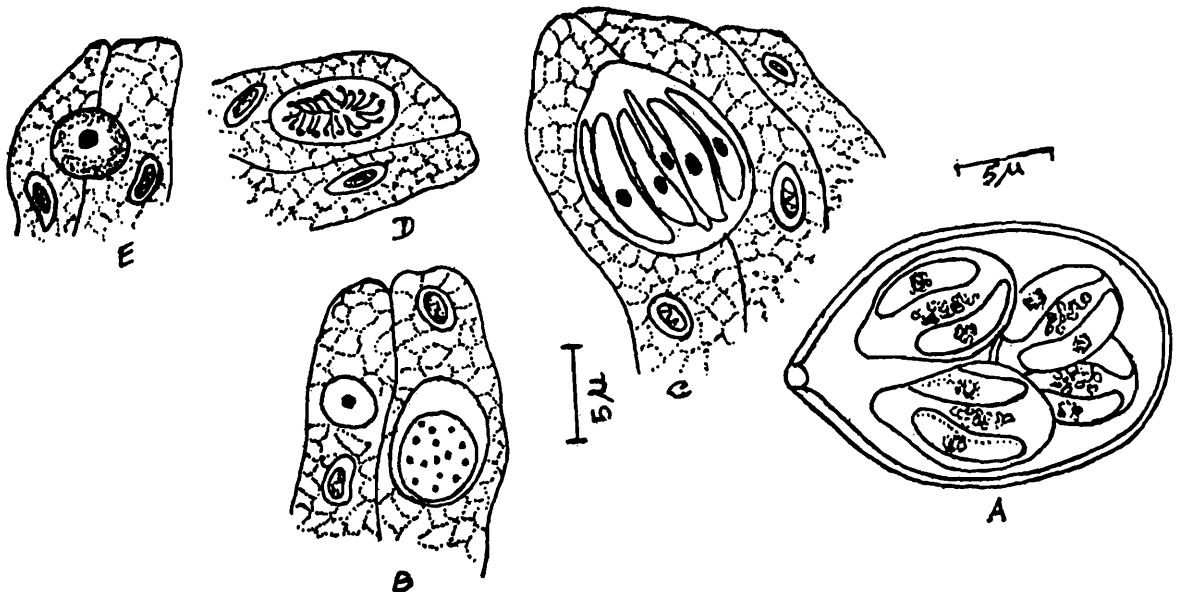


Fig. 119. A, mature oocyst, B, fully developed schizont, C, merozoites, D, microgametes and E, fertilized macrogamete of *Eimeria gallinagoi*.

a mean of 20.2 μm and 13.2-14.3 μm in width with a mean of 13.8 μm .

The shape index is 1.4. Cytoplasm is completely packed up within oocyst and provided with refractile globules. Micropyle present and oocystic residuum absent. Sporocyst pyriform in shape, anterior narrower end is provided with a small knob. It measures 6.7-8.7 μm in length with a mean of 7.7 μm and 4.5-6.5 μm in width with a mean of 5.5 μm . The shape index is 1.4. Sporocystic residuum is present as concentrated mass. Sporozoite measures 5.5 μm in length and 2.5 μm in width.

Type host : Fantail snipe, *Gallinago gallinago* (Linnaeus)

Other hosts : Unknown.

Distribution : Basanti, 24 Parganas, West Bengal.

Endogenous stages : Schizonts are spherical each measuring 5.5 μm in diameter, produce 8-12 nuclei. The fully developed merozoite measuring 8.8 μm in length with a central nucleus. The microgametocytes are subspherical each measuring 12.1 by 7.7 μm , possesses many nuclei. The macrogamete is spherical measuring 5.5 μm in diameter with a centrally placed nucleus.

Types : Present in the collection of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

142. *Eimeria gallopavonis* Hawkins

1952. *Eimeria gallopavonis* Hawkins, *Mich. St. Coll. Tech. Bull.*, 226 : 1.

Description : Oocyst elliptical measures 22.2-32.7 μm in length with a mean of 27.1 μm and 15.2-19.4 μm in width with a mean of 17.2 μm . The oocystic wall, double contoured with a smooth surface and no evidence of any micropyle. No oocystic residual body is formed but with a distinct polar granule. The sporocysts are elongated-ovoid each with one end pointed. The inner residual body represented by scattered granules.

Sporulation time : 24 hours.

Dimension of the oocysts reported by other authors are as follows :

24-35 by 17-23 μm with the mean of 29.5 by 19.3 μm (Golemansky, 1964) 22-33 by 15-19 μm with the mean of 27.1 by 17.2 μm (Pellerdy, 1974).

Type host : Domestic Turkey, *Meleagris gallopavo* Linn.

Other hosts : (i) Indian turkey, *Meleagris* sp. (= *Meleagris* sp.)
(ii) Domestic Turkey, *Meleagris* sp.

Distribution : Lucknow, Izatnagar, Uttar Pradesh.

Endogenous stages : Hawkins (1952) traced two types of schizonts, the first or the small type produces 10-12 relatively large merozoites and the second or the large one developed many merozoites. The former is found within the epithelial cells of the ileal and rectal mucosa and the later one is found supranuclearly in ileal, coecal and rectal epithelial cells. The gametocytes are found in the mucosal epithelial cells of the ileum, caecum and chiefly at the rectum. Farr (1964) reported three schizogonic processes in this species. The first generation schizont measured 25-40 by 28-30 μm and found in the crypts of leiberkuehn, each produced about 40 merozoites each of 8-10 by 1.6 μm size. The second generation schizonts were smaller each measuring 9 μm in diameter produced 8-12 merozoites. The third one also appeared after 144th hour.

Types : Not known.

Remarks : Gill (1954b) and Bhatia (1968a) have reported this parasite from India.

143. *Eimoria gennaeus* Ray and Hiregaudar

1959. *Eimeria gennaeus* Ray and Hiregaudar, *Bull. Calcutta Sch. trop. Med. Hyg.*, 7 : 111.

Distribution : Oocyst subspherical in shape, with thin wall, pale yellowish brown in colour. Endocystic wall thicker than the outer wall. Oocyst measures 21.2 μm in length and 18.3 μm in width and the shape index is 1.16. Sporocyst pear-shaped with a small stieda body and residuum. It measures 7.8 μm by 4.5 μm . Sporozoites are sickle shaped.

Sporulation time : 24-36 hours.

Type host : Kalij Pheasant, *Gennaeus horsfieldi* G. R. Gray (= *Lophura leucomelana* (Latham)).

Other hosts : Unknown.

Distribution : Zoological Garden, Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

144. *Eimeria gorakhpurensis* Bhatia and Pande emend

(Fig. 120)

1967. *Eimeria gorakhpuri* Bhatia and Pande, *Acta vet. hung.*, 17 : 359.

Description : Ellipsoidal or ovoid oocysts have thin and smooth

wall, without a micropylar cap ; each measuring $16-24\ \mu\text{m}$ by $13-17\ \mu\text{m}$ (mean 20 by $14\ \mu\text{m}$) in size. The double-contoured oocystic wall is of $1.3\ \mu\text{m}$ thickness, with a yellowish outer layer and a light violet coloured

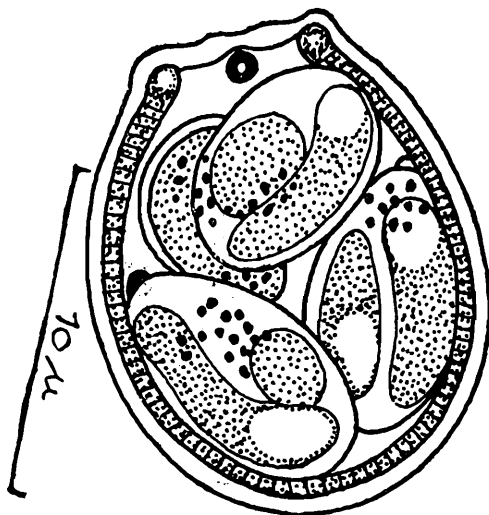


Fig. 120. Mature oocyst of *Eimeria gorakhpurensis*.

inner layer. Oocystic residuum absent. Polar granules aggregated as numerous dark particles of variable size towards one pole. Sporocysts are ovoid, each is provided with a faint stieda-body at the somewhat narrower end, measuring $8-12\ \mu\text{m}$ by $5-7\ \mu\text{m}$ in size (mean $10\ \mu\text{m}$ by $6\ \mu\text{m}$). Sporocystic residuum is granular, scattered among the sporozoites. Sporozoites are nearly comma-shaped, each measuring 6.5 by $2.7\ \mu\text{m}$ in size, on the wider end it is carrying a larger, and on the narrower end a smaller globule. It has finely granular cytoplasm with nearly central small nucleus.

Sporulation time : 48 hours at room temperature.

Type host : Guinea fowl, *Numida meleagris* Linn.

Other hosts : From type host ; Bhatia, Chauhan, Arora and Agarwal (1972, 1973) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

Distribution : Gorakhpur, Mathura, and Zoological Garden, Lucknow, Uttar Pradesh and Zoological Garden, Delhi.

Endogenous stages : The schizont measures $4.5\ \mu\text{m}$ by $3-4\ \mu\text{m}$ in size and produce 2-6 merozoites each measuring $3.3-5\ \mu\text{m}$ by $1\ \mu\text{m}$. Macrogamete measuring $11-15\ \mu\text{m}$ by $8-10\ \mu\text{m}$ with a mean of $12\ \mu\text{m}$ by $9\ \mu\text{m}$. The microgametocyte measures $7-9\ \mu\text{m}$ by $5-9\ \mu\text{m}$ with a mean of $8\ \mu\text{m}$ by $7\ \mu\text{m}$. The microgametes are slightly bent each measuring $1.3\ \mu\text{m}$ in length, arranged along the periphery. All the stages

are found in the entire length of the intestine but majority are found in the tubular portion of the caecum as stated by the authors.

Types : Not known.

145. *Eimeria grusi* Pande, Bhatia, Chauhan and Garg
(Fig. 121)

1970. *Eimeria grusi* Pande, Bhatia, Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Description : Oocysts are ellipsoidal in shape, each measuring 17-26 μm in length with a mean of 22.2 μm and 13-19 μm in width

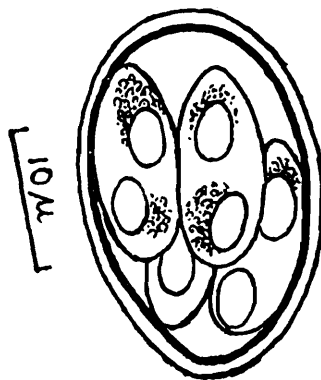


Fig. 121. Mature oocysts of *Eimeria grusi*.

with a mean of 16.5 μm . The length width ratio is 1.2-1.6 (mean 1.3). Oocystic wall 1.3 μm thick, smooth, double-contoured, with the outer layer yellowish green and the inner dark brown in colour. One or two polar granules present. Oocystic residuum, micropyle and polar cap absent. Sporocyst ellipsoidal measuring 10-15 μm in length with a mean of 13.8 μm and 5-7 μm in width with a mean of 6.0 μm , slightly narrower and capped by a dark stieda body. Sporocystic residuum present mostly in clumps of dark granules. Sporozoite measures 11 μm in length and 3.5 μm in width with one end broader and the other pointed, the former carrying a large refractile globule with a centrally placed nucleus.

Type host : Sarus crane (Demoiselle Crane), *Anthropodites vergo* (Linn.).

Other hosts : From the Type host, Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) has made a comment on the specific name and expressed a desire to change it as 'gruis' instead of 'grusi'. But the name *Eimeria gruis* is preoccupied. Yakimoff and Matschoulsky (1935) described *E. gruis* from crane exhibited at Laningrad zoo. However, the present species is distinct from *E. gruis* and can be named as *Eimeria vergo*, according to the specific name of the host.

146. *Eimeria hagani* Levine

1938. *Eimeria hagani* Levine, *Cornell Vet.*, 28 : 263.

Description : The oocyst dimension is 15.8-20.9 μm in length and 14.3-19.5 μm in width, average 19.1 μm by 17.6 μm . The shape is broadly ovoid, the wall double contoured, with smooth surface. Micropyle absent. Polar granule remains in the mature oocysts after sporulation.

Sporulation time : 24-48 hours.

Type host : Domestic Fowl, *Gallus domesticus* (= *Gallus* sp.)

Other hosts : From the type host, Gill (1954 a) and Patnaik (1963).

Distribution : Mukteswar, Uttar Pradesh ; Orissa ; Madhya Pradesh ; and Bombay, Maharashtra.

Endogenous stages : Little is known about the endogenous stages of this parasites. They are found in the anterior part of the small intestine. The schizonts are found in the epithelium. The prepatent period is 6 days and the patent period is as long as 8 days.

Type host : Chicken, *Gallus* sp.

Remarks : Pellerdy (1974) stated owing to the defficient morphological description of the species, it can only be differentiated with certainty by applying cross-immunity tests and a complete description of the endogenous stages. However, this species is antigenically unique [Edger (1977) cited by Ruff and Reid (1977) in the chapter on on avian coccidia in the *Parasitic Protozoa* edited by Kreier, J. P. 1977]. As regards pathogenicity, some pin point haemorrhages were noted at the mucosa in case of experimental infection.

147. *Eimeria innocua* Moore and Brown

1952. *Eimeria innocua* Moore and Brown, *Cornell Vet.*, 42 : 395.

Description : The oocyst more or less round in shape. The double contoured oocystic wall have a smooth surface. The oocyst measures 18.6-25.9 μm in length and 17.3-24.5 μm in width with a mean of 22.4 μm by 20.9 μm . There is no evidence of polar body in the sporulated oocyst. The sporocyst measures 14.8-16.6 μm in length and 8-9.5 μm in width and possesses a granular residuum. The sporozoite measures 9.8 μm by 3.2 μm in size.

Sporulation time : Within 24-48 hours.

Dimension of the oocysts reported by other authors are as follows :

19-29 by 17-24 μm with a mean of 23.9 by 20.9 μm (Golemansky, 1964) ; 19-26 by 17-24 μm with a mean of 22.4 by 20.9 μm (Pellerdy, 1974).

Type host : Domestic turkey, *Meleagris gallopavo gallopavo* Linn.

Other hosts : From the Type host, Patnaik (1963).

Distribution : Orissa.

Endogenous stages : This coccidium invades the epithelium of the small intestine particularly at the tip of the villi and exceptionally at the crypts (Moore and Brown, 1952). The prepatent period is about 5-6 days and the patent period lasts for 14 days. It is found to be nonpathogenic.

Types : Not known.

148. *Eimeria kapotei* Chatterjee and Ray

1969. *Eimeria kapotei* Chatterjee and Ray, *Pròc. Indian Sci Congr.*, p. 512.

Description : Oocyst oval, measuring 24-30 μm in length with a mean of 26.1 μm and 22-26 μm in width with a mean of 23.5 μm . It contains one or two refractile globules. It is provided with two layers, inner one being thicker. Micropyle present as depression at the anterior pole. Sporocyst ovoid, measures 8.5-9.5 μm , sporocystic residuum present in the form of scattered granules, stieda body present. Sporozoite bean-shaped, measures 5.6 μm in length.

Sporulation time : 3-4 days.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : All that is known about the endogenous stages of this parasite is the schizogony which takes place in the posterior portion of the small intestine. The cluster of endogenous stages are found in patches on the intestinal epithelium.

Types : Not known.

149. *Eimeria labbeana* (Labbe)

(Fig. 122)

1896. *Coccidium pfeifferi* Labbe, *Archs. Zool. exp. gen.*, 4 : 517.

1896. *Eimeria pfeifferi* Labbe, *Archs. Zool. exp. gen.*, 4 : 517.

1904. Wasielewsky, *Studien und Mikrophotogramme zur Kenntniss der Pathogenen Protozoen*. Leipzig, non *Eimeria pfeifferi* (Labbe, 1896) in *Geophilus ferruginosus*.

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

Description : Oocysts are of two forms, oval or spherical, the oval form measures 19.5-21.2 μm in length with a mean of 20.1 μm and 16.5-17.5 μm in width with a mean of 16.9 μm . The shape index is 1.1. The spherical form measures 17.5-18.5 μm with a mean of 17.9 μm . Possesses double envelop, the outer being thinner. The

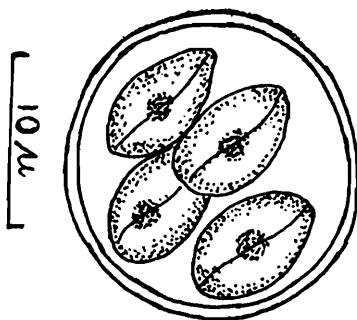


Fig. 122. Mature oocyst of *Eimeria labbeana*.

cytoplasm is refractile with refringent globules. Micropyle present, oocystic residuum absent. Sporocyst oval measuring 11.00-13.5 μm in length with a mean of 12.4 μm and 5.5-6.8 μm in width with a mean of 6.4 μm . The shape index is 1.4. The sporocystic residuum appears as a compact mass. The sporozoites are elongated each measuring 6.5 by 2.3 μm . The nucleus is situated at the middle.

Sporulation time : 24-36 hours, sometimes upto 50 hours.

Type host : Domestic pigeon, *Columba livia intermedia* Strickl (= *Columba* sp.)

Other hosts : (i) Ring necked Dove, *Streptopelia orientalis*
(ii) Domestic pigeon, *Columba domestica* (= *Columba* sp.), Srivastava (1966 b, c, 1967) and Patnaik and Ray 1966b).

Distribution : Calcutta, West Bengal.

Endogenous stages : The detail life history can be had from Srivastava (1966a), after the description of Chakravarty and Kar (1944). Two types of schizonts are found in the first generation, one measuring $6.7\ \mu\text{m}$ in diameter produces 15 small morozoites and the other measures $15.8\ \mu\text{m}$ in diameter which gives rise to 15 large merozoites. The merozoite of the former measures $6.7\ \mu\text{m}$ by $1\ \mu\text{m}$ with a compact nucleus and the later measures 11.3 by $1\ \mu\text{m}$. The second generation schizonts are also of two types, the smaller type (5.6 by $4.5\ \mu\text{m}$) giving rise to 10-15 morozoites each measuring $4.5\ \mu\text{m}$ by $2.3\ \mu\text{m}$ and the large type ($7.12\ \mu\text{m}$ by $4.8\ \mu\text{m}$) produces 20-30 large merozoites each measuring $6.8\ \mu\text{m}$ by $2\ \mu\text{m}$. The third generation schizonts are also of two types. Immature and mature microgametocytes are also found in the preparation and are of multinucleate in nature. The nuclei are arranged in a row with a central residuum. The microgamete is provided with double flagella, measuring 4.5 to $10\ \mu\text{m}$. The macrogametocytes are small each measuring 3.4 - $15.8\ \mu\text{m}$ by 2.3 - $12.2\ \mu\text{m}$ in size with a basophilic and distinctly vacuolar cytoplasm and a nucleus with prominent Karyosome. The fertilized zygote is provided with large cytoplasmic granules proceeding towards the periphery.

Types : Not known.

150. *Eimeria lophurae* Chauhan, Paliwal and Swarup

1976. *Eimeria lophurae* Chauhan, Paliwal and Swarup, *Curr. Sci.*, 45 : 591.

Description : Oocysts are ellipsoid in shape each measuring 20 - $24\ \mu\text{m}$ in length with a mean of $21.8\ \mu\text{m}$ and 14.6 - $17.3\ \mu\text{m}$ in width with a mean of $16.11\ \mu\text{m}$. Bilayered oocystic wall is $1.3\ \mu\text{m}$ thick and the outer wall is yellowish green while the inner one bluish-brown. The length width ratio is 1.23 - 1.50 with a mean of 1.35 . Oocystic residuum absent. An ovoid dark polar granule present. Sporocysts are ellipsoidal in shape each measuring 10.7 - $12\ \mu\text{m}$ in length with a mean of $11.4\ \mu\text{m}$ and 5.3 - $6.7\ \mu\text{m}$ in width with a mean of $6.3\ \mu\text{m}$. The anterior end of sporocyst is narrower than the posterior one. A small knob like stieda body is present at the anterior end of sporocyst. Sporocystic residuum present as dark scattered granules. Sporozoite elongated with one end broad and rounded and the other tapering, having two dissimilar refractile globules.

Sporulation time : Unknown.

Endogenous stages : Unknown.

Type host : Kaliz pheasant, *Lophura leucomelana* (Latham).

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Type host : Not known.

Remarks : Bhatia et al. (1973) traced one *Eimeria* sp. from the Kaliz pheasant at Delhi zoo, but did not describe it.

151. *Eimeria lucknowensis* Misra

1947. *Eimeria lucknowensis* Misra, *Proc. Indian Acad. Sci.*, 25 (B) : 75.

Description : Oocyst ovoid in shape and comes out as unsegmented condition in the faeces. Cyst wall colourless and double layered. Both ends of the oocyst are similar and rounded and there is no indication of a flatter and prolongation at either end. Oocystic residuum absent. Oocyst measures 21.4-24.5 μm by 17.4-18.8 μm in size. Sporocyst ovoid and devoids of any thickening at either pole. It measures 8.5 μm by 6.0 μm . Sporozoites are curved and club-shaped. It measures 7.6 μm in length and arranged with the concavity facing the sporocystic residuum.

Sporulation time : 3 to 4 days.

Type host : White Wagtail, *Motacilla alba* Linn.

Other hosts : From the type host, Mandal (1976).

Distribution : Lucknow, Uttar Pradesh and Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The specific name is misspelt as '*lacknowensis*' instead of '*lucknowensis*' vide Pellerdy, 1956a.

152. *Eimeria malaccae* Chakravarty and Kar

(Fig. 123)

1944. *Eimeria malaccae* Chakravarty and Kar, *Proc. Indian Acad. Sci.*, 20(B) : 102.

Description : Oocyst broadly oval, measuring 26.5 μm -30.5 μm in length with a mean of 28.5 μm and 16.5-18.5 μm in width with a mean

of $17.5\ \mu\text{m}$. The shape index is 1.6. Oocyst possesses double wall, outer being thinner. Cytoplasm is rounded and appears like refractile



Fig. 123. A, immature (round) and B, mature (oval) oocysts of *Eimeria malacca*.

globules. Micropyle present, oocystic residuum absent. Sporocyst oval, anterior end pointed and provided with a small knob. Sporocyst measures $11.5-13.5\ \mu\text{m}$ in length with a mean of $12.5\ \mu\text{m}$ and $9.5-11.5\ \mu\text{m}$ in width with a mean of $10.5\ \mu\text{m}$. The shape index is 1.1. Sporocystic residuum coarsely granular. Sporozoite measures $8.5\ \mu\text{m}$ by $2.3\ \mu\text{m}$ with tapering anterior end. Nucleus is situated near the posterior end.

Sporulation time : 48-70 hours.

Type host : Black headed Munia, *Munia (Lonchura) malacca malacca* Linn.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

153. *Eimeria mandali* Banik and Ray

1964. *Eimeria mandali* Banik and Ray, *Bull. Calcutta Sch. trop. Med. Hyg.*, 12 : 27.

Description : Oocyst round, possesses double envelop. It measures $14.5-20.6\ \mu\text{m}$ in length with a mean of $17.6\ \mu\text{m}$ and $14.2-18.8\ \mu\text{m}$ width with a mean of $16.5\ \mu\text{m}$. The shape index is 1 : 1. Cytoplasm centrally placed, granular. Micropyle present with a refractile granule below. Oocystic residuum present. Sporocyst pyriform measures $6.5-12.0\ \mu\text{m}$ in length and $4.5\ \mu\text{m}$ in width. The sporocystic

residual mass is present at the centre. Sporozoite banana-shaped, measuring $6.5\ \mu\text{m}$ in length and $2.5\ \mu\text{m}$ at broadest region.

Sporulation time : 24-72 hours

Type host : Common Pea Fowl, *Pavo cristatus* Linnaeus.

Other hosts : From the type host ; Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

Distribution : Zoological Gardens, Calcutta, West Bengal and Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

154. *Eimeria maxima* Tyzzer

(Fig. 124)

1929. *Eimeria maxima* Tyzzer, *Am. J. Hyg.*, 10 : 269.

Description : The sporulated oocyst ovoid, egg shaped or ellipsoidal, measuring $27-34\ \mu\text{m}$ by $16-28\ \mu\text{m}$ (mean $31\ \mu\text{m}$ by $23\ \mu\text{m}$) in size, with the light yellowish-brown and occasionally rough oocystic wall of $1.3\ \mu\text{m}$ in thickness. A polar granule present but oocystic residuum absent. The

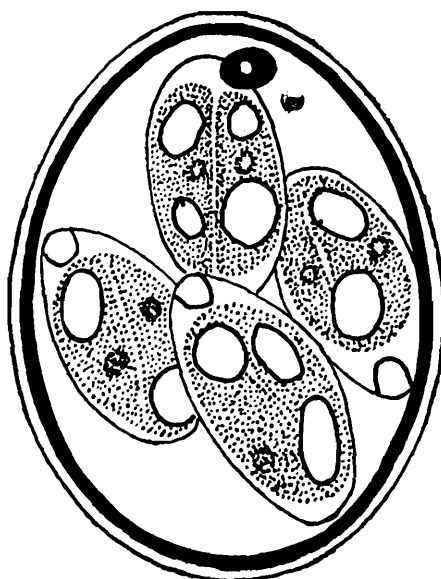


Fig. 124. Mature oocyst of *Eimeria maxima*.

ovoid sporocyst, with slightly narrower extremities, is $15-20\ \mu\text{m}$ by $8-9\ \mu\text{m}$ (mean $17\ \mu\text{m}$ by $9\ \mu\text{m}$) in size. A prominent 'Stieda' body present. The elongated sporozoite of $15\ \mu\text{m}$ by $4\ \mu\text{m}$ in size. It is provided with a large refractile globule on the broader, and a smaller globule towards the narrower end.

Sporulation time : 48 hours.

Dimension of the oocysts by other authors are as follows :

26-49 by 22-31 μm (Kotlan, 1961) ; with an average 31 by 23 μm (Long, 1959) ; 25-42 by 21-27 μm with the mean of 33.7 by 24 μm (Tecla, 1967) ; 30-33 by 22-26 μm (Soltys, 1966) ; 21-42 by 16-30 μm with a mean of 29.3 by 22.6 μm (Pellerdy, 1974).

Type host : Domestic Fowl, *Gallus* sp.

Other host : From the type host ; Ray (1945b), Gill (1954a), Patnaik (1963), Bhatia and Pande (1968c), Rahman and Ananthraman (1970) and Chandra and Chhabra (1972).

Distribution : Madhya Pradesh ; Bombay, Maharashtra ; Orissa ; Mathura, Uttar Pradesh ; Madras, Tamil Nadu.

Endogenous stages : The endogenous stages are found along the entire length of the small intestine, but more towards the anterior part. Tyzzer (1929) studied the life-cycle in detail. Schizont measures 10 μm by 8 μm is found at the tip of the villi, develops above the nuclei of the epithelial cells, and on maturation produce 8-16 merozoites. It is very likely that there is only one schizogonic generation. The microgametocyte has a granular cytoplasm measuring 34 μm by 22 μm produces many microgametes each measuring 4.5-12.0 μm in length. The macrogametes have granular cytoplasm each measuring 22.27 by 16-18 μm with a vesicular nucleus and large karyosome. The prepatent period is about 5 days. This species may cause severe pathological changes. The haemorrhagic enteritis associated with a thickening of the intestinal wall is frequently marked. Further details about the life cycle can be had from Scholtyseck, 1963, Challey and Johnson, 1968, Backer et al. 1956, Long, 1959 and Pellerdy, 1960.

Types : Not known.

155. *Eimeria mayuri* Bhatia and Pande

(Fig. 125)

1966. *Eimeria mayuri* Bhatia and Pande, *Proc. natn. Acad. Sci. India*, 36 (B) : 39.

Description : Oocyst smooth, ellipsoidal, 20-27 μm by 13-16 μm (mean 23 μm by 14 μm), with length-width ratio of 1.4-1.8 (mean 1.6). Sporont nearly filling the oocyst, with a centrally placed vesicular nucleus. Oocystic wall 1.2 μm thick, double-layered, with outer layer

light blue and inner brownish. Micropyle indistinct. Micropylar cap absent. Oocystic residuum absent. Sporulation completed in two days. One polar granule present. Sporocyst elongate-ovoid, with a somewhat narrower anterior extremity capped by a small stieda body,

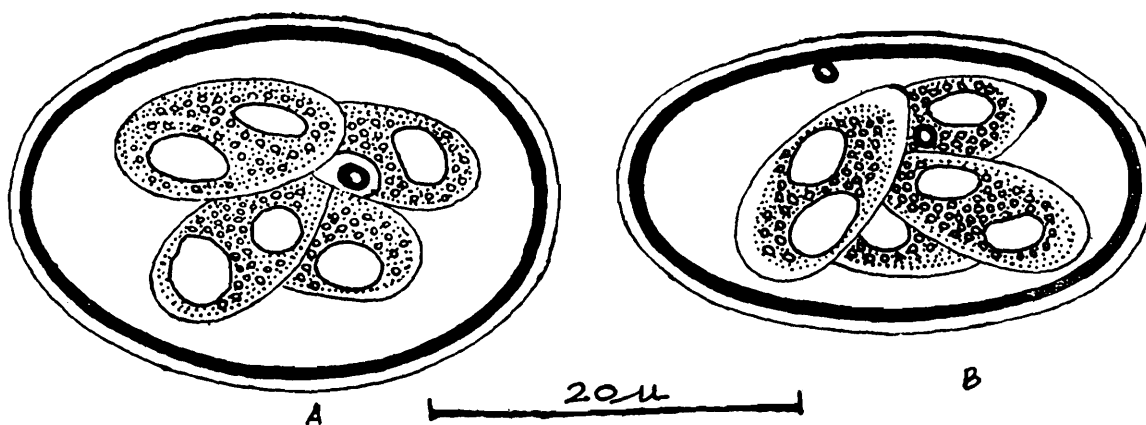


Fig. 125. A and B, mature oocysts of *Eimeria mayuri*.

measuring 10-13 μm by 5-7 μm (mean 12 μm) by 6 μm , with length-width ratio of 1.7-2.6 (mean 2.0). Sporocystic residuum present as diffuse dark granules. Sporozoite elongate, lying head to tail inside sporocyst, of 9-11 μm by 3-4 μm (mean 10 μm by 3.6 μm) in size with one large globule towards the broader end, and a small globule visible sometimes towards the narrower extremity. Cytoplasm includes dark granules.

Type host : Common Peafowl, *Pavo cristatus* (Linn.).

Other hosts : From the type host and Burmese peafowl, *Pavo muticus* (Linn.), Bhatia and Pande (1968d), Bhatia, Chauhan, Arora and Agarwal (1972, 1973) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

Distribution : Mathura, Zoological Garden, Lucknow, Uttar Pradesh and Zoological Garden, Delhi.

Endogenous stages : The mature schizont measures 9-15 μm by 6-10 μm average 11 μm by 9 μm . The merozoites are elongated each measuring 6 by 1.25 μm with central nucleus. The microgametocyte measures 9-17 μm by 9-15 μm in size with a central residuum. Macrogamete measures 14-23 μm by 10-14 μm (average 18.5 μm by 12.5 μm) with plastic granules and a large nucleus.

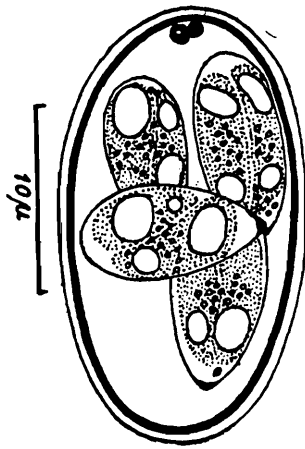
Types : Not known.

156. *Eimeria meleagridis* Tyzzer

(Fig. 126)

1927. *Eimeria meleagridis* Tyzzer, *J. Parasit.*, 13 : 215.

Description : Oocyst ellipsoidal, measuring 19—29.7 μm in length with a mean of 23.8 μm and 14.5-23.0 μm in width with a mean of 17.3 μm . It is provided with a smooth wall with one or more polar

Fig. 126. Mature oocyst of *Eimeria meleagridis*.

granules and without any oocystic residuum. The sporocyst reveals a stieda body at its tapering end with granular residual mass.

Dimension of the oocysts reported by other authors are as follows :

20-31 by 15-21 μm with a mean of 24.4 by 18.1 μm (Hawkins, 1952), 22 by 16 μm (Clarkson, 1959a), 18-31 by 12-19 μm with a mean of 23.7 by 16.8 μm (Golemansky, 1962), 19-30 by 14-23 μm with a mean of 23.8 by 17.3 μm (Pellerdy, 1974).

Type host : Domestic Turkey, *Meleagris gallopavo* (Linn.) (= *Meleagris* sp.).

Other hosts : Mexican Turkey, *Meleagris mexicana* Gould.

Distribution : Mukteswar, Zoological Garden, Lucknow, Mathura, Uttar Pradesh and Zoological Garden, Delhi.

Endogenous stages : The endogenous development takes place in the caeca (Tyzzer, 1927) and small intestine. Morehouse (1949) encountered the endogenous stages in the terminal portion of the small intestine. Hawkins (1952) found them in the caecal epithelium after 9th hour from the time of inoculation. Clarkson (1959a) reported first generation schizont in jejunum. Mature first generation schizont

measures 20 μm by 15 μm produce 50-100 merozoites, each measuring 7 μm by 1.5 μm in size. The second generation schizont produces 10 to 14 merozoites each measuring 10 μm by 2 μm with central residuum. The macrogametocyte measures 8—10 μm in diameter when matures become 20 μm with a large nucleus and granular cytoplasm. It lies below the host cell nucleus along with the microgametocyte. The prepatent period is about 5 days. It is found to be nonpathogenic.

Types : Not known.

Remarks : However, Pande *et. al.* (1970) came across the oocysts from Amherst pheasant at Lucknow Zoological Garden, Uttar Pradesh and described as 'Oocyst' ovoidal (50 measured), 22-27 μm by 17-20 μm in size (mean 23.6 μm by 18.0 μm), with a length-width ratio of 1.2-1.4 (mean 1.26). Oocystic wall 1.5 μm thick, smooth, double-contoured, the outer being yellowish green and the inner dark brown in colour. A micropyle and polar cap absent. One or 2 polar granules present. Oocystic residuum absent. Sporocyst elongate-ellipsoidal, of 12-14 μm by 5.5-7 μm in size (mean 13.0 μm by 6.5 μm). Stieda body present as a small dark knob. Sporocystic residuum present as scattered granules. Sporozoite elongated, with one end broadly rounded and the other somewhat narrower, a large globule lying towards the broader end and a small near the pointed end, with centrally placed nucleus. In Turkey coccidia, the differences in the exogenous developmental stages are extremely poor particularly among the *E. adenoides*, *E. meleagridis* and *E. meleagritidis* as stated by Clarkson (1960). The report on the occurrence and other details of this species may be had from Gill (1954b), Bhatia (1968a) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

157. *Eimeria meleagritidis* Tyzzer

(Fig. 127)

1929. *Eimeria meleagritidis* Tyzzer, *Am. J. Hyg.*, 10 : 269.

Description : The oocyst measures 15-21 μm by 12-17 μm (mean 18.5 μm by 15.6 μm , from 30 oocysts) and with a length/width ratio of 1.08-1.38 (mean 1.19), were somewhat sub-spherical or broadly oval, with a smooth double wall. The 1 μm thick oocystic wall had the outer layer of yellowish-green and the inner with a dark blue colour. Micropyle and oocystic residuum absent. One or two polar granules present. The ovoid sporocyst measures 8-12 μm by 5.3-6.0 μm (mean

9.6 μm by 5.4 μm) in size. Stieda body present, sporocystic residuum present as scattered granules tending to clump towards the middle.

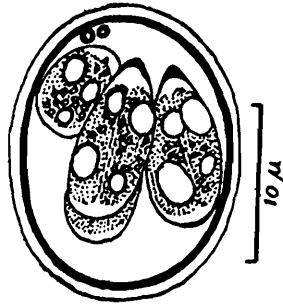


Fig. 127. Mature oocyst of *Eimeria meleagritidis*.

Sporozoite banana-shaped, with narrower but rounded extremities, having two refractile globules, the larger at the broader end, the the smaller towards the tapering extremity and a small nucleus lying between the two-more towards the middle.

Sporulation time : 48 hours.

Dimension of the oocysts reported by other authors are as follows :

16-20 by 13-17 μm with a mean of 18.1 by 15.3 μm (Tyzzer, 1929),
16-27 by 13-22 μm with a mean of 19.2 by 10.3 μm (Hawkins, 1952),
16-25 by 13-19 μm with a mean of 20.1 by 17.3 μm (Clarkson, 1959b) ;
15-20 by 13-19 μm with a mean of 17.8 by 16.4 μm (Golemansky, 1962).

Type host : Domestic Turkey, *Meleagris gallopavo* (Linn.).

Other hosts : From the type host.

Distribution : Lucknow, Izatnagar, Uttar Pradesh and Orissa.

Endogenous stages : The development takes place mainly in the upper part of the small intestine (Hawkins, 1952 ; Clarkson, 1959b). The trophozoites measures 2-3 μm in diameter from which the first generation schizont appears. Schizont measures 8 by 7 μm and the mature one produces 9-10 μm merozoites each merozoite measures 4-6 μm by 1.5 μm . The second generation schizont produces 10-12 merozoites and each merozoite measuring 5-6 μm by 1.2 μm . The microgametocyte has many nuclei produces many slender microgametes with a centrally large residuum. Horton-Simth and Long (1961) traced

the 3rd generation schizont. The prepatent period is about 114-118 hours (Clarkson, 1959b).

Fayer (1969) observed some posterior eosinophilic granules and smaller granules at the anterior region of inoculated sporozoites in the cell culture after 12th hours from the time of inoculation and concluded that those granules aggregated in the gland and first generation schizont develops which measuring $8\ \mu\text{m}$ by $7\ \mu\text{m}$. Nine to ten merozoites are developed each measuring $4\text{-}6\ \mu\text{m}$ by $1.5\ \mu\text{m}$ in size. Doran and Vetterling (1968) studied the schizogony in the turkey intestinal cells and bovine kidney cell cultures. The early stage was detected in 48 hours in turkey intestinal cells and after 5 hours in the bovine kidney cell cultures.

Mostly pathogenic. Duodenal enlargement along with haemorrhage in other parts of the intestine were observed.

Types : Not known.

Remarks : Bhatia (1968a) obtained a species and stated that the size-range and the sporulation time of the oocysts confirmed to the description of *E. meleagridis*, Tyzzer. The sizes approximate to those given by the describer as $16.2\text{-}20.5\ \mu\text{m}$ by $13.2\text{-}17.2\ \mu\text{m}$ average $18.1\ \mu\text{m}$ by $15.3\ \mu\text{m}$. The sporozoite, however, revealed, in addition to a colourless globule at the larger end, another smaller globule towards the tapering end. In spite of this minor variation, the oocystic material is identified as *E. meleagridis* by the author. This species has also been reported by Gill (1954b) and Patnaik (1963) earlier.

158. *Eimeria mitis* Tyzzer (Fig. 128)

1929. *Eimeria mitis* Tyzzer, *Am. J. Hyg.*, 10 : 169.

Description : The oocysts are yellowish tinged, smooth walled and almost spherical in shape. The oocystic size-range varies from



Fig. 128. Mature oocyst of *Eimeria mitis*.

$12.3\text{-}20.7\ \mu\text{m}$ in length and $10.7\text{-}19.2\ \mu\text{m}$ in width with a mean of $17.0\ \mu\text{m}$ by $15\ \mu\text{m}$ and the shape index varies from 1.0-1.3 with a

mean of 1.1. Polar granules present in the sporulated oocyst but without any oocystic residuum. Micropyle absent. Sporocyst 4 in number, ovoid in shape, each measuring 9-10.00 μm by 6.5 μm in (average) size. The stieda body is prominent ; sporocystic residuum granular and placed centrally.

Sporulation time : 48 hours.

Dimension of the oocysts reported by other authors are as follows :

11-21 μm by 10-18 μm with a mean of 10.6 μm by 13.8 μm (Joyner, 1958) ; 10-21 μm by 9-18 μm with a mean of 16 μm by 13 μm (Levine, 1961) ; 11-19 μm by 10-17 μm (Pellerdy, 1974).

Type host : Domestic Fowl, (*Gallus domestica* (= *Gallus* sp.).

Other hosts : From the type host, Ray (1945b) Gill (1954a), Patnaik (1963), Rahaman and Anantaraman (1970) and Chandra and Chhabra (1972).

Distribution : Madhya Pradesh ; Bombay, Maharastra ; Mukteswar, Uttar Pradesh ; Orissa and Tamil Nadu.

Endogenous stages : The development takes place in the anterior portion of the small intestine within the epithelial cells (Tyzzer, 1929, Joyner, 1958). The schizonts are found in the anterior portion of the small intestine. Each of them produces 6-24 or more bent merozoites each measuring 5 μm or 6 μm in length. The gametocytes develop more towards the posterior. The microgametocytes are subspherical each measuring 9-14 μm in diameter. A residuum is left after producing many microgametes. The macrogametes are larger and contain plastic granules. The prepatent period lasts about 4-5 days (Joyner, 1958). Previously it was treated as nonpathogenic but recent studies proved that severe mortality occurred in young chicks due this species (Pellerdy, 1974).

Types : Not known.

159. *Eimeria mivati* Edger and Seibold

(Fig. 129)

1964. *Eimeria mivati* Edgar and Seibold, *J. Parasit.*, 50 : 193.

Description : The oocysts are ellipsoidal to ovoid in shape, each measuring 10.7-20.0 μm in length and 10.1-15.3 μm in width with a mean of 15.6 μm by 13.4 μm . The shape index ranges from 1.0 to 1.3. The oocyst wall consists of three layers (viz. exo., middle and endo membranes). Micropyle is always present. Each sporulated oocyst

possesses 4 sporocysts and a refractile polar granule approximately $1\ \mu\text{m}$ in diameter. Each sporocyst possesses a residual mass approximately $2\text{-}3\ \mu\text{m}$ in diameter. Stieda body remains at the end of the



Fig. 129. Oocyst of *Elmeria mivati*.

thin walled sporocyst. The sporocyst measures $7.3\text{-}12.1\ \mu\text{m}$ by $5.0\text{-}6.1\ \mu\text{m}$ with an average of 10.5 by $5.6\ \mu\text{m}$. Each sporulated oocyst contains two sporozoites in each of 4 sporocysts. The sporozoites are crescent or banana-shaped each with pointed anterior and blunt posterior ends, measuring $11.1\text{-}13.0\ \mu\text{m}$ by $1.9\text{-}2.5\ \mu\text{m}$ with an average of $11.7\ \mu\text{m}$ by $2.1\ \mu\text{m}$ and possesses a large eosinophilic globule located posteriorly and an almost spherical nucleus slightly anterior to the centre.

Sporulation time : 12 hours or more.

Type host : Domestic Fowl, *Gallus domesticus* (= *Gallus* sp.)

Other hosts : From the type host, Gill and Grewal (1974).

Distribution : Izatnagar, Uttar Pradesh.

Endogenous stages : The development occurs along the entire length of the small intestine mainly at the duodenal loop towards the ileum and in rectal caeca. The first generation mature schizont measures $9\text{-}11.7\ \mu\text{m}$ by $9\text{-}11.1\ \mu\text{m}$, produces 10-30 merozoites each measuring $8.6\text{-}10.6\ \mu\text{m}$ by $2.1\text{-}3\ \mu\text{m}$ in size. The second generation schizont measuring $4.8\text{-}10.9\ \mu\text{m}$ by $3.9\text{-}7.5\ \mu\text{m}$, produces 16-20 merozoites each measuring $5.6\text{-}8.8\ \mu\text{m}$ long with a residuum inside, measuring $7\text{-}8\ \mu\text{m}$ in diameter. The third generation schizont measures $5.8\text{-}7.7\ \mu\text{m}$ by $4.5\text{-}6.7\ \mu\text{m}$ in size produces 14 merozoites each measuring $5.6\text{-}6.7$ by $1.1\text{-}3\ \mu\text{m}$ encircling a residuum of $5\text{-}6\ \mu\text{m}$ in diameter. The fourth generation schizont measures $9.6\text{-}17.3\ \mu\text{m}$ by $9.6\text{-}13.4\ \mu\text{m}$ and produce 16-20 merozoites each measuring $7.5\text{-}9.6$ by $0.8\text{-}1.5\ \mu\text{m}$ in size with a residuum of $10\text{-}11\ \mu\text{m}$ in diameter. The macrogametes are of almost the size of the oocysts. The microgametocyte measures $10.4\text{-}16.3$ by $8.6\text{-}15.4\ \mu\text{m}$ produces about 50-100 microgametes each measuring $2\text{-}4\ \mu\text{m}$ long and carries 2 flagella each of $5\text{-}10\ \mu\text{m}$ long. The prepatent period lasts 93-96 hours, and the patent period is as

long as 12 days. The information about the life-cycle mainly based on Long (1967a) and Pellerdy (1974). This species is also treated as pathogenic.

Types : Not known.

160. *Eimeria necatrix* Johnson

(Fig. 130)

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

Description : The oocyst broad-ovoid in shape but more stocky, and has one end less pointed ; measuring $15.3-23.3\ \mu\text{m}$ by $13.6-6.2\ \mu\text{m}$ with a mean of $20.5\ \mu\text{m}$ by $16.8\ \mu\text{m}$. The shape index is 1.0-1.6 with a mean of 1.26. The oocyst wall is smooth and double contoured.



Fig. 130. Oocyst of *Eimeria necatrix*.

There is no micropyle. No oocystic residual body is found. The sporocysts are elongated each measuring $10\ \mu\text{m}$ in length and $6\ \mu\text{m}$ in width. A polar body is present.

Sporulation time : 48 hours.

Dimension of the oocysts reported by other authors are as follows :

15-25 by $14-20\ \mu\text{m}$ with a mean of 20.5 by $17\ \mu\text{m}$ (Becker *et al.* 1956) 20 by $17\ \mu\text{m}$ (Scholtyseck, 1956) ; 15-25 by $12-22\ \mu\text{m}$ with a mean of 21 by $19\ \mu\text{m}$ (Tacla, 1967) ; 18-21 by $13-15\ \mu\text{m}$ with a mean of 17.7 by $15.5\ \mu\text{m}$ (Mohamed, 1969), 13-23 by $4-18\ \mu\text{m}$ with a mean of 16.7 by $14.2\ \mu\text{m}$ (Pellerdy, 1974).

Type host : Domestic Fowl, *Gallus domesticus* (= *Gallus* sp.)

Other hosts : From the type host, Ray (1945b), Gill (1961), Patnaik (1963), Bhatia and Pande (1968b), Rahaman and Anantaraman (1970) and Chandra and Chhabra (1972) from India and Hassan (1970) from Bangladesh.

Distribution : Mukteswar, Mathura, Uttar Pradesh ; Madras, Tamil Nadu and Bangladesh.

Endogenous stages : Tyzzer, Theiler and Jones (1932), Davis (1956) and Mohamed (1969) were the pioneers in elucidating the lifecycle of

this species. The development takes place in the small intestine and caeca. First generation schizont measures 17.1 by 12.9 μm produces 48 merozoites. The merozoites are banana-shaped and each of them has a nucleus close to the pointed end. The second generation schizonts are large each measuring 63 by 49 μm in size, produces 32-132 merozoites each measuring 10.5 by 5.5 μm in size with a granular cytoplasm and a nucleus close to the anterior end. The third generation schizont produces 4-8 small morozoites. The sexual stages are found in the caeca or in the large intestine. The macrogametocyte measures 13.1 by 12.6 μm with a large nucleus surrounded by a halo and the microgametocyte measures 12.5 by 14.3 μm . The prepatent period lasts for 7 days and the patent period is as long as 12 days. Van Doornick and Becker (1957) observed that the sporozoites invade the lamina propria earlier then the crypt of leiberkuehn. Pathogenic, clotted blood alongwith mucus debris were noted at the mucosal surface of the intestine. White and dark spots were visible at the serosal surface.

Types : Not known.

161. *Eimeria numenii* Mandal

(Fig. 131)

1965. *Eimeria numenii* Mandal, *Proc. zool. Soc. Calcutta*, 18 : 47.

Description : Oocyst spherical, possesses double envelop, the outer being thinner. Oocyst measures 20.9-23.1 μm in diameter with



Fig. 131. Mature oocyst of *Eimeria numenii*.

a mean of 22.2 μm , Cytoplasm is centrally placed and round in shape, highly globular and refractile, measures 15.4 μm in diameter. Micro-

pyle and oocystic residuum absent. Sporocyst pyriform in shape with bluntly pointed anterior end and rounded posterior end. Sporocyst measures 5.6-7.6 μm in length with a mean of 6.6 μm and 4.5-6.5 μm in width with a mean of 5.5 μm . The shape index is 1.2. The wall of the sporocyst is very thin. Sporocystic residuum present as scattered mass. Sporozoite elongated in shape with tapering anterior end. It measures 5.9 μm in length and 2.5 μm in width. The shape index is 2.3. The nucleus is situated at the middle.

Sporulation time : 60-70 hours.

Type host : Curlew, *Numenius arquata* (Linnaeus).

Other hosts : Unknown.

Distribution : Namkhana, 24 Parganas, West Bengal.

Endogenous stages : Schizont spherical measuring 5.5 μm in diameter. The microgametocyte measures 7.7 μm by 4.4 μm , produces many comma-shaped unflagelated microgametes. The macrogametes are oval each measuring 6.6 μm by 4.4 μm in size with clear cytoplasm and a central nucleus.

Types : Lying in the collection of Protozoology Laboratory, Dept. of Zoology, Culcutta University.

162. *Eimeria patnaiki* Ray

1965. *Eimeria pavonis* Patnaik, *Indian J. Microbiol.*, 5 : 45.

1966. *Eimeria patnaiki* Ray, *Indian J. Microbiol.*, 6 : 51.

1966. *Eimeria indica* Patnaik, *Indian J. Microbiol.*, 6 : 53.

Description : Oocyst smooth walled, spherical to subspherical in shape and colourless. It measures 17.5-19.35 μm in length and 13-17 μm in width with a mean of 18.5 μm by 15.5 μm . The shape index is 1.2. Micropyle absent. Polar granule and oocystic residuum present. Sporocyst lemon-shaped, measures 6.45-8.5 μm in length and 3.2-4.83 μm in width with a mean of 7.5 μm and 4.0 μm respectively. Stieda body visible as a small thickening at the narrower end. Sporocystic residuum present at early stage. Sporozoites are comma-shaped each with a large globular hyaline body at the broader blunt end.

Sporulation time : 4 to 6 days.

Type host : Common Pea-fowl, *Pavo cristatus* Linn.

Other hosts : Unknown.

Distribution : Bhubaneswar, Orissa.

Endogenous stages : Unknown.

Types : Not known.

Remarks : As the specific name 'pavonis' is preoccupied Ray 1966 renamed the species.

163. *Eimeria pavonina* Banik and Ray

1961. *Eimeria pavonina* Banik and Ray, *Bull. Calcutta Sch. trop. Med, Hyg.*, 9 : 61.

Description : Oocyst egg-shaped, double layered, the outer being thicker. Cytoplasmic mass granular and not entirely filled up the oocyst. It measures 20-28 μm in length with a mean of 26.5 μm and 16-20 μm in width with a mean of 18.5 μm . A small micropyle present with a refractile granule usually lying just underneath. Oocystic residuum present. Sporocyst boat-shaped, measuring 6-16 μm in length and 4-8 μm in width, with one end being sharply pointed than the other. A stieda body is present at the pointed end. Sporocystic residuum present as scattered granules. The sporozoites are elongated each measuring 10-12 in length.

Sporulation time : 24-72 hours.

Type host : Common Pea-Fowl, *Pavo cristatus* Linnaeus.

Other hosts : Unknown.

Distribution : Zoological Garden, Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

164. *Eimeria pavonis* Mandal

(Fig. 132)

1965a. *Eimeria pavonis* Mandal, *Proc., zool. Soc. Calcutta*, 18 : 47.

1965. *Eimeria cristata* Patnaik, *Indian J. Microbiol.*, 5 : 45.

Description : Oocyst ovoidal in shape double walled, the inner being thinner than the outer. It measures 19.8-25.4 μm in length with a mean of 17.6 μm , the shape index is 1.2 ; the cytoplasm completely fills up the oocysts and appears as refractile globular mass. Micropyle present, oocystic residuum absent. Sporocysts are more or less elliptical in shape each with double wall of uniform thickness and having knob at the anterior narrower end. Sporocyst measures 12.1-15.6 μm in length with a mean of 14.5 μm and 5.6-7.6 μm in width with a mean of 6.6 μm .

The shape index is 2.1. Sporocystic residuum present as scattered mass. Sporozoites are elongated in shape, each with pointed anterior end and nucleus is situated at the posterior end. Sporozoite measures

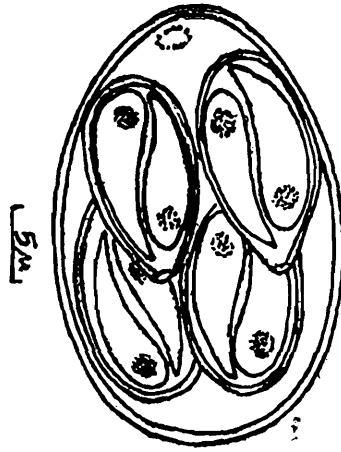


Fig. 132. Mature oocyst of *Eimeria pavonis*.

11.5-13.8 μm in length with a mean of 12.5 μm and 2.3-3.8 μm in width with a mean of 2.6 μm . The shape index is 4.8. The sporozoites lie along the longitudinal axis of the sporocyst with their anterior ends directed to opposite poles.

Sporulation time : 65-70 hours.

Type host : Common Pea-Fowl, *Pavo cristatus* Linnaeus.

Other hosts : From the type host, Chauhan *et al.* (1973) and Bhatia-*et al.* (1973).

Distribution : Mau, Uttar Pradesh. Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Likely to be present in the collection of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

165. *Eimeria picta* Bhatia

(Fig. 133)

1968. *Eimeria pictus* Bhatia, *Indian J. Microbiol.*, 8 : 239.

1974. *Eimeria picta* Bhatia, emend. Pellerdy, *Coccidia and Coccidiosis*, Verlag Paul Parey, Berlin und Hamburg, p. 318.

Description : Nearly ovoid oocysts, measuring 16-21 μm by 13-17 μm (mean 18.9 μm by 15.3 μm) (from 50 oocysts) in size. Length-width ratio 1.20-1.37 (mean 1.23). It possesses a smooth and double-contoured wall of 1.3 μm thickness, the outer coat is light-yellow and the inner

dark-green in colour. Micropyle absent. One or sometimes two polar granules were detected but without any oocystic residuum. The pear-shaped pyriform sporocyst with one end narrower, measuring 8-10 μm by 5.0-6.6 μm (mean 9.3 μm by 5.6 μm). A dark stieda body is present as a cap. Sporocystic residuum appears as loose granules or

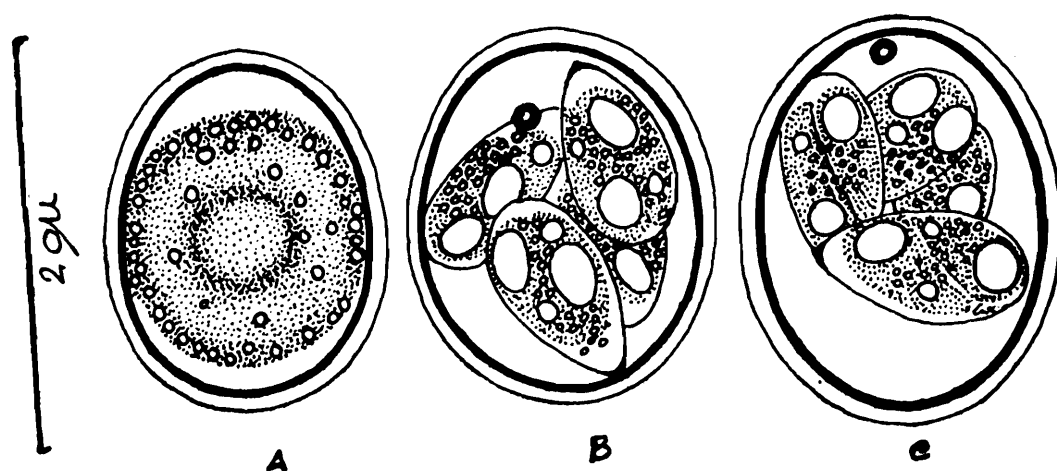


Fig. 133. A, immature B and C, mature oocysts of *Eimeria picta*.

sometimes clumped in the middle. The elongated sporozoite having one end broadly rounded and the other narrower and pointed, containing two refractile globules, the larger lying towards the broader end and the smaller near the narrower end, a small nucleus is situated towards the middle.

Sporulation time : 24 hours.

Type host : Golden pheasant, *Chrysolophus pictus* (Linn.).

Other hosts : From the type host and Silver pheasant, *Lophura nycthemera*, (= *Lophura* sp.), Pande, Bhatia, Chauhan and Garg (1970), Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) and Bhatia, Chauhan, Arora and Agarwal (1972).

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

166. *Eimeria praecox* Johnson

(Fig. 134)

1930. *Eimeria praecox* Johnson, *Ore. Aric. expt. St.*, p. 119.

Description : The oocyst spherical to elliptical in shape measuring 17.7-24.4 μm by 13.8-19.2 μm with an average of 21.2 μm by 15.64 μm .

The colour of the oocyst is yellowish and the wall is smooth with an average $0.72\ \mu\text{m}$ thickness. The shape index is 1.1-1.6 with an average

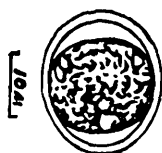


Fig. 134. Oocyst of *Eimeria praecox*.

1.3. Micropyle indistinct, polar granule present in sporulated oocyst but without any oocystic residuum. Sporocyst elongated to ovoid in shape.

Sporulation time : 48 hours at room temperature.

Type host : Domestic Fowl, *Gallus domesticus* (= *Gallus* sp.)

Other hosts : From the type hosts, Ray (1945b), Gill (1954a), Patnaik (1963) and Chandra and Chabra (1972).

Distribution : Tarai, Uttar Pradesh ; Madhya Pradesh ; Bombay, Maharashtra.

Endogenous stages : Endogenous development occurs in the upper third of the small intestine. Generally there are two schizogonic generations (Tyzzer, Theiler and Jones, 1932 and afterward by Long, 1967b). The first one measures 9-10 μm in diameter produces 16 elongated merozoites. The smaller one lies deeper but encloses few larger merozoites. The microgametocyte measures 10-14 μm in diameter contains a large residuum after the development of microgametes. Long (1967b) observed schizont measuring 20 μm in diameter (larger one) and 14 μm in diameter (smaller). Leo and Millard (1971) studied the fine structure and encountered three schizogonic generations. Nonpathogenic.

Types : Not known.

167. *Eimeria roscoviensis pluvialina* Mandal

(Fig. 135)

1965. *Eimeria roscoviensis pluvialina* Mandal, *Proc. zool. Soc. Calcutta*, 18 : 47.

1974. *Eimeria roscoviensis* Mandal, *Nomen novum*, Pellerdy, *Coccidia and Coccidiosis*, Verlag Paul Parey Berlin und Hamburg, p. 334.

Distribution : Oocyst pyriform or ovoidal in shape with double envelop. It measures 17.7-19.7 μm in length with a mean of 18.7 μm and 13.3-15.3 μm in width with a mean of 14.3 μm . The shape index

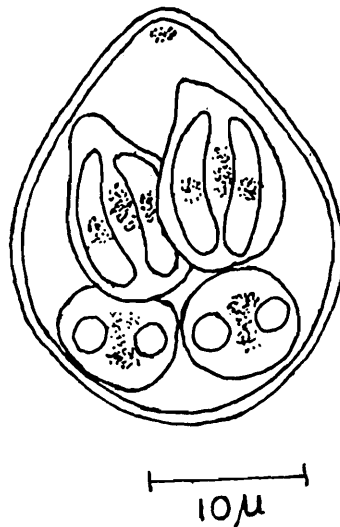


Fig. 135. Mature oocyst of *Eimeria roscoviensis pluvialina*.

is 1.3. Cytoplasm present with globular refractile mass. Micropyle absent. Oocystic residuum present. Sporocysts are pyriform each with a pointed anterior end and rounded posterior end. It measures 11.1-13.1 μm in length with a mean of 12.1 μm and 5.6-7.6 μm in width with a mean of 6.6 μm . The shape index is 1.7. Sporocystic residuum is present as scattered mass. Sporozoites are elongated in shape each with a nucleus in the central position and anterior end is narrower than the posterior one. Sporozoite measures 8.8 by 2.5 μm . The shape index is 3.5.

Sporulation time : 72-80 hours.

Type host : Golden Plover, *Pluvialis apricaria* (Linnaeus).

Other hosts : Unknown :

Distribution : Namkhana, 24-parganas, West Bengal.

Endogenous stages : The shizont measures 6.6 μm in diameter. The merozoites are spindle-shaped each measuring 7.7-8 μm long ; arranged irregularly within the mature schizonts. The microgametocyte measures 9.9 μm by 7.7 μm develops many comma-shaped microgametes. The macrogamete measures 8.8 by 5.5 μm in size with central nucleus having a distinct nuclear membrane.

Types : Lying in the Protozoology Laboratory, Dept. of Zoology, Calcutta University.

Remarks : Pellerdy (1974) treated this subspecies as a distinct species since there is no subspecies in coccidia. However the present author wants to retain this as subspecies.

168. *Eimeria sphenocercae* Ray

1952. *Eimeria sphenocercae* Ray, *J. Parasit.*, 38 : 546.

Description : Oocyst kidney-shaped with a slight bent on one side, having double contoured. It is surrounded by an exomembrane which is tight fitting all over the body except at either pole where it broadens considerably in the form of an irregular cap. In most specimens on one of the broader side of the oocyst the endocystic wall is depressed considerably giving the appearance of kidney and in some the oocyst has got an appearance of dumbbell. Perfectly cylindrical specimen is seen rarely. Micropyle is asymmetrical in position and appears as a protuberance. In some cases a plug like structure closes the opening of the micropyle. The size of the oocyst varies from 17.5-25.0 μm in length and 12.5-15.0 μm in width with the average being 19.18 μm by 12.61 μm . Sporocyst broadly oval in outline ranging from 17.5-18.5 μm in length and 12.5-13.5 μm in width, the average being 19.18 μm by 12.61 μm , having scattered sporocystic residuum.

Sporulation time : 5-6 days.

Type host : Kokla green Pigeon, *Sphenocercus sphenurus* (= *Treron* sp.).

Other hosts : Unknown.

Distribution : Mukteswar, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

**169. *Eimeria teetari* Bhatia, Pandey and Pande
(Fig. 136)**

1966. *Eimeria teetari* Bhatia, Pandey and Pande, *Acta. vet. hung.*, 16 : 329.

Description : Oocyst elliptical/ellipsoidal/ovoidal with a double contoured wall, measuring 21.0-29.0 μm in length with a mean of 24.0 μm and 19.0-23.0 μm in width with a mean 20.0 μm . The length width ratio is 1.03-1.3 with a mean of 1.16. Oocyst wall smooth, measuring 1.4 μm in thickness. Micropyle and oocystic residuum absent. Sporocyst ovoid, with bluntly narrower ends, measuring

11.0-15.0 μm in length and 6.0-8.0 μm in width with a mean of 13 μm by 7.0 μm . Prominent plug like stieda body present. Sporocystic residuum granular, dispersed around sporozoites. Sporozoite comma-

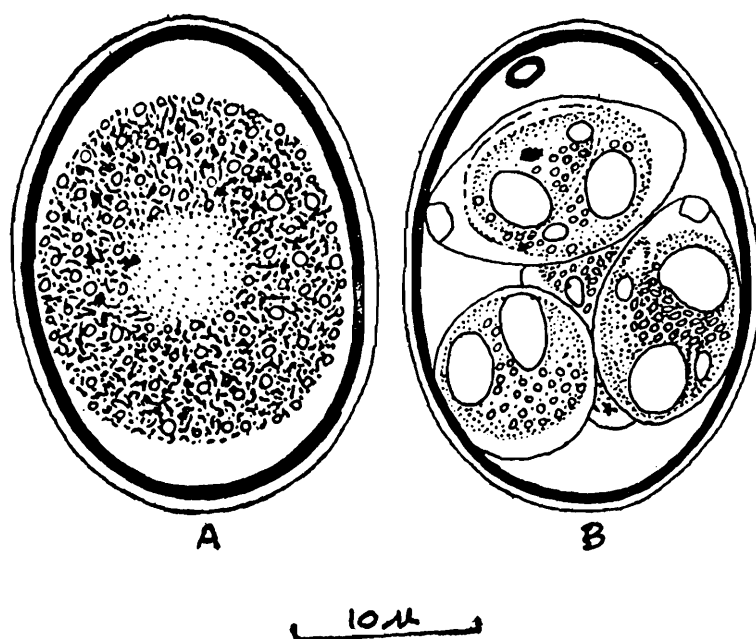


Fig. 136. A, immature and B, mature oocysts of *Eimeria teetari*.

shaped, measuring 7.0-7.5 μm in length with a mean of 7.4 μm and 3.0-3.7 μm in width with a mean of 3.5 μm , having two globules at both ends.

Sporulation time : 3 days.

Type host : Grey partridge, *Francolinus pondicerianus* (Gmelin).

Other hosts : Black partidge, *F. francolinus* (Linn.) and Chakor partridge, *Caccabis* (= *Alectoris*) *chakor* (J. E. Grey).

Distribution : Mathura, Zoological Garden, Lucknow, Uttar Pradesh and Zoological Garden, Delhi.

Endogenous stages : The endogenous stages are found in the anterior part of the small intestine. Microgametocyte (*H. Francolinus francolinus*) measures 21-34.5 μm by 17-27.6 μm (average 29.0 by 24.8 μm) and (*H. F. pondicerianus*) measures 20.7-26.7 by 17-24.1 μm (average 23 μm by 20.7 μm). The microgamete measures 2-3 μm long and encircling a large granule. Macrogamete (*H. F. francolinus*) measures 17-24 μm by 14-20.1 μm . The schizont of the former host are 8.6-14 μm by 7-10.3 μm and of the later 12-13.4 μm by 9-12 μm . The merozoite measures 4-6 μm by 1.1-1.4 μm .

Types : Not known.

Remarks : Simultaneously the authors described the oocysts and endogenous stages of this species from Black partridge (*F. francolinus*) with oocyst measuring 20.8-28.0 μm by 18.0-21.0 μm (mean 23.0 μm by 19.0 μm) ; sporocyst measuring 10.5-13.4 μm by 6.0-9.0 μm (mean 12.0 μm by 7.4 μm) and the sporozoite measures 7.4-9.80 μm by 3.4-4.0 μm (mean 7.9 μm by 3.6 μm). Sporulation time 2 days [while dealing with the coccidia of Chakor Partridge, Pande *et al.* (1970) again reported the same species and described the oocyst measuring 24-31 μm by 17-24 μm (mean 26.1 μm by 20.3 μm). Sporocyst measuring 12-14 μm by 6.5-8 μm (mean 12.9 μm by 7.3 μm) and the sporozoite measures 12 μm by 3 μm]. However, with these slightly variable measurements, it is almost certain that the authors are dealt with the same species. Of course, the describer of this species questioned the validity of such species till the cross infections experiments are conducted. Nothing has been undertaken so far.

Report on the occurrence of this species may be had from Pande, Bhatia, Chauhan and Garg (1970), Bhatia, Chauhan, Arora and Agarwal (1972, 73) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973),

170. *Eimeria tenella* (Railliet and Lucet)

(Fig. 137)

- 1891. *Eimeria avium* auct., *Coccidium tenellum* Railliet and Lucet, *Bull. Soc. zool. Fr.*, 16 : 246.
- 1893. *Coccidium globosum* Labbe, *C. r. hebd. seanc. Acad. Sci. Paris*, 116 : 1300 ; 117 : 407.
- 1909. *Eimeria tenella* Fantham, *Proc. zool. Soc. London*, 14 : 43.
- 1913. *Eimeria bracheti* Gerard, *Arch. Protistenk.*, 29 : 193.
- 1933. *Eimeria globosa* Levine and Becker, *Iowa St. Coll. J. Sci.*, 8 : 83.

Description : The oocyst broad-ovoid in shape, one end being slightly narrower than the other. The wall bears very transverse

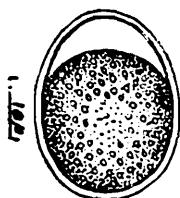


Fig. 137. Oocyst of *Eimeria tenella*.

striations on the surface, is double contoured, 1-1.5 μm in thickness and shows a moderate size micropyle. The oocyst measures 19.2-26 μm in length and 16-22 μm in width (mean 22.6 μm in length and 20 μm in width). Most sporulated oocysts develop sporocysts and a refractile granule in each, mostly polar in position with an outer residual body. The sporocyst measures 11 μm in length and 7 μm in width with a micropyle at the pointed end sealed by a slightly protruding stieda body. The sporozoites are elongated banana-shaped bodies, each measuring 6-8 μm in length, with some spherical hyaline material in the granular cytoplasm near blunt end, and the outline of the nucleus having 1 to 2 μm in diameter, showing near it. A granular sporocystic residuum is present.

Dimensions of the oocysts measured by other authors are as follows :

24.5 μm by 18.2 μm (Scholtyseck, 1953) ; 14-31 μm by 9-25 μm with a mean of 22.9 μm by 19.1 μm (Levine, 1961) ; 21-23 μm by 19 μm (Soltys, 1966) ; 16-27 μm by 15-26 μm with a mean of 21 μm by 16.6 μm (Pellerdy, 1974).

Type host : Domestic Fowl, *Gallus domesticus* (= *Gallus* sp.)

Other hosts : Pellerdy (1965) listed few with great doubt.

Distribution : Madhya Pradesh ; Bombay, Maharashtra ; Mukteswar, Uttar Pradesh ; Calcutta, West Bengal ; Orissa ; Madras, Tamil Nadu and Bangladesh.

Endogenous stages : The development of the endogenous stages are restricted to cæca but sometimes they are found in the lower region of the small intestine and colon. The sporozoites enter epithelial cells of the cæcal glands and develop at the base of the epithelial cells. Asexual stage of development initiates with the formation of trophozoite. The nucleus divides to form schizont measuring 25.3 by 21.0 μm . The mature schizont produces a large number of merozoites and regarded as first generation merozoites. Each merozoite measures 2.4 μm by 1.5 μm in size, fusiform in shape with one broader end. The merozoite soon invades the epithelial cells and ultimately gives rise to second generation merozoites. The mature schizont of which measures 42.5 μm by 37.5 μm . This merozoite measures 6.5 μm in length definitely larger than the first generation merozoite but are slender and gives rise to sexual forms. The nucleus of microgametocyte divides and produces innumerable biflagellate microgametes each having a comma-shaped slender body. Macrogametocyte oval with a well defined karyosome surrounded by a halo. The prepatent period is 7

days and the patent period lasts as long as 10 days. Mukherjea and Ray (1962) developed a method for staining the oocysts of this species.

Types : Not known.

Remarks : The presence of transverse striations on the oocyst wall and the occurrence of micropyle along with oocystic residuum have not been observed by the previous authors. However, the tissue phase and other characters have been examined by the present author. The description of endogenous stages is mainly based on Gill and Ray (1957). However, authors like Lotze and Leek (1963, 1968 and 1969) and Rose (1967a) described the excystation/release of sporozoites from oocysts. Tyzzer (1929) studied some details of the life-cycle of this species. Pettillo (1959), Chally and Burns (1959) Scholtyseck (1953) Scholtyseck, Strout and Haberkorn (1969) and Leatham (1969) studied the invasion of sporozoites in the connective tissues. The details of the endogenous development in kidney cell cultures were studied by Scholtyseck and Strout (1968), Strout and Scholtyseck (1970a, b) in the Electron microcopy.

The report on the occurrence of this species has been made by Ray (1945), Nath, Dutta and Sagar (1960, 1962 and 1965), Patnaik (1963, 1966) and Rahman and Anantaraman (1970) from Indian subregion and Hassan (1970) reported it from Bangladesh.

171. ***Eimeria tropicalis*** Malhotra and Ray
(Fig. 138)

1961. *Eimeria tropicalis* Malhotra and Ray, *Proc. Indian Sci. Congr.*, p. 412.

Description : Oocyst spherical or sub-spherical, measuring 19-24 μm in length and 18-23 μm in width with a mean of 20.5 μm . The wall of the oocyst is thick. Small oocystic residuum is seen after the

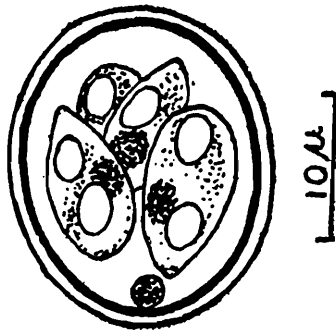


Fig. 138. Mature oocyst of *Eimeria tropicalis*.

development. Sporocyst ellipsoidal, $10\ \mu\text{m}$ in length and $6\ \mu\text{m}$ in width with a prominent stieda body. The sporocystic residuum is present as scattered mass. Sporozoites globular in shape.

Sporulation time : 40-48 hours.

Type host : Blue rock Pigeon, *Columba livia intermedia* (Strickland).

Other hosts : From the type host, Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) and Mandal (1976).

Distribution : Calcutta, West Bengal and Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : All that is known regarding the endogenous stages of this parasite is the coccidium localizes in the duodenum and the anterior portion of the jejunum.

Types : Not known.

172. *Eimeria vanelli* Mandal

(Fig. 139)

1965. *Eimeria vanelli* Mandal, *Proc. zool. Soc. Calcutta*, 18 : 47.

Description : Oocyst oval or pyriform in shape with double envelop, the outer being thinner and provided with warts. Oocyst

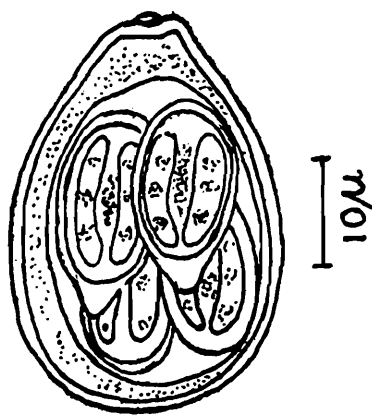


Fig. 139. Mature oocyst of *Eimeria vanelli*.

$19.9\text{-}21.9\ \mu\text{m}$ in length with a mean of $20.9\ \mu\text{m}$ and $13.3\text{-}15.3\ \mu\text{m}$ in width with a mean of $14.3\ \mu\text{m}$. The shape index is 1.4. The cytoplasm granular and refractile material completely fills up the oocysts. Micropyle present, oocystic residuum absent. Sporocyst pyriform in

shape with bluntly pointed anterior and rounded posterior ends. Sporocyst measures $11.1-13\ \mu\text{m}$ in length with a mean of $12.1\ \mu\text{m}$ and $5.6-7.6\ \mu\text{m}$ in width with a mean of $6.6\ \mu\text{m}$. The shape index is 1.8. Sporocystic residuum is present as scattered mass. Sporozoites are elongated in shape each tapering at both ends. Cytoplasm of the sporozoite shows banded appearance. Sporozoite measures $7-8.7\ \mu\text{m}$ in length with a mean of $7.7\ \mu\text{m}$ and $2.3-4.3\ \mu\text{m}$ in width with a mean of $3.3\ \mu\text{m}$. The shape index is 2.3.

Sporulation time : 72-80 hours.

Type host : Yellow-wattled Lapwing, *Vanellus malabaricus* (Boddart)

Other hosts : Unknown.

Distribution : Basanti, 24-Parganas, West Bengal.

Endogenous stages : The young schizont round, measures $5.5\ \mu\text{m}$ in diameter afterwards become elongated. Each schizont produces 6-10 merozoites, each measuring $9.9\ \mu\text{m}$ in length, arranged symmetrically. Microgametocytes are oval, each measuring $11\ \mu\text{m}$ by $7.7\ \mu\text{m}$ produces unflagellated microgametes. Macrogametocytes are also oval, each measuring $12.1\ \mu\text{m}$ by $9.9\ \mu\text{m}$ with a central nucleus and clear cytoplasm.

Types : Lying in the collection of Protozoology Laboratory, Dept. of Zoology, Calcutta University.

173. ***Eimeria vanmurghavi*** Panda, Bhatia, Chauhan and Garg
(Fig. 140)

1970. *Eimeria vanmurghavi* Pande, Bhatia, Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Distribution : Smaller oocyst subspherical to ellipsoidal, measuring $12-22\ \mu\text{m}$ in length, mean $16\ \mu\text{m}$ and $8-13\ \mu\text{m}$ in width, mean $12\ \mu\text{m}$.

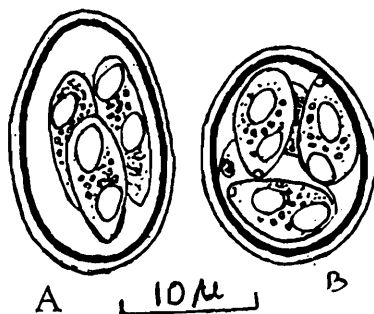


Fig. 140. A and B. mature oocysts of *Eimeria vanmurghavi*.

Length width ratio 1.06-1.7 (mean 1.33). Oocystic wall smooth, $1.3\ \mu\text{m}$ thick, double-layered, the outer light-yellowish in colour and the inner brownish. Polar granule present. Oocystic residuum absent. Micropyle and polar cap absent. Sporocyst broadly ellipsoidal, measuring $7.5\text{--}10.5\ \mu\text{m}$ in length with a mean of $8.4\ \mu\text{m}$ and $4.5\text{--}6.0\ \mu\text{m}$ in width with a mean of $5.5\ \mu\text{m}$. Sporocystic residuum present as few scattered granules. The narrower end of the sporocyst is provided with small plug-like stieda body. Sporozoite measuring $5.2\text{--}7.8\ \mu\text{m}$ by $2.06\ \mu\text{m}$ in size with one end rounded and the other pointed. The broader end shows a refractile globule, and the nucleus is lying towards the centre.

Type host : Redjungle fowl, *Gallus gallus* (Linn.).

Other hosts : From the type hosts and Grey jungle Fowl, *Gallus sonneratii* (Temminck), Bhatia, Chauhan, Arora and Agarwal (1972) and Chauhan, Bhatia, Arora Agarwal and Ahluwalia (1973).

Distribution : Zoological Garden, Lucknow, Uttar Pradesh ; and Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) made a comment that there is a little difference between the oocysts of *E. acervulina* and the present species. However, until or unless some cross infection experiments are being conducted it is difficult at this stage to say anything about the validity of this species.

174. *Eimeria* sp.

(Fig. 141)

1967. *Eimeria* sp. Bhatia and Pande, *Acta. vet. hung.*, 17 : 347.

Description : The somewhat ellipsoidal, ovoid or sub-spherical oocysts are brownish in colour and each measuring $13\text{--}17\ \mu\text{m}$ by $11\text{--}13\ \mu\text{m}$ in size (mean 15.7 by $12.0\ \mu\text{m}$). Oocystic wall is of a rough and punctate character ; the outer layer is colourless and membraneous. Micropyle broad, $4\text{--}6\ \mu\text{m}$ in width ; is peripherally thickened and placed on two prominent knobs at the ends of the inner layer. Oocystic residuum absent. Polar granule large and globule like, near the centre of the micropyle. Sporocyst ovoidal, with the narrower end carrying stieda-body, measuring $7\text{--}11\ \mu\text{m}$ by $5\text{--}7\ \mu\text{m}$ in size (mean $9.0\ \mu\text{m}$ by $5.7\ \mu\text{m}$). Sporocystic residuum present as a dark mass. Sporulation completed in 5 days at room temperature (two days in case of *H. Fulica. a atra.*)

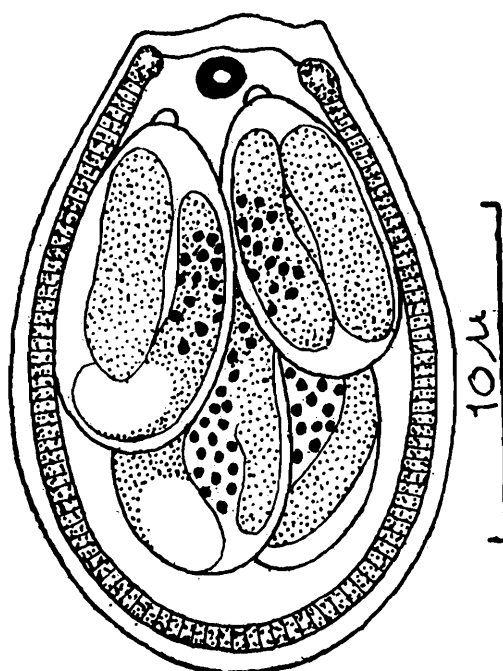


Fig. 141. Mature oocyst of *Eimeria* sp.

Hosts : Purple Moorhen, *Porphyrio porphyrio* (Linnaeus) and Coot, *Fulica a. atra* Linn.

Distribution : *Eimeria* sp. described from Purple Moorhen, *Porphyrio porphyrio* (Linn.) and from Coot, *Fulica a. atra* Linn. are similar in their structural accounts but differ only in the sporulation time. Moreover, it resembles *E. peludosa* but the significant points of differences are the longer sporulation time and absence of stieda body in *E. peludosa*. Further studies are essential to confirm the specific identity.

(G) PARASITES OF MAMMALS

Key to the species

(A) Oocyst spherical/subspherical			
(1) Oocystic residuum present			
(i) Shape of sporocyst ovoidal	...	...	<i>E. punjabensis</i>
(ii) Shape of sporocyst broadly pyriform	...	...	<i>E. andamanensis</i>
(2) Oocystic residuum absent			
(a) Sporocyst spherical	...	...	<i>E. clupearum</i>
(b) Sporocyst not spherical			
(i) Sporocyst almond shaped	...	...	<i>E. chinkeri</i>
(ii) Sporocyst pear shaped	...	...	<i>E. bahdipurensis</i>
(iii) Sporocyst lemon shaped	...	...	<i>E. suncus</i>
(iv) Sporocyst egg shaped	...	...	<i>E. tuberculata</i>
(v) Sporocyst cylindrical	...	...	<i>E. cervis</i>

(vi) Sporocyst ovoid/ovoidal		
(a) Length of sporocyst below 7 μm		
(i) Width of sporocyst above 3 μm	...	<i>E. nycticebi</i>
(ii) Width of sporocyst below 3 μm	...	<i>E. minima</i>
(b) Length of sporocyst above 7 μm		
(i) Width of sporocyst above 5.5 μm	...	<i>E. darjeelingensis</i>
(ii) Width of sporocyst below 5.5 μm	...	<i>E. zuernii</i>
(vii) Sporocyst ellipsoidal		
(i) Size of sporocyst 9.8-10.4 by 4.3-5.3 μm	...	<i>E. parahi</i>
(ii) Size of sporocyst 8.7-10.7 by 5.3-6.7 μm	...	<i>E. aurei</i>
(iii) Size of sporocyst 8.5-13.6 by 3.4-6.0 μm	...	<i>E. nilgai</i>
(B) Oocyst not spherical/subspherical		
1. Oocyst flask shaped	...	<i>E. petauristae</i>
2. Oocyst pear shaped	...	<i>E. porci</i>
3. Oocyst barrel shaped	...	<i>E. nagpurensis</i>
4. Oocyst elongated	...	<i>E. ovina</i>
5. Oocyst elongate-ellipsoidal	...	<i>E. sardari</i>
6. Oocyst elongated-ovoid	...	<i>E. tirupatiensis</i>
7. Oocyst spherical or subspherical	...	<i>E. subspherica</i>
8. Oocyst pyriform or subspherical	...	<i>E. hungarica</i>
9. Oocyst ellipsoidal or subspherical	...	<i>E. parva</i>
10. Oocyst pyriform or subspherical	...	<i>E. alabamensis</i>
11. Oocyst ellipsoidal or spindle shaped	...	<i>E. mathurai</i>
12. Oocyst elliptical to spherical	...	<i>E. malabaricus</i>
13. Oocyst subspherical to ovoid	...	<i>E. dawari</i>
14. Oocyst cylindrical or slightly oval	...	<i>E. leporis</i>
15. Oocyst elongated or ovoidal	...	<i>E. auburnensis</i>
16. Oocyst oval or subspherical	...	<i>E. dromedarii</i>
17. Oocyst round to spherical	...	<i>E. sardinae</i>
18. Oocyst subspherical to spherical or nearly spherical		
(i) Size of sporocyst 11 μm by 7 μm or below	...	<i>E. cati</i>
(ii) Size of sporocyst 14 μm by 8 μm or above	...	<i>E. christensenii</i>
19. Oocyst oval or ellipsoidal		
(A) Oocystic residuum present	...	<i>E. matsubayashii</i>
(B) Oocystic residuum absent		
(a) Sporocyst spindle shaped	...	<i>E. canadensis</i>
(b) Sporocyst not spindle shaped		
(i) Sporocyst ellipsoidal	...	<i>E. polita</i>
20. Oocyst egg shaped		
1. Oocystic residuum present	...	<i>E. wassilewskyi</i>
2. Oocystic residuum absent		
(a) Sporocyst ovoid	...	<i>E. faurei</i>
(b) Sporocyst not ovoid		
(i) Width of sporocyst 6 μm or above	...	<i>E. yakimovi</i>
(ii) Width of sporocyst below 6 μm	...	<i>E. chausinghi</i>
21. Oocystic cylindrical		
(A) Oocystic residuum present	...	<i>E. ruficaudati</i>

(B) Oocystic residuum absent			
(i) Shape of sporocyst pyriform	...	...	<i>E. antilocervi</i>
(ii) Shape of sporocyst not pyriform			
(a) Shape of sporocyst oval or round	...	...	<i>E. cylindrica</i>
22. Oocyst pyriform			
(A) Oocystic residuum present	...	...	<i>E. intestinalis</i>
(B) Oocystic residuum absent			
1. Sporocyst ovoidal or elongate ovoid	...	...	<i>E. granulosa</i>
2. Sporocyst not ovoid or elongate ovoid			
(a) Sporocyst elliptical	...	...	<i>E. bukidnonensis</i>
(b) Sporocyst lemon shaped	...	...	<i>E. bariellayi</i>
23. Oocyst ovoid/oval			
(A) Oocystic residuum present	...	...	<i>E. gaurusi</i>
(B) Oocystic residuum absent			
1. Sporocyst pyriform	...	...	<i>E. coucangi</i>
2. Sporocyst not pyriform			
(a) Sporocyst ellipsoidal or oval	...	...	<i>E. sylvilagi</i>
(b) Sporocyst broadly ellipsoidal	...	...	<i>E. ramgai</i>
(c) Sporocyst broad ovoid	...	...	<i>E. neodebliecki</i>
(d) Sporocyst ovoid	...	...	<i>E. levinei</i>
(e) Sporocyst ellipsoidal	...	...	<i>E. cameli</i>
(f) Sporocyst elongated			
(i) Length of sporocyst 10.5 μm or below	...		<i>E. perminuta</i>
(ii) Length of sporocyst above 16 μm but below 20 μm	...	...	<i>E. cerdonis</i>
(iii) Length of sporocyst above 30 μm but below 45 μm	...	...	<i>E. leukarti</i>
(g) Sporocyst oval	...	...	<i>E. pellita</i>
24. Oocyst ovoidal to ellipsoidal or vice versa			
(A) Oocystic residuum present			
(i) Shape of sporocyst oval, size 18.5 μm by 6.2 μm	...	...	<i>E. robertsoni</i>
(ii) Shape of sporocyst ovoid, size 7.75 μm by 3.75 μm	...	...	<i>E. perforans</i>
(iii) Shape of sporocyst ovoidal, size 15.25 μm -1800 μm by 7.8-7.5 μm	...	...	<i>E. magna</i>
(B) Oocystic residuum absent			
(i) Sporocyst ovoidal to oval	...	...	<i>E. stiedai</i>
(ii) Sporocyst elongate ovoid size 1.7 μm by 9 μm			
(a) Length of sporocyst 16 μm or below	...	...	<i>E. debliecki</i>
(b) Length of sporocyst 16 μm or above	...	...	<i>E. ahsata</i>
(iii) Sporocyst nearly ovoid size 8-10 μm by 6-8 μm	...		<i>E. felina</i>
(iv) Sporocyst ellipsoid size 19-23 μm by 9-10 μm	...		<i>E. mrigai</i>
(v) Sporocyst ovoid size 10.0-13.3 μm by 5.3 6.6 μm	...		<i>E. tragocameli</i>
(vi) Sporocyst pyriform	...	...	<i>E. canis</i>
25. Oocyst ovoidal			
1. Oocystic residuum present	...	...	<i>E. media</i>

2. Oocystic residuum absent
- (i) Sporocyst oval size 14-16 μm by 8-9 μm ... *E. ovoidalis*
 - (ii) Sporocyst pyriform size 11.25 μm by 6.0 μm ... *E. pandei*
 - (iii) Sporocyst ovoid size 9.5-14.5 μm by 9.0-7.5 μm ... *E. bovis*
 - (iv) Sporocyst pear-shaped size 18.0 μm by 8 μm ... *E. wyomingensis*
 - (v) Sporocyst with moderately pointed ant. end ... *E. irresidua*
26. Oocyst ellipsoidal
- (A) Oocystic residuum present
- (i) Sporocyst elongated size 8-14 μm by 4-8 μm ... *E. oryctolagi*
 - (ii) Sporocyst oval size 16-19 μm by 6.4 μm ... *E. scabra*
- (B) Oocystic residuum absent
- (i) Sporocyst spindle shaped ... *E. crandallis*
 - (ii) Sporocyst elongate ... *E. brasiliensis*
 - (iii) Sporocyst broadly ovoid ... *E. hammondi*
 - (iv) Sporocyst ovoid to elongate ... *E. cheetali*
 - (v) Sporocyst oval
- (a) Length of sporocyst 13 μm or below
- (i) Width of sporocyst 4 μm or below ... *E. ninakholyakimovi*
 - (ii) Width of sporocyst 6 μm ... *E. arloingi*
- (b) Length of sporocyst about 16 μm
- (i) Width of sporocyst 8 μm ... *E. neoleporis*
 - (ii) Width of sporocyst 10 μm or above ... *E. intricata*
- (vi) Sporocyst ellipsoidal
- (a) Size of sporocyst 7.2-10.8 μm by 3.6-5.76 μm ... *E. ailuri*
 - (b) Size of sporocyst 9.1-11.7 μm by 5.2-6.5 μm ... *E. spinosa*
 - (c) Size of sporocyst 5 μm by 3 μm ... *E. ellipsoidalis*
- (vii) Sporocyst ovoid
- (a) Size of sporocyst 11 μm -14 μm by 8 μm -10 μm ... *E. lomarii*
 - (b) Size of sporocyst 5.92 μm by 4.93 μm ... *E. newali*
 - (c) Size of sporocyst 14-15 μm by 8-11 μm ... *E. rajasthani*

175. *Eimeria ahsata* Honess

(Fig. 142)

1942. *Eimeria ahsata* Honess, *Univ. Wyo. Agric. Exp. Sta.*, 249 : 3.

Description : The oocyst ellipsoidal to ovoid in shape, measures 37-45 μm and 22-29 μm in size with a mean of 39 μm by 24 μm . The oocystic wall is thick measuring 1.3 μm with a light yellowish green outer and a yellowish brown inner layers. More than one polar granules present. Oocystic residuum absent. Micropylar cap present measuring 5-10 μm by 1-3 μm with a mean of 8 μm by 2 μm in size. Sporocyst elongate-ovoid measuring 16-21 μm by 7-10 μm with a mean of 39 μm by 9 μm . Stieda body absent. Sporocystic residuum present

as scattered granules or along the side of the sporozoite. Sporozoite banana-shaped measures $16\ \mu\text{m}$ by $4.3\ \mu\text{m}$ in size, with one end broad

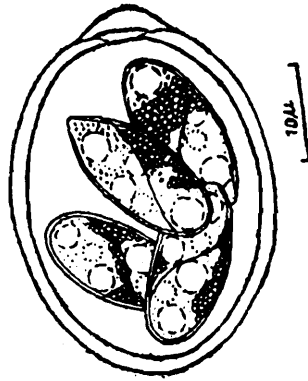


Fig. 142. Mature oocyst of *Eimeria ahsata*.

and the other tapering carrying two refractile globules with the nucleus in the middle.

Sporulation time : 2 days.

Dimensions of the oocysts reported by other authors are as follows :

36-44 by 22-29 μm with a mean of 40 by 26 μm (Levine *et al.*, 1962) ; 29-37 by 17-28 μm with a mean of 33 by 23 μm (Honess, 1942) ; 23-48 by 20-28 μm with a mean of 36 by 24 μm (Kamalapur, 1961) ; 31-39 by 22-28 μm (Donciu, 1961) ; 30-37 by 22-29 μm with a mean of 29.4 by 25.6 μm (Jackson, 1964) ; 30-39 by 18-30 μm (Chevalier, 1965) ; 30-34 by 18-24 μm (Vassiliades, 1965).

Type host : Rocky mountain big horn Sheep, *Ovis canadensis*.

Other hosts : Domestic Sheep (Lamb), *Ovis* sp., and Domestic Goat, *Capra hircus* (= *Capra* sp.).

Distribution : Mathura, Uttar Pradesh ; Orissa ; West Bengal and Sri Lanka.

Prevalence : Shah (1963) found 24% infection of sheep from Illinois and other states, Chevalier (1965) found 39% infection of sheep from Germany, and Joyner *et al.*, (1966) found 62% infection of sheep from England. Jha and Subramanian (1966) found 5% infection of goats in Uttar Pradesh from India. Wiesenhutter (1965) found 34%

and 42% of sheep and goats respectively from Syria. Sayin (1966) recorded 63% infection of Angora goats in Turkey.

Levine and Ivens (1970) have made a comment that the occurrence of this species in goat may possibly be *E. christenseni* instead.

Endogenous stages : The schizonts occur in the central portion of the mucosa of the small intestine, mostly in the jejunum, some occur in the lacteals of the villi and a very few in the muscularis mucosae. The schizonts were traced by Davis and Bowman (1970) intranuclearly inside the epithelial cells of the small intestine. It measures 1.6-5 μm within the cavity of the nucleus. The second generation schizonts were encountered inside the cytoplasm of the epithelial cells. Largest schizont measures 52 μm by 39 μm and 50 merozoites developed inside. Davis, Bowman and Smith (1963) encountered globidial schizont almost along the entire length of the small intestine measuring 265 μm by 262 μm . Gametocytes were traced in the epithelial cells of the crypts. The microgametocyte measures 36.5 μm by 23 μm and the macrogametocyte is of 35-45 μm in diameter.

Types : Not known.

Remarks : Patnaik (1963), Singh (1963), Pande, Bhatia, Dubey and Srivastava (1964), Jha and Subramanian (1965, 1966), Bhatia and Pande (1970) and Misra and Mahapatra (1972) reported this species from different parts of India. Jegatheeswaran (1967) reported this species from Sri Lanka.

176. *Eimeria ailuri* Agarwal, Ahluwalia, Bhatia and Chauhan

1981. *Eimeria ailuri* Agarwal, Ahluwalia, Bhatia and Chauhan, *Indian J. Anim. Sci.* 51 : 125.

Description : Oocyst ellipsoidal in shape measuring 21.60-27.36 μm in length and 11.52-15.54 μm in breadth with a mean of 23.76 μm by 13.32 μm . The bilayered oocystic wall is 1.5 μm thick. The outer layer is greenish and the inner one is dark brown in colour. The length width ratio of the oocyst is 1.72-1.87 with a mean of 1.78. Micropyle, polar cap, oocystic residuum and polar granules are absent. Sporocysts are ellipsoidal in shape each measuring 7.2-10.08 μm in length and 3.60-5.76 μm in breadth with a mean of 7.92 μm by 5.14 μm . The sporocyst is provided with a small stieda body at the narrower end. Sporocystic residuum present as an aggregation of some dark granules in the centre. Sporozoite measuring 6.4-8.6 μm in length and 2.6-6 μm in breadth with a mean of 7.56 μm by 2.88 μm have two

ends ; one is broader provided with a large refractile globule and the other pointed end.

Type host : Red Panda, *Ailurus fulgens* S. Cuvier.

Other host : Unknown.

Distribution : Zoological garden, Lucknow, Uttar pradesh.

Endogenous stages : Unknown.

Types : Not known.

177. ***Eimeria alabamensis*** Christensen

(Fig. 143)

1941. *Eimeria alabamensis* Christensen, *J. Parasit.*, 27 : 303.

Distribution : Oocyst pyriform to subellipsoidal, measuring 17-24 μm by 12-16 μm (mean 21 μm by 14 μm) in size, (length width ratio 1.3-1.6, mean 1.5). The oocystic wall double layered, almost colourless or light yellowish, 1.3 μm thick. Micropyle and micropylar cap absent. Oocystic residuum and polar granule absent. Parachute-shaped cap at each rounded end of developing sporocyst but disappearing with the development of sporozoites. Sporocyst elongate-

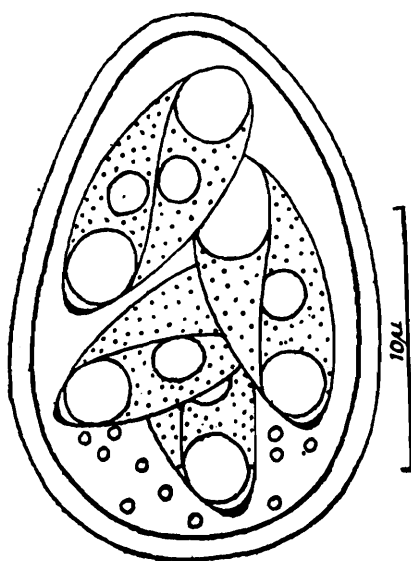


Fig. 143. Mature oocyst of *Eimeria alabamensis*.

ovoid, with slightly narrow ends, measuring 11-16 μm by 5-6 μm (mean 11.9 μm by 5.2 μm) in size. Stieda body absent. Sporocystic residuum absent. Sporozoites are elongated, banana-shaped each measuring 9 μm by 2.6 μm in size, with one end broader and other

tapering, having coarsely granular cytoplasm with three or more refractile globules, the larger at the wider end and the smallest towards the narrower tip. Prepatent period is 6-11 days.

Sporulation time : 8-10 days.

Dimensions of oocysts reported by other authors are as follows :

13-16 μm by 11-13 μm with a mean of 15.2 μm by 12.8 μm (Patnaik, 1965) ; 14-24 μm by 12-16 μm (Rakovec and Brglez, 1966) ; 17-24 μm by 12-16 μm with a mean of 21 μm by 14 μm (Bhatia *et al.*, 1968) ; 13-23 μm by 11-17 μm (Levine and Ivens, 1970) ; 13-24 μm by 11-16 μm with a mean of 18.9 μm by 13.4 μm (Pellerdy, 1974).

Type host : (Ox) Domestic cattle, *Bos taurus* (Linn.).

Other hosts : (i) Buffalo, *Bubalus bubalis* Linn.

(ii) Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Izatnagar, Agra, Mathura, Uttar Pradesh ; Karnal, Haryana.

Prevalence : Davis, Boughton and Bowman (1955) found 93% infection in dairy calves from United States ; Hasche and Todd (1959a) got 42% infection in cattle from Wisconsin ; Ruiz and Oritz (1961) obtained 20% infection in calves from Costa Rica ; Balconi (1963) received 43% infection in cattle from Guatemala ; Szanto, Mohan and Levine (1964) obtained 17% infection in cattle from Illinois, Missouri, Texas and Wyoming ; Patyk (1965) received 9% infection in calves from Poland ; Patnaik (1965) got 1% infection in buffaloes from Agra, India ; Joyner *et al.*, (1966) observed 14% infection in cattle from England ; Nyberg, Helfer and Knapp (1967) got 1% infection in cattle from Oregon ; Svanbaev (1967a) received 8% infection in calves from Kazakhstan, Bhatia *et al.*, (1968) reported 3% infection in buffaloes from Mathura, Uttar Pradesh, Vassiliades (1969) reported 2% infection in cattle from Senegal. Sayin (1969) got 10% infection in buffaloes from Turkey ; Jacobson and Worley (1969) observed 0.4% in calves from Montana.

Endogenous stages : The endogenous life-cycle of this particular species took place in nucleus of the intestinal epithelial cells, particularly to the posterior part of the small intestine as stated by Davis, Bowman and Boughton (1957). The sporozoites entered the epithelial cells of the villi of the small intestine, where they rounded off and became schizonts, they were generally in the distal end of the host cell but then entered the nucleus. The sporozoites became spindle-shaped each measuring 3-7 μm by 1.5-3 μm . Ultimately rounded off, measuring

2.8-3.5 μm . The mature schizont measures 8-18 μm gives rise to 16-32 sickle-shaped merozoites. Each merozoite measuring 7-9 μm by 1.4-2.1 μm . The micro and macrogametocytes are found intra nuclearly with in the epithelial cells of small intestinal villi. The microgametocyte measures 8.4-25.2 μm by 7-12 μm (average 15.6 by 11.5 μm), and macrogametocyte measures 7-19.6 μm by 7-11 μm (average 12 by 9.1 μm). Sampson, Hammond and Earnst (1971), Sampson and Hammond (1970), studied the ultra-structural details of schizogony in the monolayer cell culture.

Generally it is non-pathogenic, but sometimes it may exhibit some pathological symptoms in the laboratory. Davis, Bowman and Boughton (1957) observed that due to the infection of this parasite serosal enteritis developed in the lower half of the small intestine along with the massive destruction of the epithelial cells with leucocytic infiltration and villar edema. It destroyed the cell along with the nucleus. Double and rather multiple infections were found in a single cell. The schizonts as well as gametocyte might occur simultaneously in one and the same nucleus.

Prepatent period is 6-11 days as noted of Davis, Boughton and Bowman (1955); 7-9 days according to Smith and Davis (1965); 7-8 days according to Svanbaev (1967a).

Types : Not known.

Remarks : Gill (1960, 1968), Patnaik (1963, 1965) and Bhatia, Pande, Chauhan and Arora (1968) reported this species from different parts of India.

178. *Eimeria andamanensis* Mandal and Nair

(Fig. 144)

1973. *Eimeria andamanensis* Mandal and Nair, *Proc. Indian Acad. Sci.*, 77 : 273.

Distribution : Oocyst are always subspherical in shape each measuring 12.50-15.5 μm in length with a mean of 13.50 μm and 8.50-10.5 μm in width with a mean of 9.5 μm . Oocystic wall double layered, the outer is thinner one and measures 0.37 to 0.50 μm in thickness. In natural light it is pinkish in colour. The zygotic mass is spherical, clear, highly refractile and concentrated at the centre. It measures 7.5-8.5 μm in diameter. Micropyle is present, oocystic residuum is massive having a diameter 4.5-5.5 μm and located at one side in fully matured oocyst. Sporocysts are broadly pyriform;

sporocystic wall is double layered and both are very thin. Sporocyst measures $4.5-6.5\ \mu\text{m}$ in length with a mean of $5.25\ \mu\text{m}$ and $3.0-4.5\ \mu\text{m}$ in width with a mean of $3.75\ \mu\text{m}$. The shape index is 1.5. The anterior end of sporocyst is provided with a thick prominent area

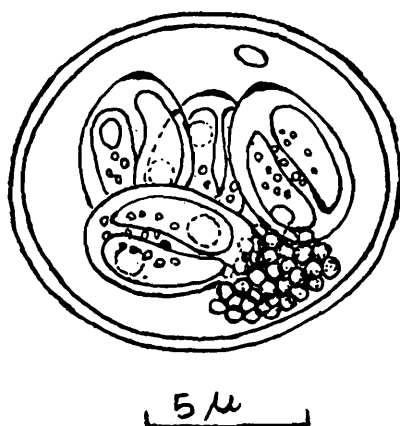


Fig. 144, Mature oocyst of *Eimeria andamanensis*.

and devoid of any plug. Sporozoite elongated ; the anterior end is more pointed than the bluntly pointed posterior end. It measures $2.5-3.5\ \mu\text{m}$ in length with a mean of $3\ \mu\text{m}$ and $1.5-2.75\ \mu\text{m}$ in width a mean of $1.5\ \mu\text{m}$ at the broader end. Sporozoites appear like shining elongated bodies within the sporocysts. The nucleus of the sporozoite is located at the posterior end and appears like a hyaline mass. The sporocystic residum is irregularly scattered inside the sporocyst and sometimes due to its enormous volume renders the observation of the sporozoite difficult.

Sporulation time : 24-36 hours.

Type host : Black headed Tomb bat, *Taphozous melanopogon* (Temminck)

Other hosts : Unknown.

Distribution : Haddo, Port Blair, Andaman Islands, India.

Endogenous stages : Unknown.

Types : Present in the collection of Zoological Survey of India, Registration No. Pt. 1581.

179. *Eimeria antilocervi* Ray and Mandal

1960. *Eimeria antilocervi* Ray and Mandal, *Bull. Calcutta Sch. trop. Med. Hyg.*, 8 : 57.
1970. *Eimeria antilocervi* Ray and Mandal, emend. Levine and Ivens, *Illinois. Biol. Monogr.*, 44 : 82.

Description : The cylindrical oocyst measures 28-34 μm by 12-16 μm . It is light brown in colour and has a distinct micropyle. Oocyst wall 1.5-2.0 μm thick, composed of a single layer. Oocystic polar granule not mentioned. Oocyst residuum absent. The pyriform sporocyst measuring 11 μm in length 7 μm in width. Sporocystic residual bodies present.

Sporulation time : 40-72 hours.

Type host : Black buck, *Antelope cervicaprae* [= *Antelope cervicapra* (Linn.)]

Other hosts : Unknown.

Distribution : Zoological Garden, Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

180. *Eimeria arloingi* (Marotel)

(Fig. 145)

1905. *Coccidium arloingi* Marotel, *Recl. Med. vet.*, 33 : 243 ; 1905, *Bull. Soc. Sci. vet. Med. Comp.*, Lyon., 8 : 52.
1909. *Eimeria arloingi* Martin, *Rev. Vet. (Toulouse)*, 34 : 201.

Description : The capped and typically ellipsoidal oocysts, of pale

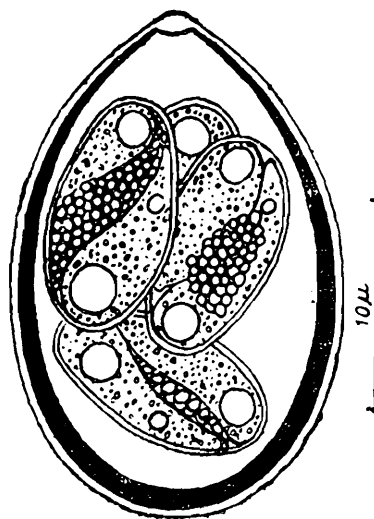


Fig. 145. Mature oocyst of *Eimeria arloingi*.

brownish yellow to orange in colour, exhibited a great variation in the size, each measuring 24.65-37.4 μm in length with a mean 30.3 μm . The prominent crescent-shaped polar cap, lying above the micropyle, measuring 3.4-7.6 μm by 1.7-3.4 μm in size. The shape index ranges from 0.16-0.82. The oocystic residuum absent. Sporocyst elongate ovoid with a rather truncated small end. Stieda body absent or vestigial. Sporocyst measures 11-17 μm in length and 6-10 μm in width with a mean of 13-15 μm by 7-8 μm . Sporocystic residuum present. Sporozoite elongated lying lengthwise, head to tail within the sporocyst. Sporozoite usually contains a large, clear globule at the broad end and a small one at the small end.

Sporulation time : One or 2 days, Ray (1952, 61) observed maturation time for *E. hawkinsi* as 10 hours at 37°C and 5-6 days at 21°C.

Dimensions of the oocysts reported by other authors are as follows :

17-42 μm by 13-27 μm (Christensen, 1938a) ; 24-38 μm by 18-20 μm (Honness, 1942) ; 25-38 μm by 17-25 μm (Balozet, 1932) ; 40-45 μm by 25-30 μm (Prasad, 1960) ; 29-41 μm by 20-28 μm average 23.76 μm by 24.14 μm in (Restani, 1966) ; 22-36 μm by 16-26 μm average 28 μm by 19-21 μm (Levine and Ivens, 1970).

Type host : Domestic goat, *Capra hircus* (= *Capra* sp.)

Other hosts : (i) From the type host (ii) Domestic Sheep, *Ovis* sp. (iii) Ladakh Goat, *Capra ibex* Linn., (iv) Rocky mountain bighorn Sheep, *Ovis canadensis*, Shaw (v) Mouflon, *Ovis musimon* Linn., (vi) Argali, *Ovis ammon* Linn.

Distribution : Hyderabad, Andhra Pradesh ; Orissa ; West Bengal ; Uttar Pradesh ; Madhya Pradesh ; Bombay, Maharashtra ; Bihar ; Punjab and also in the Zoological Garden, Lucknow, Uttar Pradesh.

Prevalence : Most common in sheep. Christensen (1938a) found in 9% of sheep from Idaho, Maryland, New York and Wyoming. From Tunisia, Balozet (1932) obtained it in 52% of sheep and 56% of goat. Jacob (1943) reported it in 58% sheep and 11% in goats from Germany. From Kazakhstan, Svanbaev (1957) reported this species and is predominant in goats rather than in sheep. Fernando (1967) got 43% infection in goats at Ceylon.

Location : Small intestine.

Endogenous stages : Lotze (1953) observed mature schizonts or globidia, each measuring 146 μm by 122 μm ; m contains enormous number of merozoites. Each merozoite measures 9 μm by 2 μm . Levine, Ivans and

Fritz (1962) studied two types of schizonts in kid. The small schizont sometimes measures 10-14 μm by 9-10 μm and contain 16-22 merozoites each measuring 9 μm by 8.4 μm . The giant schizont measures 280 μm by 150 μm with many merozoites each measuring 10-12 μm by 8.12 μm . But they thought that the small schizont might be either *E. arloingi*, *E. crandallis*, *E. christensen* or might be a fourth species which had not yet began to produce oocyst in the faeces. The mature microgametes were slender, each measuring 3.5 by 0.4 μm ; crescent-shaped structure arranged at the periphery around a residuum. The microgametocyte measures about 11-26 by 8-16 μm . The macrogamete measures 18-29 by 14.8-22.2 μm or 23.8-30.6 by 17-21.1 μm . Sometimes the gametocytes aggregate to form a white plaque of 5 mm in diameter on the mucus membrane of the small intestine.

Sayin (1965) observed only one type of immature giant schizont measuring 140 μm by 100 μm in the ileum of a goat. He further studied the microgametocyte measuring 15-23 by 10-14 μm and the macrogametocyte of 18-29 by 22.2-24.8 μm in size. From India, Singh and Pande (1967b) and Pande *et al.* (1967) studied the developmental stages in the large intestine of a goat and observed both micro and macrogametocytes each measuring 23.8-30.6 μm by 17-12.1 μm and 23.8-27.2 μm by 17-20.4 μm respectively. The former is found with many comma shaped microgametes.

Types : Not known.

Remarks : Levine and Ivens (1970) described *Eimeria ovina* from sheep and stated that *E. arloingi* of sheep can be separated from *E. arloingi* of goat due to presence of straight side wall in the oocyst with slightly flattened micropylar end. Levine (personal communication) further stated that number of species of goat do not infect sheep and *vice versa*. Therefore the Coccidia of goat and sheep require thorough revision [vide *E. ovina* Levine and Ivans (1970)].

Most common species of goat, from India authors like Ray (1949), Sharma (1951-52), Rao and Hiregaudar (1954), Gill and Katiyar (1961), Singh (1963, 1964), Shah and Joshi (1963), Pande, Bhatia, Dubey and Srivastava (1964), Sivdas, Rajan and Nair (1965), Sharma Deorani (1966), Jha and Subramanian (1965), Bhatia and Pande (1966, 69 and 70), Bali (1972), Misra and Mohapatra (1972), Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973), Bhatia, Chauhan, Arora and Agarwal (1973) and Krishnamurthy and Kshirsagar (1976) reported this parasite from different parts of India. Fernando (1957) reported it from Sri Lanka.

181. *Eimeria auburnensis* Christensen and Porter

(Fig. 146)

- 1939 *Eimeria auburnensis* Christensen and Porter, *Proc. helminth. Soc. Wash.*, 6 : 45.
 1939. *Eimeria ildefonsi* Torres and Ramos, *Argu. Inst. Pesquisas Agronom.*, 2 : 79,
 1954. *Eimeria bombayensis* Rao and Hiregaudar, *Bombay vet. Coll. Mag.*, 4 : 24.
 1959. *Eimeria* sp. Pop-cenitch and Bordjocoki, *Acta. vet. Beograd.*, 9 : 65.

Description : Oocyst ovoid or ellipsoidal, with a narrower micropylar end, of 32-44 μm by 20-27 μm (mean 38 μm by 24 μm) in size, (length width ratio 1.36-1.74 mean 1.58). Oocystic wall smooth but occasionally coarsely granular, yellowish brown, 1.5-2.0 μm thick. Micropyle 3-5 μm wide. Micropylar cap absent. Oocystic residuum absent. Two or three polar granules present in some oocysts. Sporocyst elongate-ovoid or ellongate-ellipsoidal, measuring 17-21 μm by 8-9 μm (mean 19 μm by 8 μm in size). Stieda body present as a dark knob over the narrower end. Sporocystic residuum present as a centrally

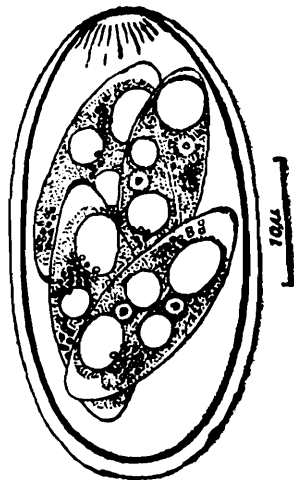


Fig. 146. Mature oocyst of *Eimeria auburnensis*.

situated mass of granules or in scattered groups or arranged as a streak along the sporozoites. Sporozoite elongate, with one end broader and other narrower, 15-18 μm by 4 μm in size. Two refractile globules present, the larger towards the wider end and the smaller towards the narrower end with a nucleus surrounded by fine granules, lying between the two globules. Prepatent period is about 18 days.

Sporulation time : 3-4 days.

Dimensions of the oocysts reported by other authors are as follows :

31-44 by 20-27 μm with a mean of 38 by 24 μm (Bhatia *et al.*, 1968) ; 35-44 by 19-26 μm with a mean of 37 by 22 μm (Nyberg and

Hammond, 1965) ; 32-46 by 20-25 μm with a mean of 38.4 by 23.1 μm (Pellerdy, 1974).

Type host : Ox, *Bos taurus* (Linn.).

Other hosts : Indian cattle, *Bos indicus* (= *Bos* sp.) ; Zebu (*Bos indicus*) [= *Bos* sp.] ; Buffalo, *Bubalus bubalis* Linn.

Distribution : Izatnagar, Agra, Mathura, Uttar Pradesh ; Karnal, Haryana.

Prevalence : Davis and Bowman (1952) found cent percent infection in calves from Alabama ; Hasche and Todd (1959a) obtained 45% infection in cattle from Wisconsin ; Szanto, Mohan and Levine (1964) reported 46% infection in beef calves from Illinois ; Nyberg, Helfer and Knapp (1967) observed 14% infection in cattle from Oregon ; Jacobson and Worley (1969) got infection in 32% calves and 12% cattle from Montana. Torres and Ramos (1939) reported 32% infection in cattle from Brazil ; Supperer (1925) found 3% infection in cattle from Austria ; Joyner *et al.*, (1966) got infection in 34% cattle of England ; Marinkelle (1964) reported 32% infection in calves from Colombia. Ruiz and Oritz (1961) observed 1% infection in calves from Costa Rica ; Balconi (1963) reported 43% infection in cattle from Guatemala ; Watanebe and Iwata (1956) reported 2% infection in cattle from Japan ; Chroust (1964) observed 18% infection in calves from Czechoslovakia ; Patyk (1965) noted 15% infection in calves from Poland ; Vassiliades (1969) reported 12% infection in cattle from Senegal ; Svanbaev (1967a) observed 5% infection in cattle at Kazakhstan. According to Lee and Armour (1959) this species was very common at Vom Nigeria ; Sayin (1969) reported 44% infection in buffaloes from Turkey ; Patnaik (1965) found 19% infection in buffaloes from Agra, Uttar Pradesh, India and Bhatia *et al.* (1968) got 32% infection in buffaloes from Mathura, Uttar Pradesh, India.

Endogenous stages : Several authors have worked on the endogenous cycle of *E. auburnensis*. Hammond, Clerk and Miner (1961) were the first who attempted to trace the life-cycle of the parasite. They reported the sexual stage in the ileal villi and the mesodermal cells of the lamina propria. The microgametocyte measured 67-103 μm by 48-83 μm with the mean of 85 μm by 65 μm containing thousands of microgametes. Each microgamete measures 4-8 μm by 0.5-0.75 μm with two flagella each about 10-12 μm long.

Davis and Bowman (1962) encountered the giant schizont measuring 78-250 μm by 48-150 μm with the mean of 140 μm by 92 μm in the

lamina propria of the small intestine. The microgametocyte measures 36-288 μm by 27-150 μm with the mean of 125.5 μm by 79.5 μm . Chobotar and Hammond (1967) have described the globidial schizont measuring 78-250 μm by 48-150 μm with the mean of 140 μm by 92 μm , located in the epithelial cells lining the crypt of Lieberkuehn.

Scholtyssek, Hammond and Ernst (1966) studied the ultrastructure and noted the glycogen granule of 0.3-1.0 μm in diameter at the margin of the macrogamete, associated with one or more adjacent granules. The dark bodies were found large each measuring 1.5 μm in diameter. The wall forming bodies, each measuring 1.7 μm in diameter differentiated from the dark bodies by their slightly larger size, were also encountered. The parasitophorous vacuole relatively large, containing amorphous electron-dense material, appeared around the macrogamete. The process of pinocytosis was encountered in the macrogametes (Scholtyssek, Hammond and Chobotar (1967).

Hammond, Scholtyssek and Miner (1967) reported thousands of irregularly arranged nuclei inside the microgametocyte except at the surface while studying the ultrastructure. The glycogen granules were not seen but large and small thick-walled vacuoles either empty or containing electron dense material were encountered. The parasitophorous vacuoles were present at early development of microgametes but usually not found around the mature one.

Hammond, Scholtyssek and Chobotar (1969) studied the ultrastructure of the microgametocyte. They noticed a compact nucleus and relatively few electron-dense masses in the nucleus of developing microgametocyte. The basal body of the flagellum appeared at the anterior end of the mature microgamete with large mitochondrion.

Hammond, Ernst and Chobotar (1967) and Hammond, Chobotar, and Ernst (1968) encountered broadly lanceolate sporozoites each measuring 16-21 μm by 3.5-9 μm with the mean of 18.7 μm by 5.6 μm . The sporozoite is vesicular having a large refractile body at the posterior end with one or more smaller bodies anterior to the nucleus. There is a nipple like projection at the anterior end, occasionally with median rod like bodies.

Chobotar (1968) reported mature smaller schizont measuring 6-12 μm by 5-9 μm with the mean of 8.5 μm by 6 μm in the lamina propria of small intestine, 12-14 days after inoculation. The schizont is provided with 4-11 spindle-shaped merozoites each measuring 7-9 μm by 1-2 μm with the mean of 8 μm by 1.5 μm . The microgametocyte measures 61-151 μm by 42-109 μm with the mean of 103 μm by 70 μm .

In India, Patnaik and Pande (1965) and Bhatia and Pande (1967b) described the endogenous stages. However they were dealing with a mixed infection.

According to Christensen and Porter (1939) prepatent period is 24 days ; Hammond, Clark and Miner (1961) reported it as 18-20 days ; Svanbaev (1967a) encountered the same as 18-19 days ; Chobotar (1968) noted it as 16-17 days.

Types : Not known.

Remarks : Authors like Gill (1960a, 68), Patnaik (1963), Bhatia, Pande, Chauhan and Garg (1971) reported it from different parts of India.

182. *Eimeria aurei* Bhatia, Chauhan, Agarwal and Ahluwalia

(Fig. 147)

1979. *Eimeria aurei* Bhatia, Chauhan, Agarwal and Ahluwalia, *Indian J. Parasit.*, 3 : 49.

Description : The oocysts are subpherical in shape each measuring 15.0-17.0 μm in length with a mean of 16.3 μm and 13.0-15.0 μm in width with a mean of 14.7 μm . The thin and smooth oocystic wall of about 1.0 μm in thickness, consisting of inner dark brown and outer

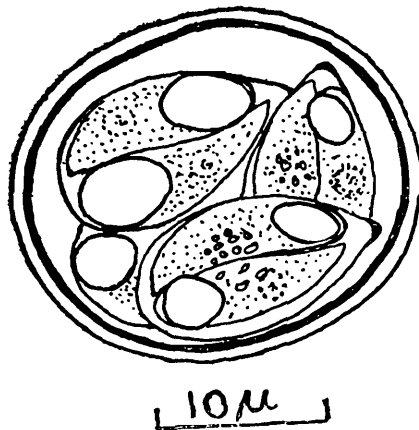


Fig. 147. Mature oocyst of *Eimeria aurei*.

straw-coloured layers. There is no micropyle and oocystic residuum. One or more polar granules present as small dark particles. Sporulated oocyst contains four sporocysts, which are ellipsoidal in shape each with one end broad and other narrow carrying a distinct stieda body as a small dark thickening. The sporocyst measures 8.7-10.7 μm in length

with a mean of $10.2\ \mu\text{m}$ and $5.3\text{-}6.7\ \mu\text{m}$ in width with a mean of $5.7\ \mu\text{m}$. Sporocystic residuum is present as round mass of coarse granules. Elongated sporozoites are two in number lie head to tail inside the sporocyst and each measures $9.0\ \mu\text{m}$ in length and $2.6\ \mu\text{m}$ in width. A large refractile globule is present at the broader end of the sporozoite.

Sporulation time : Unknown.

Type host : Jackle, *Canis aureus naria*.

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

183. ***Eimeria bandipurensis*** Ray, Banik and Mukherjee

(Fig. 148)

1965. *Eimeria bandipurensis* Ray, Banik and Mukherjee, *J. Protozool.*, 12 : 478.

Description : Oocyst spherical or egg-shaped the former measuring $16\text{-}18\ \mu\text{m}$ with a mean of $17\ \mu\text{m}$ and the later measuring $16\text{-}20\ \mu\text{m}$ by $14\text{-}18\ \mu\text{m}$ with a mean of $18\ \mu\text{m}$ by $16\ \mu\text{m}$. It is provided with double wall of uniform thickness and pale yellow in colour. Micropyle and

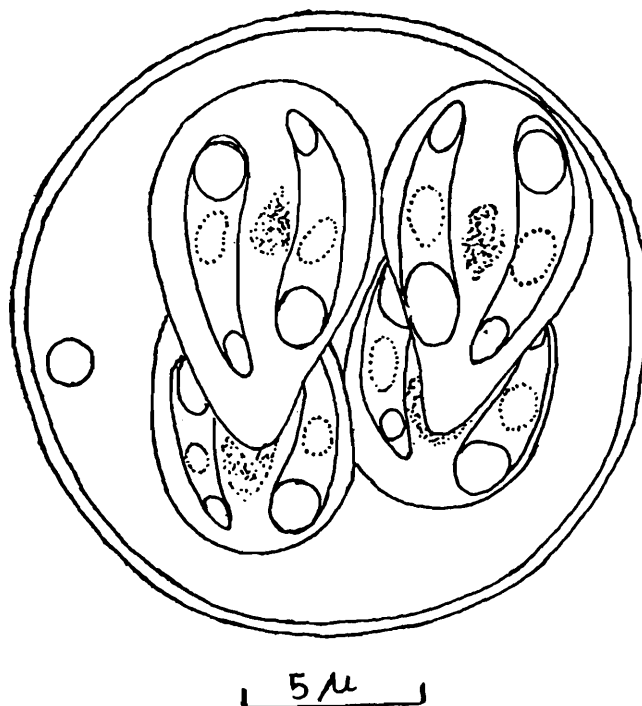


Fig. 148. Mature oocyst of *Eimeria bandipurensis*.

oocystic residuum absent. Sporocysts broadly pear-shaped each with a stieda body at the narrow end. It measures 6-10 μm in length with a mean of 8 μm and 6-8 μm in width with a mean of 6.5 μm . The sporocystic residuum present as refractile globules lying in between the two sporozoites. Sporozoites banana-shaped each with one end rounded and other pointed, having a clear globule at each end. Oocyst measuring 15-19 μm by 20-25 μm was noted by Joseph (1979). He further observed the surface pitting and striations on the outer wall of the oocyst.

Sporulation time : 48-120 hours.

Type host : Indian Palm Squirrel, *Funambulus palmarum* (Linnaeus).

Other hosts : Unknown.

Distribution : Bandipur, West Bengal ; Kottayam, Kerala, Mandal (1976) and Joseph (1979),

Endogenous stages : Unknown.

Types : Not kdown.

184. *Eimeria bareillyi* Gill, Chhabra and Lall

(Fig. 149)

1963. *Eimeria bareillyi*, Gill, Chhabra and Lall, *Arch. Protistenk.*, 106 : 571.

Description : Oocysts are pyriform, each with the narrower anterior end truncated and slightly flattened, measuring 24-31 μm in length

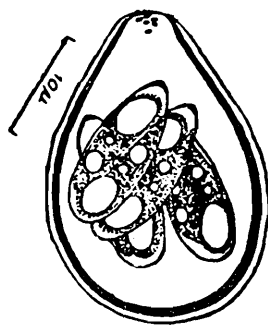


Fig. 149. Mature oocyst of *Eimeria bareillyi*.

and 15-21 μm in width with a mean of 28 μm by 19 μm . The length/width ratio is 1.3-1.8 with the mean of 1.4. A mass of few granules, as a small body laying below the micropyle both in unsporulated and sporulated oocysts, is seen. Oocystic wall double-layered,

yellowish brown ; residuum and polar granule absent. Sporocysts elongate-ovoid, each with one end broader and the other pointed, 15-18 μm by 7-8.5 μm (mean 17 μm by 7.3 μm) in size. Stieda body present ; sporocystic residuum is present as a small central mass or scattered in the middle of the sporozoite. Sporozoites elongated, somewhat banana-shaped, each measuring 12 μm by 4 μm in size, with one end broader and the other pointed ; having two refractile globules, a larger at the broader end and the smaller lying with a centrally placed nucleus at the anterior end. The prepatent period is 12-13.5 days as noted by Shastri *et al.* (1973)

Sporulation time : 3-4 days. Chauhan *et al.* (1980) noted that the optimum tempt. for sporogony is between 30°C-35°C, when minimum 4 days require for maturity. Lethal tempt. is noted as 40°C.

Dimension of the oocysts reported by other authors are as follows :

24-31 by 15-21 μm mean 28.0 μm by 19.0 μm (Bhatia *et al.*, 1968) ; 28.6-35.0 μm by 20.0-25.7 μm mean 31.6 μm by 22.6 μm (Krishnamurthi and Shastri, 1976).

Type host : Buffalo, *Bubalus bubalis* Linn.

Distribution : Bareilly, Izatnagar, Mathura, Uttar Pradesh ; Parbhani, Maharashtra.

Prevalence : Bhatia *et al.* (1968) found 5% infection in buffaloes from Mathura, Uttar Pradesh and reported that higher incidence is found in rainy season than the winter or summer ; Shastri *et al.* (1974) reported some infection in Maharashtra.

Endogenous stages : While studying the endogenous cycle of *E. bareillyi*, Pande, Bhatia and Chauhan (1971) found slight prominent, whitish, opalescent areas of 3-6 μm in diameter at the anterior portion of the jejunum. Typically pyriform oocysts were also obtained each measuring 23-27 μm by 13-17 μm with the mean of 24.6 μm by 14 μm . Oocystic wall is of 1.3 μm thick carrying a prominent and almost flat micropyle 4-5 μm wide from mucosal scrapings. The microgametocyte measuring 20-37 μm by 18-25 μm and possesses 2.6-3 μm long microgamete, were also encountered. The macrogametocyte measures 23-25 μm by 14-17 μm enclosing a large nucleus and plastic granules. The parasites are located supranuclearly in the epithelial cells of the villi and subnuclearly in the epithelial cells of the crypts. The schizogonic stages have not yet been observed. Shastri and Krishnamurthi (1975) found this species abundantly in the middle third of jejunum through out the length of the villi.

Prepatent period 12-13 days as noted by Shastri and Krishnamurthi (1975).

Types : Not known.

Remarks : In addition, authors like Chhabra (1968), Bhatia, Pande, Chauhan and Garg (1971) and Shastri, Krishnamurthi and Ghafoor (1973) reported this parasite from different parts of India. Chauhan *et al.* (1980) studied the epidemiology of this parasite.

195. *Eimeria bovis* (Zublin)

(Fig. 150)

- 1908. *Coccidium bovis* Zublin (in partim) Schweizer, *Arch. Treiherlk.*, 50 : 123.
- 1912. *Eimeria bovis* Fiebiger, *Die tierischen Parasiten der Haus und Nutztiere, Ein Lehr- und Handbuch mit Bestimmungstabellen für Tierärzte und Studierende.*, Wein und Leipzig. XVI+424 pp.
- 1921. *Eimeria canadensis* Bruce (partim), *J. Am. vet. med. Ass.*, 58 : 638.
- 1927. *Eimeria smithi* Yakimoff and Galouzo, *Arch. Protistenk.*, 58 : 185.
- 1935?. *Globidium fusiformis* Hassan, *Indian J. vet. Sci.*, 5 : 177.
- 1953. *Eimeria* (*Globidium*) *bovis* Reichnow, *Lehrbuch der Protozoenkunde Jena*, 777.
- 1959. *Eimeria aureyi* Rao and Bhatawadekar, *Bombay vet. Coll. Mag.*, 8 : 23.

Description : Oocyst broadly ovoid, with a narrower micropylar end, 23-33 μ m by 15-26 μ m (mean 28 μ m by 21 μ m) in size (length/

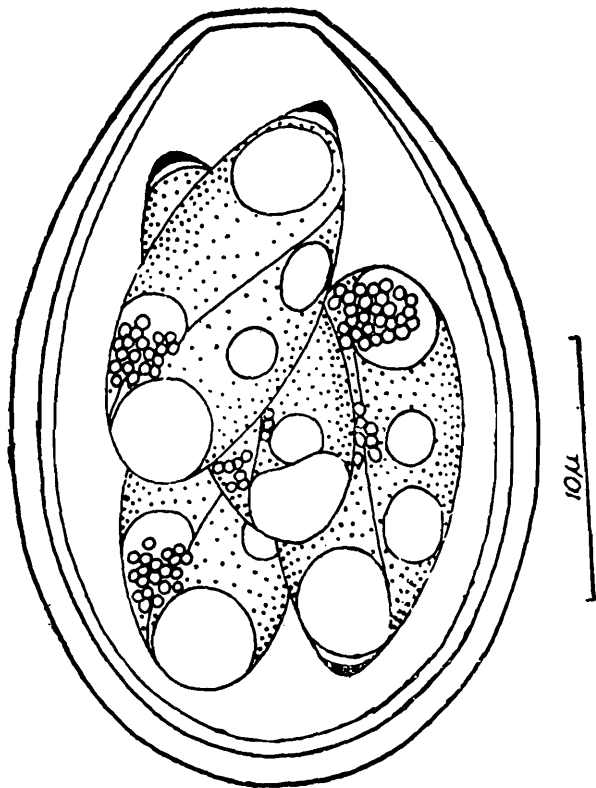


Fig. 150. Mature oocyst of *Eimeria bovis*.

width ratio 1.2-1.5, mean 1.36). Oocytic wall smooth, double layered, light yellowish brown of $1.5\ \mu\text{m}$ thick. Micropyle present as a light area at the narrower end. Micropylar cap absent. Oocystic residuum and polar granules absent. Sporocyst elongated ovoid, of $15\text{-}17\ \mu\text{m}$ by $6\text{-}7\ \mu\text{m}$ (mean $16\ \mu\text{m}$ by $6.6\ \mu\text{m}$) in size. Stieda-body is capping the narrower end as dark knob. Sporocystic residuum granular, lies along the longitudinal axis of sporozoites. Sporozoite elongate, somewhat banana-shaped, of $13\ \mu\text{m}$ by $3\ \mu\text{m}$ in size with finely granular cytoplasm, having two refractile globules, the larger one lies at its wider end and the other towards the tapering extremity ; with a centrally situated nucleus surrounded by small granules.

Sporulation time : 3-4 days.

Type host : Ox, *Bos taurus* (Linn.)

Other hosts : (i) Zebu, *Bos indicus* (= *Bos* sp.), (ii) Buffalo, *Bubalus bubalis* Linn. (iii) Indian cattle, (Domestic) *Bos indicus* (= *Bos* sp.) (iv) Indian Bison or Gour, *Bos gaurus* (H. Smith).

Dimension of the oocysts reported by other authors are as follows :

$30\text{-}35\ \mu\text{m}$ by $20\ \mu\text{m}$ (Zublin, 1908) ; $23\text{-}34\ \mu\text{m}$ by $17\text{-}23\ \mu\text{m}$ with a mean of 27.7 by $20.3\ \mu\text{m}$ (Christensen, 1941) ; $25\text{-}33\ \mu\text{m}$ by $14\text{-}23\ \mu\text{m}$ with a mean of $28\ \mu\text{m}$ by $20\ \mu\text{m}$ (Nyberg and Hammond, 1965).

Distribution : Agra, Mathura, Izatnagar, Uttar Pradesh ; Karnal, Haryana ; Aurey Milk Colony, Bombay, Maharashtra and Betla Forest, Palamau, Bihar.

Prevalence : Boughton (1945) found 41% infection in bovine from United States ; Hasche and Todd (1959a) observed 41% infection in cattle from Wisconsin ; Szanto, Mohan and Levine (1964) got 52% infection in calves from Illinois. Nyberg, Helfer and Knapp (1977) reported 62% infection in cattle from Oregon ; Jacobson and Worley (1969) received 61% infection in calves and 30% in cattle from Montana. Fitzgerald (1962) reported as a predominant species in the cattle of Utah ; Supperer (1952) observed 66% infection in cattle from Austria ; Joyner *et al.* (1966) reported 75% infection in bovis from England. Chroust (1964) received 69% infection in calves from Czechoslovakia ; Patyk (1969) got 23% infection in calves from Poland ; Torres and Ramos (1939) found 49% infection in cattle from Brazil. Balconi (1963) reported 41% infection in cattle from Guatemala ; Ruiz (1959) got 7% infection in cattle from San Jose, Costa Rica. Vassiliades (1959) got 21% in cattle from Senegal ; Yakimoff, Gousseff and Rastegaieff (1932) reported 40% infection in the cattle of Uzbekistan. Yakimoff (1933) received

44% infection in zebu, 30% in cattle and 23% in buffalo from Azerbaidzhan. Marchenko (1937) reported 54% infection in cattle from North Caucasus. Patnaik (1965c) reported 52% infection in buffalo from Agra, Uttar Pradesh and Rao and Hiregauder (1954a) found some infection in buffalo from Bombay, India. Svanbaev (1967a) got 26% in cattle from Kezakhstan. Bhatia *et al.* (1968) reported 31% in buffalo from Mathura, Uttar Pradesh, India ; Sayin (1969) got 34% infection in buffalo from Turkey.

Endogenous stages : Hammond *et al.* (1946) have observed the sporozoites in the small intestine invading the endothelial cells of the lacteals in the villi. The schizonts appeared after 5 days and formed the giant schizonts after 14-18 days from the date of inoculation. Each mature schizont measured 207-435 μm by 134-267 μm with the mean of 281 μm by 203 μm containing numerous merozoites. The schizonts appear as white balls, visible in naked eyes. The sexual stages in the epithelial cells of intestinal glands, caecum and colon had also been observed by the same authors. The macrogamete was provided with the plastic granules inside the cytoplasm.

Hammond, Anderson and Miner (1963), first pointed out the second schizogonic generation. The mature schizonts were encountered in the epithelial cells of the caecum and colon each measuring 9 μm by 10 μm in diameter, containing 30-36 merozoites each of 3.5 μm by 1.1 μm in size. Finally the merozoite attained the size of 6-7 μm in length.

Hammond, Ernst and Goldman (1965) studied the first generation merozoites in details where each merozoite measured 11-16 μm by 1-2 μm with the mean of 13.5 μm by 1.4 μm in size. The merozoites showed flexing and gliding movements *in vitro* and revealed a dark caplike covering with a terminal pore anteriorly. Some granules in the posterior 2/3 and a rod-like structure extending along the middle of the merozoite were found. The nucleus was localized at the posterior third of the body with the chromatin arranged around the periphery of the nucleus.

Sheffield and Hammond (1966) studied the ultrastructure of first generation merozoites. They detected spindle-shaped merozoite with 22 subpellicular fibrils from a polar ring, formed at the anterior part of the merozoite. The conoid consists of one or more fibrils round in a tight helix and two rhoptries passed through the conoid. Numerous glycogen granules, ribosomes and one or two mitochondria were encountered in the cytoplasm. The golgi apparatus was located at the flattened anterior end of the nucleus. The endoplasmic

reticulum consists of numerous cisternae, presents both posterior and anterior to the nucleus.

Hammond, Ernst and Miner (1966) allowed the sporozoites to invade upto 8 days and found the daughter nuclei along the periphery of the schizonts with the pellicular invagination. Round or elliptical blastopores measuring 5-20 μm in diameter was recorded on the 12th day. A single row of the blastopores was also detected at the periphery formed by the nuclei which ultimately extended as radial outgrowths leaving a short survival residual bodies of various sizes.

Scholtyseck, Hammond and Ernst (1966) studied the ultrastructure of the macrogametes. Glycogen inclusion measuring 0.3-1.3 μm in diameter, lipid bodies and wall forming bodies about 1.8 μm long were observed in the macrogamete. Microtubule measuring about 500° A in diameter and 1000° A deep appeared as blind pouches on the surface of the macrogamete. The nucleus is provided with relatively large nucleolus having prominent granules in the karyosome with some pores on the nuclear membrane.

Sheffield and Hammond (1967) noted the ultrastructural structure of the first schizont. They noticed that the cytoplasm is divided into many blastopores. Many nuclei are formed resulting from the repeated divisions and arranged at the periphery of each blastopore. They formed a complex structure in the cytoplasm of each merozoite at the anterior end. A thickened layer under the cytoplasmic membrane appeared in the inner membrane of the merozoite. A central opening located at the membrane corresponding to the conoid was also noticed with the subpellicular fibrills. The merozoite developed through the blastopore to a cone-shaped projection alongwith a finger-like bud, containing the rhoptries of a nucleus. Golgi apparatus and other cytoplasmic structures appeared from the blastopore. The blastopore hold the attachment of the merozoite and remained as such until the the attachment was dislocated,

Hammond, Scholtyseck and Miner (1967) studied the fine structure of the macrogametocyte.

In India very little work on the endogenous stages has been done. Patnaik and Pande (1965) and Bhatia and Pande (1967b) attempted to describe the schizogonic process in the small intestine of buffalo but the species was tentatively identified, and they were dealing with mixed infection. Pande *et al.* (1968) described several stages from the same host but did not assign them as *E. bovis*,

Prepatent period : 16-21 days according to Hammond, Davis and Bowman (1944); 18-20 days also noted by Hammond *et al.* (1946); 7-16 days have been found by Senger *et al.* (1959) and 17-18 days by Svanbaev (1967a).

Types : Not known.

Remarks : Report on the occurrence on this parasite in India may be had from Ware (1936), Gill (1960a, 68), Patnaik (1963, 65c); Bhatia, Pande, Chauhan and Garg (1971) and Mandal and Chaudhury (1981).

186. *Eimeria brasiliensis* Torres and Ramos

(Fig. 151)

1939. *Eimeria brasiliensis* Torres and Ramos, *Argu. Inst. Pesquisas. Agronom.*, 2 : 79.
 1952. *Eimeria boehmi* Supperer, *Osterreich Zool. Ztschn*, 3 : 591.
 1952. *Eimeria orlovi* Basanov (vide Pellerdy, 1974).
 1959. *Eimeria gokaki* Rao and Bhatawadekar, *Bombay vet. Coll. Mag.*, 8 : 23.
 1961. *Eimeria helenae* Donciu, *Cercetari asupra coccidiilor la animale le domestice in R. P. R. Bucuresti. Ed. Acad. Rep. Pop. Rom., Bucurest.* pp. 89.

Description : Oocyst ellipsoidal or ovoidal, 31-44 μm by 20-29 μm (mean 39 μm by 27 μm) in size, (length-width ratio 1.35-1.56, mean 1.44). Oocystic wall double layered, colourless to slightly yellowish-

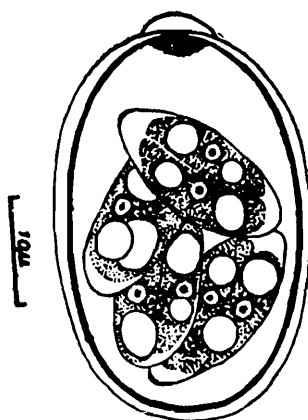


Fig. 151. Mature oocyst of *Eimeria brasiliensis*.

brown, 1.3 μm thick. Micropyle 6-7 μm wide. Micropylar cap present, 8-10 μm by 0.8-3.0 μm (mean 9.0 μm by 2.3 μm) in size. Oocystic residuum and polar granule absent. A light small homogenous protoplasmic granular mass, as a small body, present below the micropyle in most of the oocysts either unsporulated or sporulated. Sporocyst elongate-ovoid, measuring 17-21 μm by 8-9 μm (mean 20 μm by 8.4 μm) in size. Stieda-body present as a fine cap at the narrower pole. Sporozo-

cystic residuum present as small granular mass at different positions near the centre, in one side or towards the poles. Sporozoite elongate, banana-shaped, of $16\ \mu\text{m}$ by $4.7\ \mu\text{m}$ in size, having one end broader and the other bluntly tapering with a large refractile globule at the wider end and a smaller between the nucleus surrounded by fine granules, and the narrower tip.

Sporulation time : 5-6 days.

Dimension of the oocyst reported by other authors are as follows :

$34\text{-}43\ \mu\text{m}$ by $24\text{-}30\ \mu\text{m}$ with a mean of $37\ \mu\text{m}$ by $27\ \mu\text{m}$ (Torres and Ramos, 1939) $34\text{-}49\ \mu\text{m}$ by $21\text{-}33\ \mu\text{m}$ (Supperer, 1952) ; $37\ \mu\text{m}$ by $26\ \mu\text{m}$ (Bazanov, 1952, cit. Orlov, 1956) ; $38\ \mu\text{m}$ by $26\ \mu\text{m}$ (Donciu, 1961) ; $31\text{-}34\ \mu\text{m}$ by $20\text{-}29\ \mu\text{m}$ with a mean of $39\ \mu\text{m}$ by $27\ \mu\text{m}$ (Bhatia, *et al.* 1968) ; $37\text{-}38\ \mu\text{m}$ by $21\text{-}28\ \mu\text{m}$ (Rakovec and Brgiez, 1966) ; $33\text{-}42\ \mu\text{m}$ by $23\text{-}30\ \mu\text{m}$ with a mean of $38.5\ \mu\text{m}$ by $26\ \mu\text{m}$ (Ernst Stevens and Copper, 1971).

Type hosts : Ox, *Bos taurus* (Linn.).

Other hosts : (i) Buffalo, *Bubalus bubalis* Linn. (ii) Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Mathura, Izatnagar, Uttar Pradesh ; Bombay, Maharashtra ; Karnal, Haryana.

Prevalence : Hasche and Todd (1950a, b) found 3% infection in cattle from Wisconsin ; Bhatia *et al.* (1968) got 2% infection from water buffalo in India. The percentage of infection varies from 1.6% to 7% as reported by different authors (Levine and Ivens, 1970) from Brazil, England, Austria, Rumania, Kazakhstan and Turkey.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Gill (1960a), Patnaik (1963, 65c) and Rao and Bhatawadekar (1959) reported this species from different parts of India.

187. *Eimeria bukidnonensis* Tubangui

(Fig. 152)

1931. *Eimeria bukidnonensis* Tubangui, *Philip. J. Sci.*, 44 : 253.

1935. *Eimeria thianethi* Gwelessiany, *Annls. Parasit. hum. comp.*, 13 : 338.

Description : Oocyst pyriform, measuring $38\text{-}46\ \mu\text{m}$ in length and $25\text{-}35\ \mu\text{m}$ in width with a mean of $42\ \mu\text{m}$ in length and $31\ \mu\text{m}$ in width. The length/width ratio is 1.2-1.5 Oocystic wall dark, yellowish

to brown, two-layered, the thicker outer wall of $2.9\ \mu\text{m}$ with interrupted radial striations/streaks and spotted or speckled with irregular refractile dark protuberances, and an inner wall of $1.0\ \mu\text{m}$ thickness. On rupture of the outer oocystic coat, minute granules liberated on the inner coat. Micropyle at the narrow end is $3.8\text{-}4.7\ \mu\text{m}$ (mean $4.0\ \mu\text{m}$) wide.

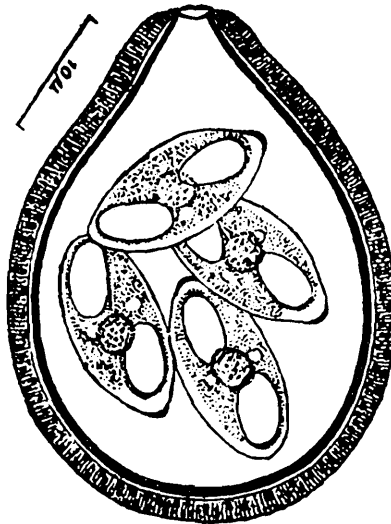


Fig. 152. Mature oocyst of *Eimeria bukidnonensis*.

Micropylar cap absent. Sporocyst ovoid, measuring $15\text{-}19\ \mu\text{m}$ in length and $8\text{-}11\ \mu\text{m}$ in width with a mean of $17\ \mu\text{m}$ in length and $9\ \mu\text{m}$ in width. Stieda body present as a dark cap over the narrower end. Sporocystic residuum present as a rounded mass of fine granules mostly situated centrally. Sporozoite elongate, with one end much broader and the other bluntly pointed, measuring $13.3\ \mu\text{m}$ in length and $5.3\ \mu\text{m}$ in width having a large globule at the broader end and a nearly central nucleus. Prepatent period is 25 days.

Sporulation time : 5-7 days.

Dimansion of the oocysts as reported by other authors are as follows :

$47\text{-}50$ by $33\text{-}38\ \mu\text{m}$ with a mean of $48.6\ \mu\text{m}$ by $36.6\ \mu\text{m}$ by (Tubangui, 1931) $33\text{-}41\ \mu\text{m}$ by $24\text{-}28\ \mu\text{m}$ with a mean of $36.6\ \mu\text{m}$ by $26.7\ \mu\text{m}$ (Christensen, 1941) ; $34\text{-}50$ by $26\text{-}34\ \mu\text{m}$ with a mean of $39\ \mu\text{m}$ by $30\ \mu\text{m}$ (Svanbaev, 1967a) ; $43\text{-}54\ \mu\text{m}$ by $29\text{-}29\ \mu\text{m}$ (Levine and Ivens, 1970).

Type Host : Domestic cow, *Bos indicus* (= *Bos* sp.)

Other hosts : From the type host and Buffalo, *Bubalus bubalis* Linn.

Distribution : Mathura, Izatnagar, Uttar Pradesh ; Karanal, Haryana.

Prevalence : Initially Christenten (1938b) reported this species from American Cattle. Szanto, Mohamad and Levine (1964) found 1%

infection in calves from Illinois ; Jacobson and Worley (1969) got 9% in calves, and in cattle from Montana ; Joyner *et al.* (1966) observed 2% in cattle from England ; Patyk (1965c) received 30% in Calves from Poland ; Patnaik (1965) obtained 3% in buffaloes from Gaya, India ; Bhatia *et al.* (1968) noted 5% infection in buffaloes from Mathura, India ; Svanbaev (1967a) recorded 9% in cattle from Kazakhstan.

Endogenous stages : Very little is known about the endogenous cycle of *E. bukidnonensis*. Davis and Bowman (1964) found the binucleated schizont measuring 5.5 μm in diameter after 11 days from the date of infection inside the parasitophorous vacuole of 11 μm wide and about 12 feet back from the caecum. Also they reported numerous merozoites each measuring 9-13 μm long throughout the small intestine, after 13 days from the date of infection. Large number of oocysts were observed beneath the epithelium about half way down to the muscularis mucosa after 25 days.

Prepatent period ; Ten days according to Baker (1939), 15-17 days as noted by Davis and Bowman (1964) and according to Svanbaev (1967a) it is 24-25 days.

Types : Not known.

Remarks : Further information may be had from Gill (1960a, 68 and 73) and Patnaik (1963).

188. *Eimeria cameli* (Henry and Masson)

1932. *Globidium cameli* Henry and Masson, *Ann. Parasit.*, 10 : 385.
 1950. *Eimeria casahstanica* Tsygankov, In Russian *Izv. Akad Nauk Kaz. SSR. Ser. Parazitol.*, 8 : 174.
 1953. *Eimeria (Globidium) cameli* Reichenow, *Doflein's Lehrbuch der Protozoenkunde*, 6th ed Jena, pp. 777-1213.
 1956. *Eimeria noelleri* (Henry and Masson) Pellerdy, *Acta vet. hung.*, 6 : 75.

Description : The oocysts are ovoid, each measuring 67 μm in length and 57 μm in width. The oocystic wall is three layered ; the outermost thick, pitted and of greenish-yellow colour, the middle darker, and the innermost dark-green. A micropyle is visible at the anterior end. The centrally placed sporont measured 41 μm in diameter. According to Ziganoff (1950) the sporont was 43.5 μm in diameter, the sporocyst measured 40-50 μm in length and 14.5-20 μm in width (mean 44.7 μm by 17.8 μm). The sporozoite elongated, rounded at one end, and measures 13-14.5 μm in length and 5.8-7.3 μm in width (mean 14 μm by 6.5 μm). Granular residual bodies are seen scattered in the sporocyst.

Sporulation time : 10-15 days.

Type host : Bactrian Camel, *Camelus bactrianus* (Linn.).

Other hosts : One humped Camel, *Camelus dromedarius* (Linn.).

Distribution : Mathura, Uttar Pradesh ; Dubey and Pande (1964a).

Endogenous stages : Henry and Masson (1932) studied the smallest schizont measuring 3-4 μm in diameter, occurring in the epithelial cells of the small intestine. The largest globidium measures 350 μm in diameter and contain small granules or spherules ultimately give rise to microgametes. Macrogamete measures 52-100 μm by 44-87 μm with refractile cytoplasmic granules.

Types : Not known.

189. *Eimeria canadensis* Bruce

(Fig. 153)

1921. *Eimeria canadensis* Bruce, *J. Am. vet. med. Ass.*, 58 : 638.

1931. *Eimeria zurnabadensis* Yakimoff, *Arch. Protisienk.*, 75 : 157.

1954. *Eimeria bombayensis* Rao and Hiregaudar, *Bambay vet. Coll. Mag.*, 4 : 24.

Description : Oocyst ellipsoidal, measuring 25-37 μm by 18-28 μm (mean 31 μm by 22 μm) in size (length-width ratio 1.3-1.7 mean 1.4).

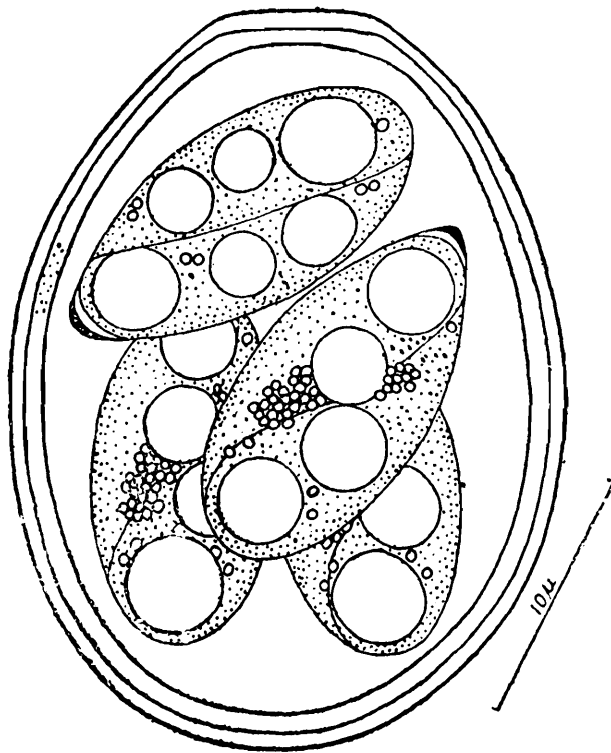


Fig. 153. Mature oocyst of *Eimeria canadensis*.

Oocystic wall double-layered, light yellowish, $1.2\ \mu\text{m}$ thick. Micropyle visible as a flattening of the pole. Micropylar cap absent. Oocystic residuum and polar granule absent. Sporocyst elongate-ovoid, measuring $13\text{--}17\ \mu\text{m}$ by $6.6\text{--}8.9\ \mu\text{m}$ (mean $16\ \mu\text{m}$ by $7.5\ \mu\text{m}$) in size. Stieda body present as a dark cap over the narrow end. Sporocystic residuum present as loose granules in linear masses or distributed along sides. Sporozoite elongate, banana-shaped, measuring $14\ \mu\text{m}$ by $3\ \mu\text{m}$ in size, with one end wider and the other tapering, having a centrally situated nucleus, with a large refractile globule at the wider end and two smaller ones lying between the nucleus and the narrow tip—the one towards the later being the smallest.

Sporulation time : 3-4 days.

Dimension of the oocysts reported by other authors are as follows :

$28\text{--}38\ \mu\text{m}$ by $20\text{--}29\ \mu\text{m}$ with a mean of $33\ \mu\text{m}$ by $24\ \mu\text{m}$ (Levine and Ivens, 1970) ; $28\text{--}37\ \mu\text{m}$ by $20\text{--}27\ \mu\text{m}$ with a mean of $32.5\ \mu\text{m}$ by $23.4\ \mu\text{m}$ (Pellerdy, 1974).

Type host : Ox, Domestic cattle, *Bos taurus* (Linn.).

Other hosts : Buffalo, *Bubalus bubalis* Linn.

(i) Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Mathura, Agra, Izatnagar, Uttar Pradesh ; Karnal, Haryana.

Prevalence : Hasche and Todd (1959a) found 35% infection in cattle from Wisconsin ; Balconi (1963) found 39% infection in the cattle of Guatemala ; Szanto, Mohan and Levine (1964) got 35% infection in cow calves from Illinois ; Joyner *et al.* (1966) obtained 13% in cattle from England ; Bhatia *et al.* (1968) reported 9% infection in buffaloes from Mathura, Uttar Pradesh, India ; Sayin (1969) got 20% infection in buffaloes of Turkey ; Jacobson and Worley (1969) obtained 5% infection in calves and 3% in cattle from Montana.

Endogenous stages : Unknown.

Types : Not known.

Remarks : All that is known about this species from India is due to Gill (1960a, 68, 73), Patnaik (1963, 65c, 73) and Patnaik and Pande (1965).

190. *Eimeria canis* Wenyon

1923. *Eimeria canis* Wenyon, *Ann. trop. Med. Parasit.*, 17 : 231.

Description : The oocysts are ovoid to ellipsoidal in shape and each measures $18\text{--}45\ \mu\text{m}$ by $11\text{--}28\ \mu\text{m}$ in size. The wall is well

developed and pink in colour its outermost layer is distinct, and has tendency to peel off. It leaves the anterior pole of the oocyst uncovered, where there is a clearly visible micropyle. The innermost layer of the sporulated oocyst is distinctly visible. During sporulation pyramidal stages are observed. Initially the sporoblasts are quadrangular, and clearly distinct from the sporonts. At one end of the sporocyst a knob-like structure is often visible. There is evidence of a sporocystic residuum.

Sporulation time : 3-4 days.

Type host : Dingo, *Canis dingo*.

Other hosts : Domestic cat, *Felis domestica* Linn. (= *Felis* sp.). and Domestic dog, *Canis familiaris* Linn. (= *Canis* sp.), Rao and Hiregaudar (1952) for both the hosts.

Description : Bombay, Maharashtra.

Endogenous stages : Unknown.

Types : Not known.

191. *Eimeria cati* Yokimoff

1933. *Eimeria cati* Yakimoff, *Annls. Soc. belge. Med. trop.*, 13 : 93.

Description : Oocysts are subspherical to spherical, each measuring 19-25 μm by 19-22 μm with a mean of 21 μm by 19 μm , the length width index ranges from 1.0-1.3. Oocyst wall 1-2 μm thick, composed of two layers, the outer thicker, greyish and inner contour darker. Sporont is as wide as the oocyst. Micropyle, polar cap and oocystic residuum absent. Polar granule present. Sporocysts ellipsoidal, each measuring 10-11 μm by 7 μm . Stieda body absent. Sporocystic residuum absent.

Sporulation time : 8 days.

Type host : Domestic cat, *Felis catus* (= *F. domestica* Linn.) (= *Felis* sp.).

Other hosts : Jungle cat, *Felis chaus* Guldensteadt, Dubey and Pande (1963).

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) questioned the validity of some carnivore coccidia, as the coccidia is rare in the order Carnivora. Moreover, most of the Carnivores ingest other animals where coccidia generally harbour and it may be possible that these variable sizes of oocysts are nothing but the coccidia of the ingested animals. A review of carnivore coccidia is needed before making any further comments.

192. *Eimeria cerdonis* Vetterling

(Fig. 154).

1965. *Eimeria cerdonis* Vetterling, *J. Parasit.*, 51 : 897.

Description : Oocyst broadly ovoid, slightly flattened at the anterior end. Sporulated oocyst measures 27-29 μm by 21-23 μm with a mean of 28.0 μm and 21.8 μm ; the length width ratio ranges from 1.2-1.3 with a mean of 1.2. Oocystic wall two layered, about 1.5 μm in thickness; the outer layer rough, dark yellow, devoid of striations,

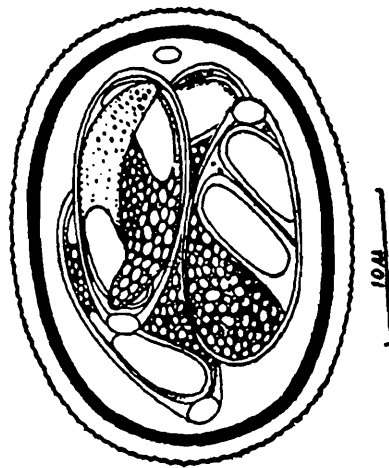


Fig. 154. Mature oocyst of *Eimeria cerdonis*.

the inner layer smooth, dark brown. Micropyle and micropylar cap absent. One or more (maximum 6) oocystic polar granules present. Oocystic residuum absent. Sporocyst elongate, stieda body present as pluglike. Sporocyst measures 16-17 μm by 7-9 μm with a mean of 16.3 μm by 8.0 μm , the length width ratio being 2.0. Sporozoites banana-shaped lying length wise, head to tail within sporocysts. Sporozoite usually contained 1 or 2 large globules.

Type host : Domestic pig, *Sus scrofa domestica* [= *Sus scrofa* (Linn.)].

Other hosts : Form the type host.

Distribution : Mhaw, Jabalpur, Madhya Pradesh ; Izatnagar, Aligarh, Uttar Pradesh ; Karnal, Haryana.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) is of opinion that the oocysts of *E. cerdonis* and *E. polita* are identical but differ due to the surface of the oocyst. In the former it is scabrous and in the later both smooth and scabrous surfaces are found. Vetterling (1965) while describing *E. cerdonis* did not compare this species with *E. polita* as he has synonymised *E. polita* with *E. deblickei*. He further stated that *E. cerdonis* was not possible to distinguish from *E. deblickei* until a pure culture of the later had been obtained from a single oocyst infection. Moreover, the oocyst of *E. cerdonis* had yellow cast, whereas in *E. deblickei* it is colourless. However, at present, it is wise enough to keep *E. cerdonis* as distinct species so also *E. polita*. Further information may be had from Shrivastav and Shah (1968) and Upadhyay, Ahluwalia and Asthana (1977). Mandal (1980) gave a detail account of swine coccidia in India.

193. *Eimeria cervis* Mandal and Chaudhury

1982. *Eimeria cervis* Mandal and Chaudhury, *Sonderdruck aus Verhandungsbericht des xxiv. Internationalen Symposiums über die Erkrankungen der Zootiere, Veszprem 1982*, pp. 327-330.

Description : Oocyst subspherical, yellowish green in colour, measuring 12.65 μm -14.57 μm in length with a mean of 13.62 μm and 9.90 μm -11.50 μm in width with a mean of 10.82 μm . Having one thin inner and one thick outer layer, measuring, .80 μm -1.00 μm ; micropyle, oocystic residuum absent. In some instances the authors have observed a few refractile globules after the complete development of the oocysts. Sporocyst cylindrical, slightly curved with one end narrower than the other. The broader end is provided with a shining globular area. The sporocyst measures 6.60 μm -8.25 μm in length and 2.20 μm -3.30 μm in width. Sporocystic residuum absent. Sporozoite club shaped with a blunt posterior and a tapering anterior end. A globular refractile body was observed at the posterior end of the sporozoite. The sporozoites lie head to tail in position inside the sporocysts. The sporozoite measures 3.30 μm -6.05 μm in length with a mean of 4.69 μm and 1.10 μm -1.76 μm in width with a mean of 1.39 μm .

Sporulation time : 2-3 days at room tempt. 28°C-30°C.

Type host : Spotted deer, *Axis axis* (Erxleben).

Other hosts : Unknown.

Distribution : Sundarbans Tiger Reserve, 24-Parganas, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

194. *Eimeria chausinghi* Pande, Bhatia, Chauhan and Garg
(Fig. 155)

1970. *Eimeria chausinghi* Pande, Bhatia Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Distribution : Oocyst egg-shaped, measuring 20-27 μm by 15-21 μm in size (mean 24.8 μm by 18 μm), with the length-width ratio of 1.2-1.4 (mean 1.3). Oocystic wall 1.3 μm thick, smooth, double contoured the outer layer cap absent. Oocystic residuum and polar granule absent. Sporocyst ellipsoidal, with somewhat narrower extremities,

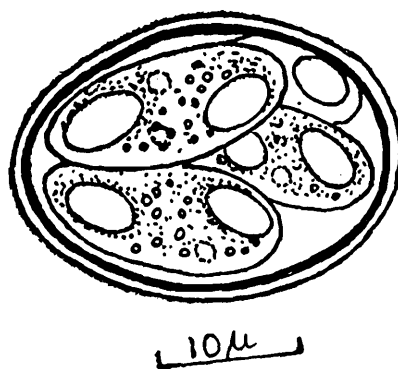


Fig. 155. Mature oocyst of *Eimeria chausinghi*.

measuring 13-16 μm by 5.6-7.5 μm (mean 14 μm by 6.6 μm) in size. Stieda body present as a fine cap. Sporocystic residuum consisting of a few dark granules. Sporozoite measuring 11 μm -14.0 μm by 3 μm -4 μm in size. (mean 12.7 μm by 3.6 μm) with one end broadly and the other pointed, the former carrying a large refractile globule, and a small nucleus is situated at the centre.

Type host : Four-horned antelope, *Tetracerus quadricornis* Blainville.

Other hosts : Unknown.

Distribution : Mathura, Zoological Garden, Lucknow, Uttar Pradesh ; Nandankanan Zoological Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Report on further occurrence of this species from the Indian sub-continent may be had from Patnaik and Acharjyo (1971) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973).

195. *Eimeria cheetali* Bhatia

(Fig. 156)

1968. *Eimeria cheetali* Bhatia, *Indian J. Microbiol.*, 8 : 249.

Distribution : Ellipsoidal oocyst measuring 24.0-30.7 μm by 14.0-16.0 μm (mean 26.3 μm by 14.8 μm) had double-layered and 1.0-1.3 μm thick oocystic wall with the outer layer yellowish-green and the inner dark-brown in colour. Micropyle, 2.0-2.6 μm wide, present as a flattened area. Oocystic residuum and polar granules absent. Ovoid

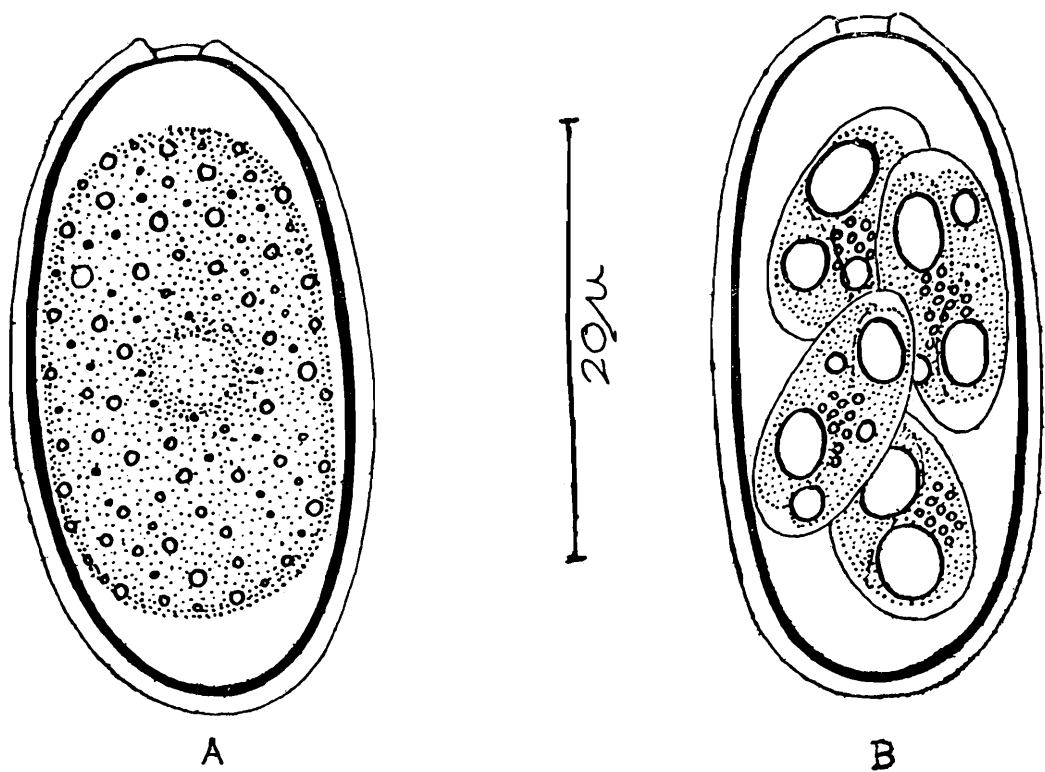


Fig. 156. A, immature and B, mature oocysts of *Eimeria cheetali*.

to elongate-ovoid sporocyst measured 9.3-12.0 μm by 5.0-6.7 μm (mean 11.8 μm by 6.5 μm) in size, stieda body absent. Sporocystic residuum

present as scattered granules. The banana-shaped sporozoite with one end broader and $8.9\ \mu\text{m}$ by $2.6\ \mu\text{m}$ in size. It reveals two refractile globules, the larger towards the broader end and the smaller towards the narrower end, and the nucleus lying between them.

Sporulation time : 3 days.

Type host : Spotted deer, *Axis axis* (Erxleben)

Other hosts : (i) Black buck, *Antelope cervicapra* Linn.
(ii) Chinkara, *Gazella gazella* (Pallas).

Distribution : Zoological Garden, Lucknow, Uttar Pradesh ; and Zoological Garden, Delhi.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pande, Bhatia, Chauhan and Garg (1970), Patnaik and Acharjyo (1971), Bhatia, Chauhan, Arora and Agarwal (1973) and Chauhan Bhatia, Arora, Agarwal and Ahluwalia (1973) also reported this species from different Zoological Gardens of India.

196. ***Eimeria chinkari*** Pande, Bhatia, Chauhan and Garg
(Fig. 157)

1970. *Eimeria chinkari* Pande, Bhatia, Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Distribution : Oocyst subspherical measuring $24\text{--}27\ \mu\text{m}$ by $19\text{--}25.5\ \mu\text{m}$ in size (mean $25.3\ \mu\text{m}$ by $22.3\ \mu\text{m}$), with length-width ratio of

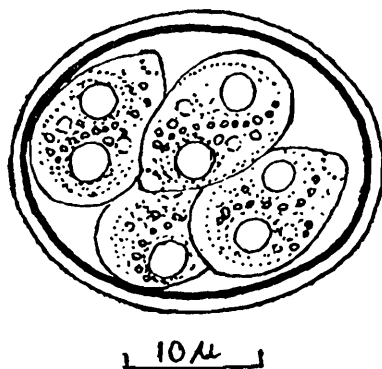


Fig. 157. Mature oocyst of *Eimeria chinkari*.

1.06-1.3 (mean 1.11). Oocystic wall smooth, $1.3\ \mu\text{m}$ thick, double contoured, with the outer layer light greenish blue and the inner dark

yellowish-blue in colour. Micropyle and polar cap absent. Oocystic residuum and polar granule absent. Sporocyst somewhat almond-shaped, with the narrower end carrying a prominent plug-like stieda body, measuring 13-14.3 μm by 7.8-9.5 μm in size (mean 13.8 μm by 8.2 μm). Sporocystic residuum present as scattered dark granules. Sporozoites with 2 prominent globules, one being larger, and a small nucleus lying between them.

Type host : Chinkara, *Gazella gazella* (Pallas).

Other hosts : Unknown.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Remarks : Bhatia, Chauhan, Arora and Agarwal (1973) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) reported this species afterwards.

Endogenous stages : Unknown.

Type : Not known.

197. *Eimeria christenseni* Levine, Ivens and Fritz
(Fig. 158)

1962. *Eimeria christenseni* Levine, Ivens and Fritz, *J. Parasit.*, 48 : 255.

Description : The oocyst ovoid, rarely ellipsoidal, and slightly flattened at the micropylar end, sporulated oocyst measures 22-43 μm by 24-30 μm with a mean of 39 μm by 26 μm . Oocyst wall composed

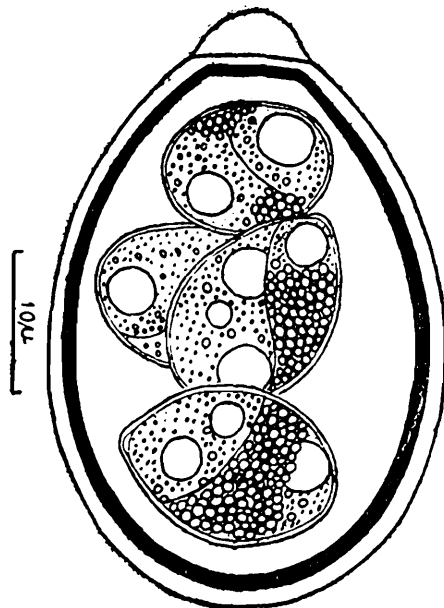


Fig. 158. Mature oocyst of *Eimeria cristenseni*.

of two layers, the outer one smooth, pale-yellowish about $1.0\ \mu\text{m}$ thick ; and the inner one brownish yellow, $0.4\ \mu\text{m}$ thick ; the intact oocysts often appeared to have colourless outermost layer of $0.3\ \mu\text{m}$ thick, but no evidence of such a layer could be seen in crushed oocysts and its appearance was probably an optical illusion. Micropyle present at smaller end of the oocyst. Micropylar cap prominent, colourless round-shaped, the micropylar cap of sporulated oocyst ranges from $2-3\ \mu\text{m}$ by $5-10\ \mu\text{m}$ with a mean of $3\ \mu\text{m}$ by $7\ \mu\text{m}$. In one or more oocysts polar granules are present but oocystic residuum absent. Sporocysts broadly ovoid. Stieda body absent. Sporocyst measured $14-18\ \mu\text{m}$ by $8-11\ \mu\text{m}$ with a mean of $15\ \mu\text{m}$ by $10\ \mu\text{m}$. Sporocystic residuum present. Sporozoites lie head to tail inside sporocysts. One large and one or two small clear globules usually present in each sporozoite.

Sporulation time : Not known.

Type host : Domestic goat, *Capra hircus* (= *Capra* sp.)

Other hosts : Unknown.

Distribution : Izatnagar, Uttar Pradesh ; Madhya Pradesh.

Prevalence : Shah and Joshi (1963) examined 300 goats in Madhya Pradesh which showed 5% infection. Jha and Subramanian (1966) detected 1% infection out of 243 goats examined in Uttar Pradesh, while Chevalier (1966) found the same in 9% out of 40 goats in Germany.

Location : Small intestine, ceacum and colon.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Further details may be had from Shah (1965), Jha and Subramaniam (1965), Pande, Bhatia, Chauhan and Kala (1967), Bhatia and Pandey (1968) and Bhatia and Pande (1970).

198. *Eimeria clupearum* (Thelohan)

1892. *Coccidium* sp. Thelohan, *C. r. Seanc. Soc. Biol.*, Paris, 44 : 12.

1894. *Coccidium clupearum* Thelohan, *Archs. Zool. exp. gen.*, 2 : 541.

1896. *Goussia clupearum* Labbe, *Archs. Zool. exp. gen.*, 4 : 517.

1909. *Eimeria clupearum* Doflein, *Lehrbuch der Protozoenkunde*. Jana, p. ?

1919. *Eimeria wenyoni* Dobell, *Parasitology*, 11 : 147.

Description : The oocyst is spherical, light brown in colour, and possesses a fairly thick wall, roughened on the outer surface and lined

by a delicate membrane on the inner surface. The oocyst measures 18-21 μm (mean 19.5 μm) in diameter. It contains four sporocysts, each having rounded ends. The sporocyst measures 10 μm in diameter. Each sporocyst contains two sporozoites and some residual substances in the form of one or two masses of refractile material. Each sporozoite is provided with rounded anterior end and pointed posterior end and contains an ovoid refractile body in the anterior portion.

Type host : Herring, *Alosa sardiana* ; *Clupea harengus*.

Other hosts : Sardine, *Sardina* (= *Clupea*) *pilchardus* ; Spart, *Sprattus* (= *Clupea*) *sprattus* ; Ancovy, *Engraulis encrasicolus* ; Round herring, *Etrumeus micropus* ; Sardine, *Sardina melanosticta* ; and Mackerel, *Scomber scomber*. Also reported from Man.

Distribution : Calcutta, West Bengal.

Types : Not known.

Remarks : The species originally found in large numbers in the intestine of herrings, mackerel and sparts, which might be the possible reason that the oocysts were found in the faeces of man. Knowles (1924) recorded this species from the faeces of man. The occurrence of *Eimeria sardinae* (Thelohan) in man who visited South Africa, India and Ceylon is included by Bhatia (1938) in his Fauna volume and vividly been discussed but has not been incorporated here as this species is not definitely reported from India.

199. ***Eimeria coucangi*** Patnaik and Acharjyo
(Fig. 159)

1970. *Eimeria coucangi* Patnaik and Acharjyo, *Orissa vet. J.*, 5 : 13.

Description : The oocyst oval, colourless, thin-walled and had no visible micropyle. It measures 18-24 μm in length by 15-21 μm in

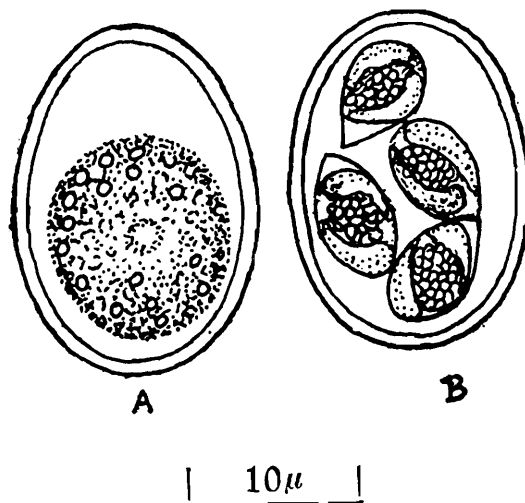


Fig. 159. A, immature and B, mature oocysts of *Eimeria coucangi*,

width with a mean of $21\ \mu\text{m}$ by $17\ \mu\text{m}$ and the shape index is 1.23. The sporont was granular and spherical with diameter of $15\ \mu\text{m}$. They sporulate into four pyriform sporocysts each of $8\ \mu\text{m}$ in length and $5\ \mu\text{m}$ in width. The oocystic residuum absent. Each sporocyst contains two nearly arranged sporozoites each of $5\ \mu\text{m}$ long and a granular sporocystic residuum.

Sporulation time : Twelve days.

Type host : Slow loris, *Nycticebus coucang* (Boddaert)

Other hosts : Unknown.

Distribution : Nandankanan Zoological Garden, Orissa ; the host was brought from Assam as stated by the authors.

Endogenous stages : Unknown.

Types : Not known.

Remarks : From the description and the diagrams, it appears that *E. nycticebi* and *E. coucangi* are the same. The authors might have confused the shape of the sporocyst by observing the oval-shaped form from the above, under the microscope, which appears spherical. However, at the present moment it is not possible to comment further until some cross infection experiments are carried out.

200. *Eimeria crandallis* Honess

(Fig. 160)

1942. *Eimeria crandallis* Honess, *Univ. Wyo. Agric. Expt. Sta.*, 249 : 3.

Description : The oocyst more or less spherical to oval or ellipsoidal, measuring $17\text{--}23.8\ \mu\text{m}$ in length and $17\text{--}22.1\ \mu\text{m}$ in width with a mean of $20.4\ \mu\text{m}$ by $18.4\ \mu\text{m}$. The shape index ranged from 0.74-0.93.

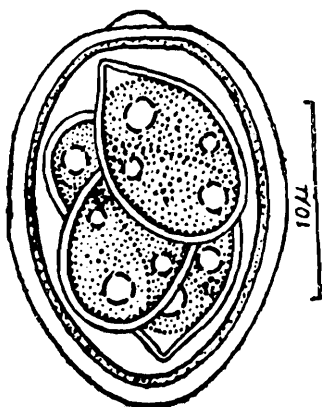


Fig. 160. Mature oocyst of *Eimeria crandallis*,

Its colour is light yellow with a greenish tinge, at times which is very faint or colourless. The sporont measures 13.6-15.3 μm in diameter. Mycropyle present with a very small polar cap measuring 2.6 μm in width and 0.8 μm in height. The oocystic residuum absent. The sporocysts ovoid, measuring 13.6 μm in length and 3.6 μm in width with a mean of 10 μm by 7 μm with no stieda body. Sporocystic residuum usually present. Sporozoite contains one or two clear globules.

Sporulation time : 24-72 hours.

Dimension of the oocysts reported by other authors are as follows :

Oocyst from *Capra hircus* measures 20-27 μm by 17-20 μm (average 23 μm by 19 μm) as stated by Levine, Ivens and Fritz (1962) and Kamalapur (1961). From Indian goats it measures 18-28 μm by 15-20 μm average 22 μm by 18 μm and 19-27 μm by 14-20 μm (average 22 μm by 18 μm) as noted by Shah and Joshi (1963) and Singh (1964) respectively. The average dimension of oocyst from goat is 23.4 μm by 18.3 μm as stated by Chevalier (1966).

Type host : Rocky Mountain bighorn sheep, *Ovis c. canadensis* Shaw.

Other hosts : Domestic goat, *Capra hircus* (= *Capra* sp.) ; Siberian wild goat, (*Capra siberica* (Pallas), Domestic sheep, *Ovis aries* (= *Ovis* sp.) ; Siberian wild goat, *Capra siberica* (Pallas), Domestic sheep, *Ovis aries* (= *Ovis* sp.) ; Agrali, *Ovis amon* (Linn.) ; Mouflon, *Ovis musimon* Shaw. Ladhak goat/Alpine Ibex, *Capra ibex* (Linn.) ; Wild goat, *Capra aegagrus* (Erxleben).

Distribution : Izatnagar, Uttar Pradesh ; Bihar ; West Bengal ; Bombay, Maharashtra ; Madhya Pradesh ; Orissa ; Kashmir and Madras, Tamil Nadu.

Prevalence : *E. crandallis* is reported from 24% of sheep from Illinois as noted by Shah (1963) ; from England, Joyner *et al.* (1966) reported this species from 90% of sheep. Patyk (1965) got this species in 1% of sheep from Poland. From Turkey, Sayin (1966) got infection in 11% of goats. Wiesenhütter (1965) got 25% sheep and 22% goats infected with this species from Syria. From India, Shah and Joshi (1963) got 10% infection in goats of Madhya Pradesh, Singh (1964) found 20% and Jha and Subramanian (1966) obtained 13% of goats infected with this species while examining them from Uttar Pradesh.

Endogenous stages : Only account that is available due to the *in*

vitro examination of De Vos and Hammond (1971). As such the endogenous stages are unknown.

Types : Not known.

Remarks : Further information on this species may be had from Sharma (1951-52), Ray (1961), Patnaik (1963), Singh (1963), Pande, Bhatia, Dubey and Srivastava (1964), Jha and Subramanian (1965), Singh and Pande (1967a, b), Pande, Bhatia, Chauhan and Kala (1967), Bhatia and Pande (1970), Bali (1972) and Bhatia, Chauhan, Arora and Agarwal (1973).

201. *Eimeria cylindrica* Wilson

(Fig. 161)

1931. *Eimeria cylindrica* Wilson, *Va. Agr. Exp. Sta. Tech. Bull.*, 42 : 1.

Description : Oocysts are cylindrical or somewhat sub-cylindrical, each measuring 20-34 μm by 12-17 μm (mean 26 μm by 14 μm) in size (length-width ratio 1.8-2.3 mean 1.83). Oocystic wall two layered, colourless or somewhat straw coloured, 1.3 μm thick. Micropyle absent. Sporocyst elongate ovoid, measuring 9-13 μm by 4-6 μm

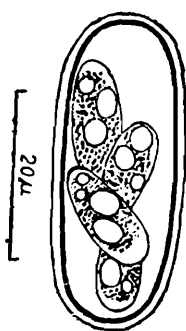


Fig. 161. Mature oocyst of *Eimeria cylindrica*.

(mean 10.4 μm by 5.2 μm) in size. Stieda-body present as a light cap over the narrow end. Sporocystic residuum present as free scattered granules in different positions. Sporozoites elongate, banana-shaped each measuring 7-9 μm by 2.0-2.6 μm (mean 7.6 μm by 2.1 μm) in size with the large refractile globule at the wider end and the smaller globule located anterior to the centrally situated nucleus but towards the narrower and tapering end. Prepatent period is 11-20 days.

Dimension of the oocysts reported by other authors are as follows :

16-27 μm by 12-15 μm with a mean of 23.3 by 12.3 μm (Pellerdy, 1974) ; 16-30 μm by 12-17 μm with a mean of 21-25 μm by 13-15 μm (Levine and Ivens, 1970).

Type host : Ox, *Bos taurus* (Linn.).

Other hosts : (i) Buffalo, *Bubalus bubalis* Linn.

(ii) Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Agra, Mathura, Izatnagar, Uttar Pradesh ; Orissa ; Karnal, Haryana.

Prevalence : Hasche and Todd (1959a) found 20% infection in cattle from Wisconsin ; Supperer (1952) got 4% in cattle from Austria ; Chroust (1964) reported 8% in calves from Czechoslovakia ; Szanto, Mohan and Levine (1964) observed 12% in beef calves from Illinois ; Patyk (1965) noted infection in calves from Poland ; Patnaik (1965) observed 7% in buffaloes from Agra, India, Joyner *et al.* (1966) reported 13% in cattle from England ; Nyberg, Helfer and Knapp (1967) got 10% in cattle from Oregon ; Jacobson and Worley (1969) reported 2% infection in calves from Montana ; Vassiliades (1969) received 6% infection in cattle from Senegal ; Sayin (1969) reported 5% infection in buffaloes from Turkey.

Endogenous stages : Unknown, however, Patnaik and Pande (1965) studied the endogenous stages in buffaloes, but the species was not considered as *E. cylindrica* because the authors were dealing with the mixed infection.

Types : Not known.

Remarks : Further information may be had from Ray (1941), Gill (1960a, 68), Patnaik (1963) and Bhatia, Pande, Chanuhan and Arora (1968).

202. *Eimeria darjeelingensis* Sinha and Sinha

(Fig. 162)

1980. *Eimeria darjeelingensis* Sinha and Sinha, *Acta Protozool.*, 19 : 293.

Description : Oocysts are subspherical in shape each measuring 15.0-18.7 μm in length and 13.2-17.4 μm in width with the mean of 16.7 μm by 14.9 μm . Oocystic wall is smooth, bilayered with an uniform thickness of 0.3 μm . Oocystic residuum, micropyle and polar granule absent. Sporocyst ovoid, single layered, 0.16 μm in thickness and measuring 7.1-8.9 μm in length and 5.5-7.0 μm in width with the

mean of $8.0\ \mu\text{m}$ by $5.6\ \mu\text{m}$. A small stieda body and sporocystic residuum in the form of refractile granules, $0.5\ \mu\text{m}$ in diameter, are

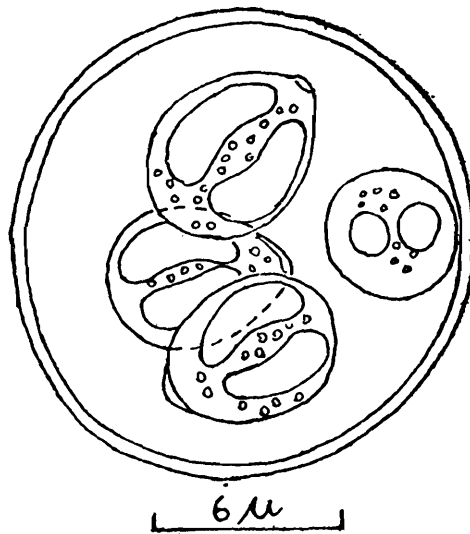


Fig. 162. Mature oocyst of *Eimeria darjeelingensis*.

present. Each sporocyst develops two sporozoites each measuring $4.0\text{-}5.5\ \mu\text{m}$ in length and $1.4\text{-}1.8\ \mu\text{m}$ in width with a mean of $4.4\ \mu\text{m}$ by $1.6\ \mu\text{m}$.

Sporulation time : 38-52 hours.

Type host : House-shrew, *Suncus murinus soccatus* (Hodgson).

Other hosts : Not known,

Distribution : Darjeeling, West Bernal.

Endogenous stages : While studying the endogenous stages of *E. darjeelingensis* the authors observed a large number of trophozoites in the epithelial and subepithelial cells of the mucosa of the small intestine. The trophozoite is subspherical to ovoid in shape measuring $5.6\text{-}7.7\ \mu\text{m}$ in length and $5.2\text{-}6.3\ \mu\text{m}$ in width, with the mean of $6.4\ \mu\text{m}$ by $5.8\ \mu\text{m}$. Cytoplasm is homogeneous and contains a sub-central nucleus with a distinct nuclear membrane. Binucleated schizont measures $9.3\ \mu\text{m}$ by $6.3\ \mu\text{m}$ and the multinucleated one with 12 nuclei measures $13.9\ \mu\text{m}$ in length $11.9\ \mu\text{m}$ in width. Young macrogamete with centrally placed nucleus is ovoid, measuring $12.6\ \mu\text{m}$ by $9.3\ \mu\text{m}$. A fully developed macrogamete with a sub-central nucleus attains $14.8\ \mu\text{m}$ by $11.0\ \mu\text{m}$ in size. The young microgametocyte is spherical measuring $6.3\ \mu\text{m}$ in diameter and contains several small nuclei arranged at the periphery. Mature microgametocyte is subspherical measuring $5.7\text{-}11.0\ \mu\text{m}$ in length

and 5.6-9.0 μm in width with the mean of 8.3 μm by 7.0 μm . It contains small comma shaped microgametes.

Types : Lying with the collection of the describer.

Remarks : This species has some resemblance with *E. suncus* described from *S. m. murinus*.

203. ***Eimeria dawari*** Bhatia, Chauhan, Arora and Agarwal

(Fig. 163)

1973. *Eimeria dawari* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 43 : 944.

Description : Oocysts sub-spherical to ovoid, each measuring 21.0-22.6 μm by 18.6-20.0 μm (mean 21.7 μm by 19.7 μm). Oocystic wall double-contoured, with outer light yellowish green and inner dark yellowish-brown layers. Micropyle and polar cap absent. Length

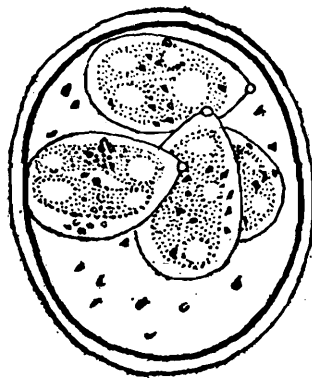


Fig. 163. Mature oocyst of *Eimeria dawari*.

width ratio ranges between 1.07 and 1.21 (mean 1.14). Oocystic residuum absent. Polar granules present as numerous dark particles scattered around the sporocysts. Sporocysts broadly ellipsoidal, each with one end narrower measuring 10.6-12.0 μm by 6.6-8.0 μm (mean 11.0 μm by 7.2 μm). Stieda body present as small dark area. Sporozoites elongate, each carries two refractile globules, one towards either end.

Sporulation time : Unknown.

Type host : Barking deer, *Muntiacus muntjak* (Zimmermann)

Other hosts : Unknown.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : *E. sardari* and *E. dawari* are very much alike except the size and shape of the oocysts. On personal discussion with the authors I could not come to any conclusion regarding the separate entity of these two species. However, for convenience these species have been retained as such.

204. *Eimeria deblicieki* Douwes

(Fig. 164)

- 1921. *Coccidium suis* Jaeger, *Beitrage zur Anreicherung der Parasiteneir im kot der Haustiere*. Diss. Munchen, p. ?
- 1921. *Eimeria brumpti* Cauchemez, *Bull. Soc. Path. exot.*, 14 : 645.
- 1921. *Eimeria jalina* Krediet, Over het voorkomen van protozoen-cysten en ontwikkelingsvormen von coccidien in den darm van mensch en enkele dieren. *T. Vergelijk. genesk.*, 6 : 95.
- 1921. *Eimeria suis* Noller, *Arch. Schiffs. U. trop. Hyg.*, 25 : 35.
- 1921. *Eimeria tuis* Noller (lapsus), *Arch. Schiffs. U. trop. Hyg.*, 25 : 35.
- 1921. *Eimeria deblicieki* Douwes, *Bijdrage tot de kennis van enkele darmprotozoen der huisdieren in het bijzonder bij schaap en varken* Diss., Utrecht, p. 62.
- 1935. *Eimeria scrofae* Galli-Valerio, *Zentbl. Bkt. I. Abt. Orig.*, 135 : 318.
- 1949. *Eimeria polita* Pellerdy (partim), *Acta. vet. hung.*, 1 : 101.
- 1965. *Eimeria neodeblicieki* Vetterling (partim), *J. Parasit.*, 51 : 897.
- 1965. *Eimeria porci* Vetterling (partim), *J. Parasit.*, 51 : 897.

Description : Oocyst ellipsoidal to ovoid, sporulated oocyst measuring 20-29 μm by 14-20 μm with a mean of 24.2 μm by 16.8 μm .

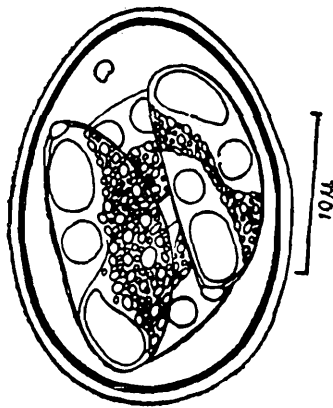


Fig. 164. Mature oocyst of *Eimeria deblicieki*,

The length width ratio ranges from 1.3 to 1.5 with a mean of 1.4. Oocystic wall composed of two layers, 1-2 μm in total thickness, the inner one yellowish brown. The polar granules (maximum 3) present. Sporocyst elongate-ovoid, asymmetrical, one side slightly flattened, stieda body present. Sporocyst measures 13-16 μm by 6-7 μm with a mean of 14.7 μm by 6.4 μm . The length width ratio ranges from 2.1-2.3 with a mean of 2.2 ; sporocystic residuum present. Sporozoites elongate lying length wise, head to tail in side the sporocyst, each containing two clear globules.

Sporulation time : 4-6 days (Kutzer, 1960), 8-13 days (Wiesenhütter, 1962b), 5-7 days (Pastuszko, 1966) 5-10 days (Vetterling, 1965), 14-16 (de Graaf, 1925), 5-9 days (Henry, 1931), 8-9 days (Pellerdy, 1949) Upadhyay and Ahluwalia (1977) noted this as 4-6 days at 26°C.

Dimension of the oocysts reported by other authors are as follows :

28-32 by 18-25 μm (Jaeger, 1921) ; 12-15 by 10-12 μm (Noller, 1921) ; 24-35 by 18-24 μm (Krediet, 1921) ; 12-19 by 12-20 μm (Henry, 1931) ; 15-24 by 13-18 μm (Galli-Valerio, 1935, ; 13-25 by 12-19 μm (Kutzer, 1960) ; 15-25 by 11-18 μm (Boch, Pezenburg and Rosenfeld, 1961) ; 12-50 by 10-30 μm (Donciu, 1961) ; 20-30 by 14-19 μm with the mean of 24.9 by 17 μm (Vetterling 1965) ; 13-23 μm by 13-19 μm (Pastuszko, 1966) ; 18-24 by 15-20 μm (Pellerdy, 1974) ; 16-20 by 14-18 μm (Wiesenhütter, 1962b).

Type host : Domestic pig, *Sub scrofa domestica* [= *Sus scrofa*]

Other hosts : From the type host.

Distribution : Mhow, Jabalpur, Madhya Pradesh ; Izatnagar, Aligarh, Uttar Pradesh ; Karnal, Haryana.

Endogenous stages : The schizont measures 18 μm by 21 μm and gives rise to 25 merozoites each measuring 4.7 μm by 1.2 μm in size. The microgametocyte measures 16 μm by 10 μm and produces about 70 microgametes each measuring 2-3 μm by 5-7 μm in size. The macrogametocyte measures 12-18 μm by 8-10 μm with clear cytoplasm and a large nucleus.

The details about the endogenous stages can be had from Wiesenhütter (1962a). Boch and Wiesenhütter (1963) and Vetterling (1965, 1966).

Types : Not known.

Remarks : Further information may be had from Ahluwalia (1959), Gill (1960b), Patnaik (1963), Mishra (1967 a, b), Sinha (1963), Shrivastav

and Shah (1968), Upadhyay, Ahluwalia and Asthana (1977) and Upadhyay and Ahluwalia (1977 a, b).

205. *Eimeria dromedarii* Yakimoff and Matschoulsky
(Fig. 165)

1932. *Eimeria cameli* Noller (partim), *Sitz. Ber. Ges. Naturf. Freunde.*, Berlin, p. 417.

1934. *Eimeria cameli* Iwanoff-Gobzem (partim), *Dt. Ost. tierarztl. Wschr.*, 42 : 49.

1939. *Eimeria dromedarii* Yakimoff and Matschoulsky, *Jl. Roy. microsc. Soc.*, 59 : 26.

Description : Oocyst subspherical to spherical, measuring 26-28 μm in length with a mean of 27 μm and 21-23 μm in width with a mean of

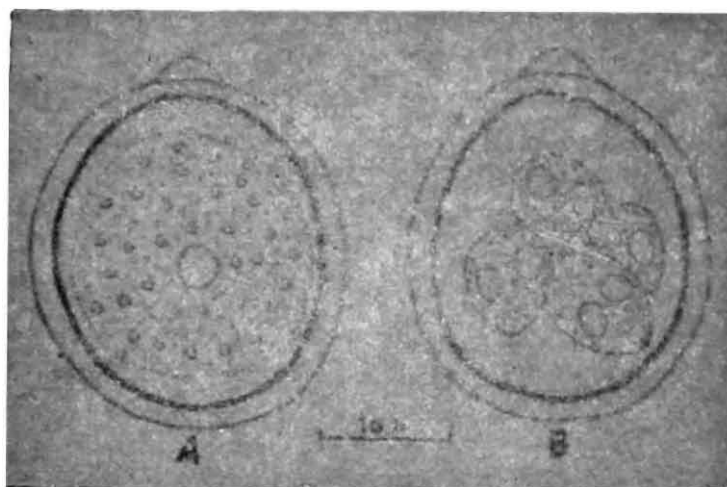


Fig. 165. A, immature and B, mature oocysts of *Eimeria dromedarii*.

21 μm . The shape index is 1.19-1.33. Double layered. Micropyle and oocystic residuum absent. Sporocyst ovoid measuring 10-11 μm in length with a mean of 10 μm and 8.5 μm in width. Each sporozoite contains two or more prominent globules.

Sporulation time : 9 days.

Type host : One humped camel, *Camelus dromedarius* (Linn.)

Other hosts : From the type host and Bactrian Camel, *Camelus bactrianus* (Linn.).

Distribution : Bikanir, Rajasthan, Dubey and Pande (1964a).

Endogenous stages : Unknown.

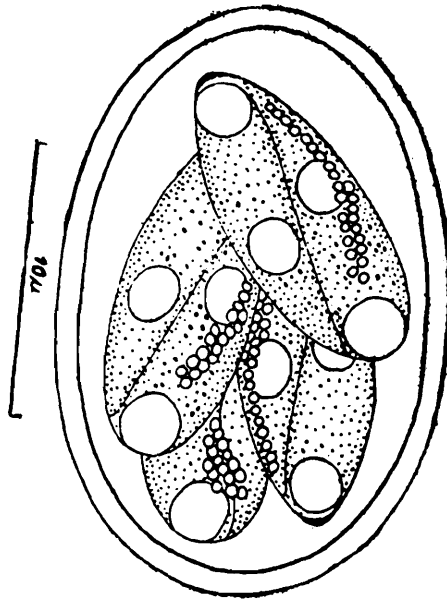
Types : Not known.

206. *Eimeria ellipsoidalis* Becker and Frye

(Fig. 166)

1929. *Eimeria ellipsoidalis* Becker and Frye, *J. Parasit.*, 15 : 175.

Description : Oocyst ellipsoidal to slightly ovoid, measuring 15-26 μm by 12-16 μm (mean 20 μm by 14 μm) in size ; (length-width ratio 1.2-1.6 mean 1.44). Oocystic wall double layered, light yellowish-green, 1.3 μm thick. Micropyle present as a small light area at one pole with a slightly thin wall. Micropylar cap absent. Oocystic residuum and polar granule absent. Sporocyst elongate-ovoid, measuring 10-13 μm by 5-6.0 μm (mean 12.2 μm by 5.4 μm) in size. Stieda body

Fig. 166. Mature oocyst of *Eimeria ellipsoidalis*.

present as a somewhat flattened dark knob. Sporocystic residuum present as a mass of loose granules either centrally situated or towards the poles. Sporozoite elongate, banana-shaped, with one end broad and the other blunt, measuring 11 μm by 2.6 μm in size, with a prominent refractile globule behind the wider end and the centrally placed nucleus surrounded by small granules. Prepatent period is about 10 days.

Sporulation time : 3-4 days.

Dimension of the oocysts reported by other authors are as follows :

12-27 μm by 10-18 μm , average 17 μm by 13 μm (Christensen, 1941) ; 21 μm by 15 μm (Cordero del Campillo, 1960) ; 18-26 μm by 13-18 μm , average 23 μm by 16 μm (Levine and Ivens, 1967) ; 15-25 μm by 12-16 μm average 20 μm by 12 μm (Bhatia *et al.* 1968), 18-28 μm by 16-18 μm , average 21.6 μm by 15.3 μm (Patnaik, 1965c).

Type host : Ox, *Bos taurus* (Linn.).

Other hosts : Buffalo, *Bubalus bubalis* Linn.

(i) Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Agra, Mathura and Izatnagar, Uttar Pradesh ; Karnal, Haryana.

Prevalence : From South-Eastern United States, Boughton (1945) reported 45% cases of bovine coccidiosis, Hasche and Todd (1959a) got infection in 43% cattle at Wisconsin ; Szanto, Mohan and Levine (1964) came across 40% infection in cow calves of Illinois. Nyberg, Helfer and Knapp (1967) reported 33% case from the cattle of Oregon. From Montana, Jacobson and Worley (1969) got 14% infection in cow calves and 3% in adult. Ruiz (1959) reported 3% and Ruiz and Oritz (1961) got 4% cases at Costa Rica. From Guatemala, Balconi (1963) recorded 47% infection. Supperer (1952) came forward with 15% infection from Austria so also Chroust (1964) from Czechoslovakia who received 34% infection. Patyk (1965) got 13% infection from Poland ; Joyner *et al.* (1966) reported 26% infection from cattle of England ; Vassiliades (1969) got 12% infection in Sinegal. Yakimoff, Gousseff and Rastegaieff (1932) reported 23% cases of Oxen coccidia from Uzbekistan. Yakimoff (1933) got 27% infection in oxen, 6% in zebu and 52% of water buffaloes in Azerbaidzhan. From Japan, Iwata (1956) (vide Levine and Ivans, 1970) got 0.4% infection in cattle. In India Patnaik (1965c) found 21% infection in buffaloes from Agra and Bhatia *et al.* (1968) received 20% infection at Mathura from Buffaloes.

Endogenous stages : Boughton (1945) reported the endogenous stages in the epithelial walls of the mucosa of the small intestine. Merozoites were detected in the scrapings of small intestinal mucosa 11 days after inoculation (Hammond, Sayin and Miner, 1963). The fully developed schizont measures 9-15 μm by 7.5-15 μm with a mean of 11 μm by 9 μm and gives rise to 24-36 merozoites. The merozoite measures 8-11 μm by 1-2 μm . The gametocytes were found at the terminal segment of the small intestine mainly at the ileum. The immature gametocytes were detected 8 days after inoculation and the mature one was detected after 11 days at the bottom of the crypts in the epithelial cells. After 14 days the fully developed micro and macrogametocytes were also detected by the same authors. The microgametocyte measures 12-16.5 μm by 11-16.5 μm (average 15 μm by 13 μm) and produces 2-3 μm long many microgametes. Patnaik and Pande (1965) detected endogenous stages in the intestine of domestic buffalo but they were dealing with the mixed infections. The schizogony of this species was studied

by Speer and Hammond (1971b) in the Madin Darby bovine Kidney, embryonic bovine Trachea, synovial or spleen cell cultures. Sporozoite measures $5\text{--}6\ \mu\text{m}$ by $2.4\ \mu\text{m}$ after one day, having three refractile globules each measuring $1.5\ \mu\text{m}$ in diameter with an eccentric nucleus. After sometime, the sporozoite rounded off and formed the schizont measuring $5.9\ \mu\text{m}$ by $5.4\ \mu\text{m}$. The authors could trace 4-42 nuclei inside the schizont on the 4th day. With a little difference the same authors got almost similar results in all types of *in vitro* cell cultures.

Types : Not known.

Remarks : Authors like Gill (1960a, 1968 and 1973), Patnaik (1963) and Patnaik and Pande (1965) made further contribution on this parasite from India.

207. *Eimeria faurei* (Moussu and Marotel)

(Fig. 167)

- 1901. *Coccidium* sp. Moussu and Marotel, *C. r. Seanc. Soc. Biol.*, Paris, 53 : 1087.
- 1902. *Coccidium faurei* Moussu and Marotel, *Arch. Parasit.*, 6 : 82.
- 1909. *Eimeria faurei* Martin, *Rev. Vet.*, Toulouse, 34 : 201, 273, 413.
- 1921. *Coccidium caprae* Jaeger, Beitrage zur Anreicherung der parasiteneier im Kot der Haustiere. Diss., Munchen, pp. 48.
- 1921. *Coccidium ovis* Jaeger, Beitrage zur Anreicherung der parasiteneier im Kot der Haustiere, Diss., Munchen, pp. 48.

Description : The oocyst hen egg-shaped with a brownish yellow colour which, in some showed a greenish tinge, measures $23.8\text{--}38.34\ \mu\text{m}$ in length with a mean of $29.52\ \mu\text{m}$ and $18.8\text{--}23.8\ \mu\text{m}$ in breadth with

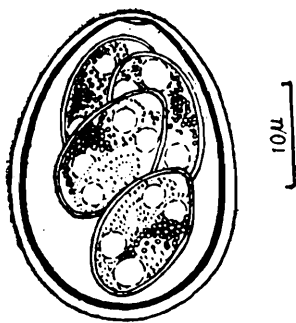


Fig. 167. Mature oocyst of *Eimeria faurei*.

a mean of 22.36 μm . The prominent micropyle, at the narrower end, measures 3.1-5.1 μm in width with no cap over it. The sporont measures 16.2-20.4 μm in maximum diameter. Oocystic residuum absent, polar granules present. The elipsoidal sporocyst, with narrow ends, measures 15-17 μm by 8-10 μm in size. The granular sporocystic residual body lies scattered among the sporozoites without any stieda body. Sporozoites elongate lie head to tail each with one or two large globules.

Sporulation time : 24-48 hours.

Dimension of the oocysts reported by other authors are as follows :

25-36 μm by 19-28 μm mean 29 μm by 21 μm (Christensen, 1938a) ; 27-35 μm by 20-23 μm mean 31.5 μm by 22 μm (Balozet, 1932) ; 27-30 μm by 18-28 μm mean 28 μm by 23 μm (Kamalapur, 1961) ; 27-33 μm by 19-25 μm mean 29 μm by 22 μm (Shah and Joshi, 1963) ; 28-37 μm by 21-27 μm mean 32 μm by 23 μm (Chevalier, 1965) ; 28-35 μm by 19-25 μm mean 31.1 μm by 22.2 μm (Restani, 1966) ; 18-42 μm by 18-30 μm (Moussu and Marotel, 1902), 36-40 μm by 18-27 μm (Pellerdy, 1974).

Type host : Domestic sheep, *Ovis aries* (= *Ovis* sp.).

Other hosts : From the type host and (i) Domestic goat, *Capra hircus* (= *Capra* sp.) (ii) Rocky Mountain big born sheep, *Ovis canadensis* Shaw (iii) Argali, *Ovis ammon* (Linnaeus) (iv) Oriental sheep, *Ovis orientalis* Gmelin (v) Barbary sheep, *Ammotragus lervia* (= *Ovis tragelapus* (Peller) (vi) Ibex, *Capra ibex* Linnaeus (vii) Chamois, *Rupicapra rupicapra* (viii) Siberian Wild goat, *Capra siberica* (Pallas).

Distribution : Haryana ; Punjab ; Bombay, Maharashtra ; Madhya Pradesh ; Uttar Pradesh ; Orissa and West Bengal.

Prevalence : Christensen (1938a) found infection in 11% of sheep from Idaho, Maryland, Newyork and Wyoming. From Tunisia, Balozet (1932) reported infection in 21% of sheep and 18% of goats from Germany ; Svanbeav (1957) reported in 43% of sheep and 40% of goats from Kazakhstan.

Location : Small intestine.

Endogenous stages : Prepatent period is 9-10 days. Endogenous cycle is still wanting. Lotze (1953) studied only giant schizont measuring 100 μm in diameter with numerous merozoites. From India, Singh and Pande (1967a, b) encountered giant schizont in the large intestine of a goat and considered it to be due to the infection of *E. faurei*. However, they were dealing with mixed infection.

Remarks : Authors like Ray (1949), Sharma (1951-52), Rao and Hiregaudar (1954), Ray (1961), Patnaik (1963), Shah and Joshi (1963), Singh (1963, 64), Jha and Subramanian (1965-66), Jha (1966), Bhatia and Pande (1970), Bhatia, Ahluwalia and Chauhan (1972b), Misra and Mohapatra (1972), Krishnamurthy and Kshirsagar (1976) have contributed much about this parasite from India. Hassan (1970) reported this parasite from Bangladesh.

208. *Eimeria felina* Nieschulz

1924. *Eimeria felina* Nieschulz., *T. Diergenees K. Jaarb.*, 51 : 129.

Description : Oocysts are ovoidal/ellipsoidal, each measuring 15-19 μm by 11-17 μm (mean 19 μm by 15 μm), the length-width index ranges from 1.16-1.44. Oocyst wall 0.8-1.5 μm wide, composed of two layers, outer thicker and yellowish to orange in colour and the inner one darker with a shining inner contour. Sporont was centrally placed. Micropyle, polar cap, polar granule and oocystic residuum absent. An unorganised mass was constantly seen. Sporocyst nearly ovoid, measuring 8-10 μm by 6-8 μm (mean 10 μm by 8 μm). Stieda body prominent at the narrower end as a cap. Sporocystic residuum present. Sporozoite large comma-shaped and measures 8-9 μm by 2-3 μm .

Sporulation time : 24 hours.

Type host : Domestic cat, *Felis catus* (*F. domestica* Linn. = *Felis* sp.).

Other hosts : (i) Jungle cat, *Felis chaus* Guldensteadt, Dubey and Pande (1963a) and (ii) Lion, *Panthera leo* (Linn.).

Description : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : As discussed after describing *E. cati* under remarks.

209. *Eimeria gaurusi* Patnaik and Acharjyo

(Fig. 168)

1971. *Eimeria gaurusi* Patnaik and Acharjyo, *Orissa vet. J.*, 6 : 133.

Description : The oocyst smooth walled, colourless and oval in shape. Micropyle indistinct. It measures 20.5-22 μm by 18-19.5 μm with a shape index (L/B) of 1.01. The sporont when fresh was

globular in shape and measures $15\ \mu\text{m}$ in diameter. On maturation, the sporont develops into four oval sporocysts, each containing two

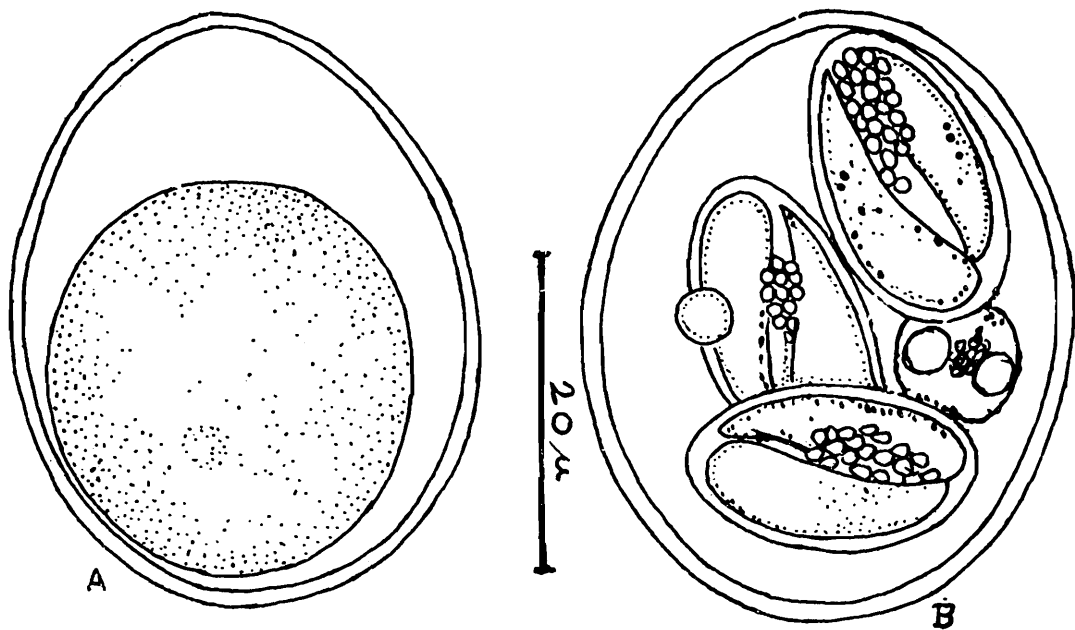


Fig. 168. A, immature and B, mature oocysts of *Eimeria gaurusi*.

sporozoites. The oocystic and sporocystic residual bodies present. The sporocyst measures $10.5\ \mu\text{m}$ by $4.5\ \mu\text{m}$ and sporozoite measures $7\ \mu\text{m}$ by $1.5\ \mu\text{m}$.

Sporulation time : 72 hours.

Type host : Gaur or Indian Bison, *Bos gaurus* (Smith)

Other hosts : Unknown.

Distribution : Nandankanan Zoological Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

210. *Eimeria granulosa* Christensen

(Fig. 169)

1938. *Eimeria granulosa* Christensen, *J. Parasit.*, 24 : 453.

Description : The oocyst pyriform, egg or urn-shaped, measuring $22\text{--}35\ \mu\text{m}$ by $17\text{--}25\ \mu\text{m}$ with an average of $29.4\ \mu\text{m}$ by $20.9\ \mu\text{m}$ in size. The large is the oocyst, the darker is the brownish-yellow or yellowish-brown clour, having a clearly visible micropyle $3\text{--}5\ \mu\text{m}$ in diameter with a polar cap of $5\ \mu\text{m}$ wide and $1\text{--}2.5\ \mu\text{m}$ in height. Oocystic residuum

or polar granule absent. The spherical sporont measures 14-23 μm with a mean of 16.5 μm in diameter. Sporocyst ovoid or elongate ovoid, rounded at both ends. Stieda body faintly perceptible. It

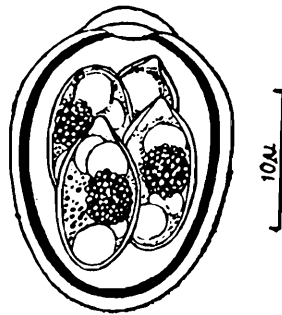


Fig. 169. Mature oocyst of *Eimeria granulosa*.

measures 13-16 μm by 8-9 μm with a mean of 15 μm by 8 μm . Sporocystic residuum present as loosely scattered granules. Sporozoite elongated with one end narrower than the other lying lengthwise, head to tail position with 1-3 clear globules.

Sporulation time : 3 or 4 days.

Dimension of the oocysts measured by other authors are as follows :

22-35 by 17-25 μm with a mean of 29.4 by 20.9 μm (Christensen, 1938a) ; 30-35 by 21-22 μm with a mean of 31 by 22 μm (Shah, 1963) and 28-37 by 21-26 μm with a mean of 32.5 by 24.0 μm (Jackson, 1964).

Type host : Domestic sheep, *Ovis aries* (= *Ovis* sp.)

Other hosts : From the type host and (i) Rocky mountain bighorn sheep, *Ovis canadensis* Shaw, (ii) Domestic sheep, *Ovis* sp. (iii) Domestic goat, *Capra hircus* (Linn.) (= *Capra* sp.).

Distribution : Hissar, Haryana ; Orissa ; Madhya Pradesh and Uttar Pradesh.

Prevalence : Christensen (1938a) found 10% infection of sheep from Maryland and Newyork ; Hamilton (1940, 1941) found 16% infection of sheep from northern Utah ; Saha (1963) found 4% of sheep from Illinois and other states ; Joyner *et al.* (1966) found 9% infection of sheep from England ; Jacob (1943) found 1% infection of sheep from Germany ; Patyk (1965) found 3% of lambs aged 1-8 months from Poland ; Merdivenci (1959) found 6% infection of sheep from Turkey ; Wiesenhütter (1965) found 13% from Turkey, and Sayin (1966) found

3% from Angora goats in Turkey. Saha and Joshi (1963) found 1% infection from goats in Madhya Pradesh, India. Jha and Subramanian (1966) found 10% infection of goats in Uttar Pradesh, India.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Further information about this parasite from India may be had from Sharma (1951-52), Jha and Subramanian (1965), Misra and Mohapatra (1972) and Krishnamurthy and Kshirsagar (1976).

211. *Eimeria hammondi* Dubey and Pande

1963. *Eimeria hammondi* Dubey and Pande, *Indian J. Microbiol.*, 3 : 103.

Description : Oocyst ellipsoidal in shape, measuring 24-29 μm by 19-22 μm , the length-width index ranges from 1.10-1.34. Oocyst wall 1-2 μm thick, composed of two layers, the outer thicker, greenish and inner darker with a shining inner contour. Sporont was as wide as the oocyst. Sporulation completed in 6 days. Four sporoblasts were observed on second day. Micropyle, polar cap, polar granule and oocystic residuum absent. Sporocysts broadly ovoid. Stieda body vestigial and visible only as a small thickening at the narrower end of the sporocyst. Sporocyst measures 11-14 μm by 8-10 μm , with a mean of 12 μm by 8 μm . Sporocystic residuum distributed throughout the sporocyst. Sporozoites comma-shaped, each with a central nucleus and a globule at the narrower end. It measures 8-10 μm by 2-3 μm .

Type host : Jungle cat, *Felis chaus* Guldensteadt.

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

212. *Eimeria hungarica* Pellerdy

(Fig. 170)

1934. *Eimeria exigua* (partim) Yakimoff, *Zentol. Bakt. I. Abt. Orig.*, 131 : 18.

1938. *Eimeria exigua* var *septentrionalis* Madsen (partim), *Medd. Om Grondland*, 116 : 6.

1943. *Eimeria minima* Carvalho (partim), *Iwoa St. Coll. J. Sci.*, 18 : 103.

1956. *Eimeria hungarica* Pellerdy, *Acta. vet. hung.*, 6 : 451 ; 1974, *Coccidia and Coccidiosis*, Verlag Paul Parey, Berlin und Hamburg, p. 455 ; Levine and Ivens, 1972, *J. Protozool.*, 19 : 572.

Description : The oocyst round or subspherical in shape, measuring 13-15 μm by 12-14 μm with an average of 14 μm by 13 μm . There is no evidence of micropyle. Both the oocystic and sporocystic residual

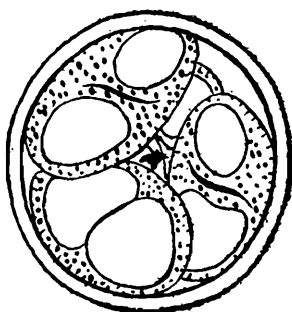


Fig. 170. Mature oocyst of *Eimeria hungarica*.

body are absent. The shape index is about 1.07. Sporocyst faintly visible, having an ovoid with bluntly pointed anterior end. Sporozoite is having a refractile globule of medium size and rather large for the size of the sporozoite.

Sporulation time : 2-3 days at room temp.

Type host : European Hare, *Lepus europaeus* Pallas.

Other hosts : Domestic rabbit, *Oryctolagus cuniculus* (Linn.) (= *Oryctolagus* sp.).

Distribution : Kashipur, Uttar Pradesh ; Ludhiana, Punjab.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Gill and Ray (1960) reported *E. exigua* from Domestic rabbit and described as fragile, colourless small ovoidal oocysts ; absence of micropyle and absence of both residual bodies with delicate sporocysts. Measurements of oocyst ranges from 17-22.5 μm , mean 18.75 μm , width 8-14 μm , mean 11.5 μm .

213. *Eimeria intestinalis* Cheissin

(Fig. 171)

1948. *Eimeria intestinalis* Cheissin, *Uch. Zap. Karelo-Finsk. Univ.*, 13 : 179.

1954. *Eimeria agnosta* Pellerdy, *Acta vet. hung.*, 4 : 259.

Description : The oocyst pear-shaped or pyriform, measuring 25-30 μm in length and 17.5-20 μm in width, with a mean of 26.92 μm by 18.88 μm . The shape index is 1.45. The oocyst wall is yellowish and

smooth. A large round oocystic residual body and a finely granular central round sporont are present. A well visible granular primary residual body measuring 3-5 μm in diameter is always present.

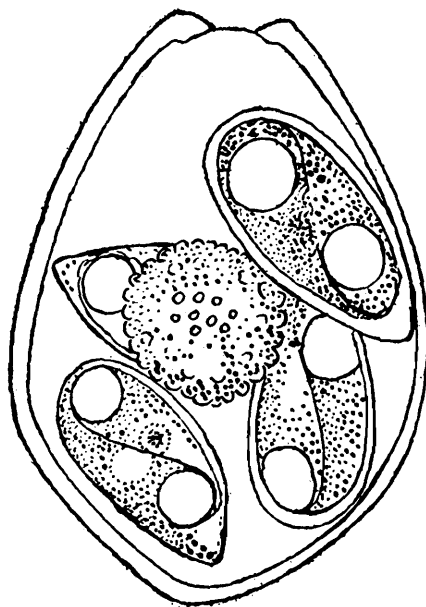


Fig. 171. Mature oocyst of *Eimeria intestinalis*.

Micropyle distinct. The round sporoblast develops to a elongated-ovoid sporocyst with anterior end bluntly pointed. Sporozoite is having a big or medium sized refractile globule and a central nucleus. Sporocystic residual body round or oval, measuring 1.5-3.0 μm in diameter.

Sporulation time : 1-2 days.

Type host : Tame Rabbit (=Domestic), *Oryctolagus cuniculus* (Linn.). (= *Oryctolagus* sp.).

Distribution : Kashipur, Uttar Pradesh and Ludhiana, Punjab 1960, Gill and Ray (1960).

Endogenous stages : There are 3 generation schizonts in the villar cells of the ileum. The first one measures 15-25 μm in diameter. Each produces 20-60 spindle-shaped merozoites each measuring 7-8 μm by 2 μm . Two types of second generation schizonts are found. 'Type A' schizont measures 13-30 μm in diameter and produces 70-150 slender merozoites, each measures 6-12 μm by 5-1.0 μm . 'Type B' schizont measures 13-16 μm in diameter and produce 35-80 merozoites. The third generation schizont measures 10-16 μm in diameter produces 15-25 merozoites each measuring 10-12 μm by 1 μm . The gametocytes are

found above the host cell nucleus in the epithelial cells of the villi of the small intestine, caecum, and ascending colon. The microgametocyte reaches 20-27 μm by 18-20 μm in size and forms nearly 250-500 microgametes, each measuring 3-4 μm by 5 μm with 2 flagella each of 5-7 μm in length. The prepatent period is 9-10 days and the patent period generally 6-8 days.

Types : Not known.

214. *Eimeria intricata* Spiegel

(Fig. 172)

1910. *Eimeria* (*Globidium*) *gilruthi* Chatton, *Bull. Soc. zool. Fr.*, 35 : 197.
 1912. *Globidium faurei* in Henry and Masson (vide Pellerdy, 1974, *Coccidia and Coccidiosis*, Verlag Paul Parey Berlin und Hamburg, p. 784).
 1925. *Eimeria intricata* Spiegel, *Z. Infektkankh. u. Hygiene der Hasstiere*, 28 : 42.
 1949. *Globidium* (*Marotelia*) *faurei* in Marotel (vide Pellerdy, 1974, *Coccidia and Coccidiosis* Verlag Paul Parey, Berlin und Hamburg, p. 784).

Description : The oocyst measures 37.4-51.0 μm in length and 28.9-37.4 μm in breadth with a mean of 45.5 μm by 32.7 μm . The

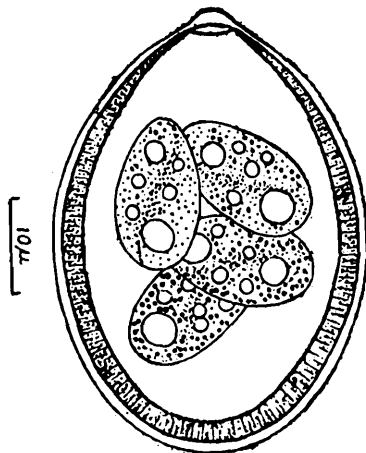


Fig. 172. Mature oocyst of *Eimeria intricata*.

shape is ellipsoidal to ovoid. The shape-index varies from 0.65-0.83 μm . The exocystic wall of the oocyst is very thick. The large micropyle measures 3.4-8.5 μm in size and appears as a wide gap below the crescent-shaped polar cap which is colourless and 8.5-13.6 μm wide and 2.6-5.4 μm in height. The sporont measures, in its maximum diameter, 20.0-25.8 μm and was not easily visible on account of the darker nature of the oocystic wall. The sporocyst pyramidal in shape, and pointed

at ends. At one of the ends, a colourless stieda body is present. The sporocyst measures 17-20.4 μm by 10.2-11.9 μm in size. A large sporocystic residuum present. Sporozoite elongate, with one end narrower than the other lying head to tail in position with 2-3 clear globules.

Sporulation time : 4-6 days at room temperature. Bhatia *et al.* (1978) studied the sporogony and found that the optimum tempt. for completing the sporogony is 33°C and maximum is 38°C. lethal tempt. varies between 40°C-43°C.

Type host : Domestic sheep, *Ovis aries* (= *Ovis* sp.)

Other hosts : From the type host and Rocky mountain high-horn sheep, *Ovis ammon* (Linnaeus); Domestic goat, *Capra hircus* (= *Capra* sp.) Roe deer, *Capreolus capreolus* (Linn.) Fallow deer, *Dama dama* (Linnaeus).

Distribution : Punjab, Uttar Pradesh ; Bombay, Maharashtra ; West Bengal ; Orissa ; Bihar and Madhya Pradesh.

Prevalence : Commonly found, Christensen (1938a) got infection in 14% of sheep from Maryland, Newyork and Weyoming ; Jacob (1943) found in 13% of sheep from Germany ; Balozet (1932) got it in 3% of sheep in Tunisia and Svanbaev (1957) obtained in 4% of sheep from Kazakhstan.

Location : Uncertain, likely to be in abomesum and small intestine. Bhatia *et al.* (1980) got the infection in the lumen of the crypts of Leiberkuhn in mid-small intestine of experimental lamb.

Endogenous stages : The schizont measures 32-37 μm by 21-25 μm and contain 25-40 spindle-shaped merozoites. Each merozoite measures 7-9 μm by 2.5-3 μm . The largest schizont (globidia) measuring 65-145 μm and contains large merozoites each measuring 19.5 μm by 40 μm . The oocyst in the section measuring 36-46 μm by 25-37 μm with a mean of 41 μm by 30 μm . The macrogamete measures 36-54 μm by 25-36 μm with a mean of 42 μm by 30 μm . The fully developed microgametocyte measures 61-250 μm by 36-71 μm with a mean of 113 μm by 52 μm . The microgamete measures 4.6-6 μm long. All these are known due to the contributions made by Davis and Bowman (1965), Pande Bhatia and Chauhan (1966) and Lotze and Leek (1970). The gobidia measured by these authors are 65 by 45 μm , 32-37 μm by 21-25 μm and 56 μm by 30 μm respectively. The gametogonic stages were detected by Michel and Probert (1970). In India Bhatia *et al.* (1980) studied the endogenous stages of this parasite and found that all

the developmental stages are found in the lamina propria of jejunum and ileum of the small intestine with maximum concentration of the developmental stages in the first half of the ileum. Schizonts, micro and macrogametocytes and oocysts were found in the lumen of the crypts of Leiberkhun.

Types : Not known.

Remarks : Another common species. Information in this regard may be had from Ray (1949), Rao and Hiregaudar (1954), Ray (1961), Patnaik (1963), Singh (1963, 64), Shah and Joshi (1963), Pande, Bhatia, and Chauhan (1966), Jha (1966), Jha and Subramanian (1965, 66), Bhatia and Pande (1970), Bali (1972), Bhatia, Ahluwalia and Chauhan (1972a), Misra and Mohapatra (1972) and Krishnamurthy and Kshirsagar (1976).

215. *Eimeria irresidua* Kessel and Jankiewicz

(Fig. 173)

1931. *Eimeria irresidua* Kessel and Jankiewicz, *Am. J. Hyg.*, 14 : 304.

1941. *Eimeria elongata* Marotel and Guilhon, *Recl. Med. vet.*, 117 : 321.

Description : The oocyst ovoid in shape, measuring 31-43 μm in length and 22-27 μm in width with a mean of 38.8 μm by 25.6 μm . The wall gradually increases in thickness towards micropylar end so

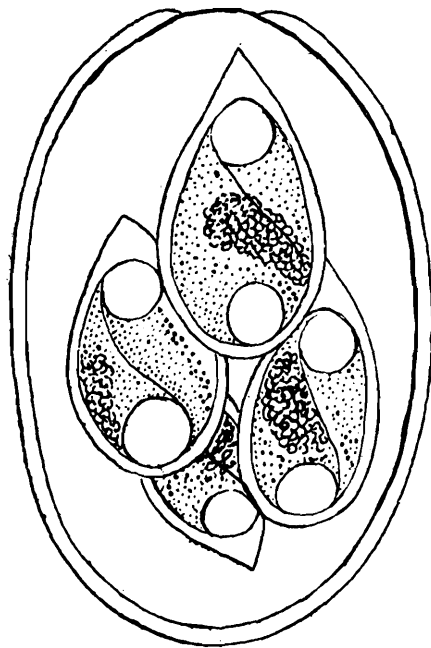


Fig. 173. Mature oocyst of *Eimeria irresidua*,

as to form moderately distinct shoulder or only slightly prominent shoulder, or it is of the same thickness throughout-forming no 'shoulder' at all at the micropyle. Oocystic residual body absent. Sporocysts moderately pointed at the anterior end or slightly blunt, in a few, large, measuring $18\ \mu\text{m}$ in length and $9\ \mu\text{m}$ in width in average size. Sporozoites having refractile large globule, with a central nucleus.

Sporulation time : 72 hours.

Type host : 'California rabbit', (= Domestic) *Oryctolagus cuniculus* (Linn.).

Other hosts : Black-naped Hare, *Lepus ruficaudatus* [= *Lepus negricolis ruficaudatus* (Geoff.)] ; Domestic rabbit, *Oryctolagus cuniculus* (Linn.) (= *Oryctolagus* sp.).

Distribution : Mukteswar, Kashipur, Uttar Pradesh ; Ludhiana, Punjab.

Endogenous stages : The schizonts are found in the epithelial cells of the villi from the duodenum to the ileum. First generation schizonts are of two types (Rutherford, 1943) 'Type A' possesses 2-4 merozoites each measuring about $6.5-7.3\ \mu\text{m}$ by $1.5-1.8\ \mu\text{m}$; 'Type B' about $13-17\ \mu\text{m}$ in diameter and containing 36-48 merozoites each measuring about $11.5\ \mu\text{m}$ by $1.8\ \mu\text{m}$. The second generation schizonts are also of two types. 'Type A' produces 8-16 merozoites each measuring about $7\ \mu\text{m}$ by $2\ \mu\text{m}$ but the 'Type B' having 48-75 merozoites each measures about $7\ \mu\text{m}$ by $1\ \mu\text{m}$. Macrogamete measures $36\ \mu\text{m}$ by $24\ \mu\text{m}$. The microgametocyte measures about $29\ \mu\text{m}$ by $20\ \mu\text{m}$ and produce a large number of biflagellate microgametes. The prepatent period is 9 days and the patent period is 17-21 days.

Types : Not known.

Remarks : Further information on this parasite may be had from Ray (1945b) and Gill and Ray 1960).

216. *Eimeria leporis* Nieschulz

(Fig. 174)

1923. *Eimeria leporis* Nieschulz, *Dt. ost. tierarztl. Wschr.*, 31 : 245.

Description : The oocysts are cylindrical to slightly oval in shape, each measuring $22-28\ \mu\text{m}$ in length and $15-26\ \mu\text{m}$ in width with a mean of $28\ \mu\text{m}$ by $18\ \mu\text{m}$. The shape index 1.2. The oocystic wall is of

uniform thickness without any micropyle. Oocystic residuum present as a spherical to oval mass, measuring 6-10 μm (mean 8 μm) in diameter. Sporocystic residuum appears as spherical or oval body measuring 1.5-

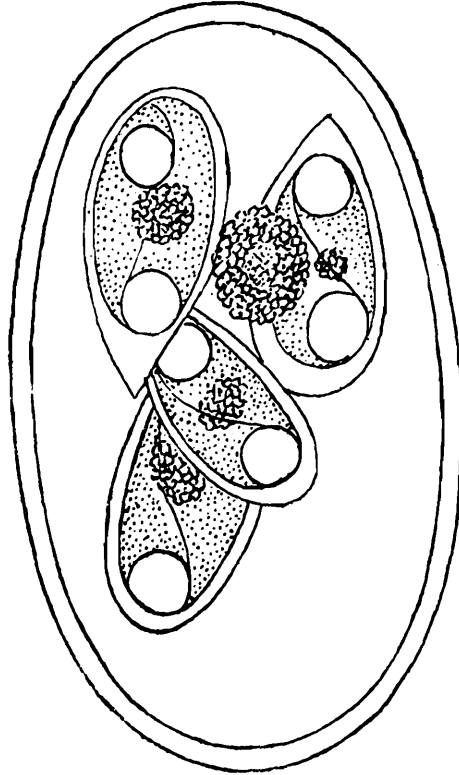


Fig. 174. Mature oocyst of *Eimeria leporis*.

4 μm (mean 3 μm) in diameter. Sporozoite is provided with a refractile globule of medium or large size.

Sporulation time : 2-3 days as per original describer.

Type host : East Greenland Hare, *Lepus arcticus greenlandicus* Rhoads.

Other hosts : Black-naped Hare, *Lepus ruficaudatus* [= *Lepus nigricolis ruficaudatus* (Geoff.)].

Distribution : Kashipur, Uttar Pradesh ; Ludhiana, Punjab, Gill and Ray (1960).

Endogenous stages : Unknown.

Types : Not known.

168. *Eimeria leuckarti* (Flesch)

1883. *Globidium leuckarti* Flesch, Zool. Anz., 6 : 396.

1940. *Eimeria* (*Globidium*) *leuckarti* Reichenow, Z. Infektkrankh. U. Hygiene der Haustiere, 56 : 126.

Description : The oocyst large, deep brown in colour and oval in shape with one end pointed than the other, measuring 84 μm in length and 56 μm in breadth. The oocystic wall is bilayered. The outer layer is thick, granular, brownish in colour, measuring 5-7 μm and slightly thinner towards the pointed end while the underlying layer is orange colour, thin and transparent. A distinct micropyle without a polar cap is visible on both the layers. Sporont 35-40 μm , circular and coarsely granular in consistency. The sporulated oocyst possesses neither a residuum nor a polar granule. The sporocysts are elongated in shape, each measuring 30-44 μm in length and 12-14 μm in width having two sporozoites. The sporozoites are spindle shaped, each measuring 20 μm in length and 5 μm in width with a small amount of sporocystic residuum.

Sporulation time : 15 days.

Type host : Donkey, *Equus asinus*.

Other hosts : Horse, *Equus caballus*.

Locality : Mangrol, Bombay, Maharashtra, Hiregaudar (1956b).

Endogenous stages : A large number of workers noticed ellipsoid bodies or globidia in the stroma of villi of the small intestine of horse. Dolenc (1966) noted endogenous stages in the medial and terminal segments of the jejunum and ileum. The youngest schizont lies within the parasitophorus vacuole with a central nucleus and few cytoplasmic granules. The growing schizont attains the size 200 by 130 μm . The mature one measures 220 by 70 μm with several thousands merozoites in each. The microgametocytes generally found in the lacteal of villi and the mature one measures 210 by 190 μm . The macrogametocytes are round each measuring 12-20 μm in diameter with a central nucleus.

Types : Not known.

Remarks : Pellerdy (1974) has vividly discussed about the Globidia which is very common in horse, sheep, goats, cows and buffaloes. These globidia or cysts are found in the small intestine, ranging 230-300 μm sometimes regarded as magaloszizonts or giant schizonts. The mature one is provided with a large number of merozoites occasionally with variable sizes. There are still some doubt to treat them as developmental stages of *Eimeria*. They are generally found in the abomasum and small intestine occasionally in the posterior intestinal segments, caecum, mesenteric lymph nodes etc. On careful analysis of the literature the same author has synonymised the genus

Globidium with the genus *Eimeria* but stated that the term 'Globidium' of 'Globidial' schizogony can be retained which is regarded as a pathological process arises from the establishment of many such Globidia in the organism. The present author has examined some globidia through the courtesy of Dr. B. B. Bhatia, Mathura Veterinary College, Uttar Pradesh, in sheep.

169. ***Eimeria levinei*** Krishnamurthy and Kshirsagar

(Fig. 175)

1980. *Eimeria levinei* Krishnamurthy and Kshirsagar, *Arch. Protistenk.*, 123 : 215.

Description : The oocyst ovoid in shape measuring 36.0-40.0 μm in length with a mean of 38.64 μm and 26.0-29.6 μm in width with a mean of 27.86 μm . The single layered oocystic well measuring about 1.6 μm thick, is transparent and colourless. There is no micropyle or a micropylar cap. One prominent and somewhat elongated polar

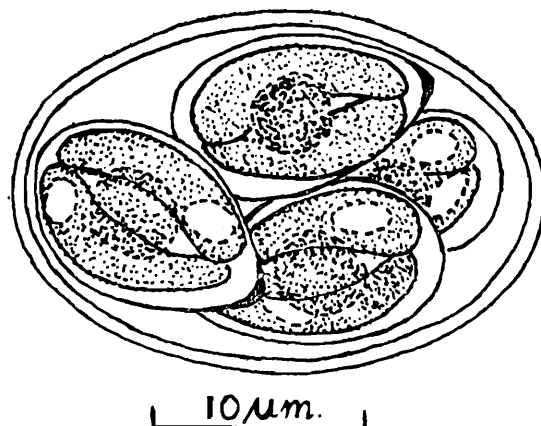


Fig. 175. Mature oocyst of *Eimeria levinei*.

granule is present. But the oocyst is lack of any oocystic residuum. The sporulated oocyst has four ovoid or elongated sporocysts. The sporocyst measures 16.0-19.2 μm in length with a mean of 16.65 μm and 11.2-12.8 μm in width with a mean of 11.95 μm . The length/width ratio of the sporocyst is 1.33-1.71 μm with a mean of 1.44. Each sporocyst possesses a very small stieda body. The sporocystic residuum is a very prominent spherical and granular mass, with a diameter of about 4.5 μm . The sporozoites are elongated or kidney shaped and each is slightly bent at one end. Each sporozoite possesses a refractile granule of moderate size at one end.

Sporulation time : 80 to 90 hours.

Type host : Rat, *Rattus rattus rattus*.

Other hosts : Unknown.

Distribution : Aurangabad, Maharashtra.

Endogenous stages : Unknown.

Types : Not known.

Remarks : *Eimeria levinei* is already described by Bray, 1958 and as such, one of the authors viz., R. Krishnamurthy has been intimated for renaming the species, as 'levinei' is preoccupied. Moreover, the host subspecies, *R. r. rattus* is not found within the Indian subregion. There might be some error in identifying the host material at subspecific level.

219. *Eimeria lomarii* Dubey

(Fig. 176)

1963. *Eimeria lomarii* Dubey, *Indian J. Microbiol.*, 3 : 143.

Description : Oocyst ellipsoidal in shape, measuring 24-29 μm by 19-22 μm , the length-width index ranges from 1.10-1.34. Oocyst wall

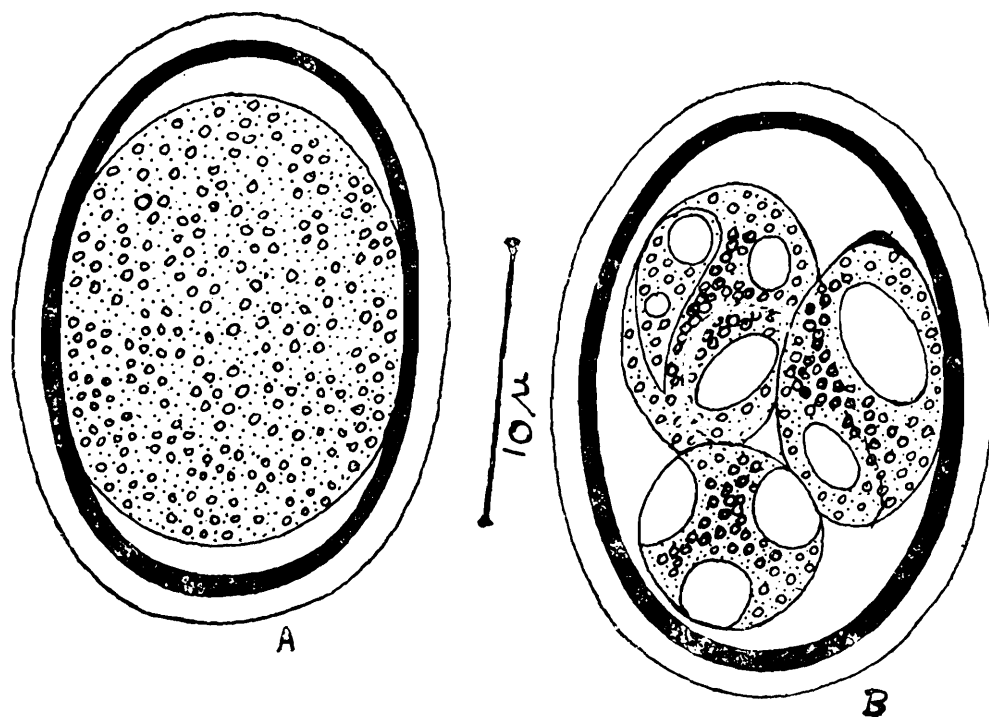


Fig. 176. A, immature and B, mature oocysts of *Eimeria lomarii*.

1.2 μm thick, composed of two layers, the outer thicker, greyish and inner darker with a shining inner contour. Sporont is as wide as the

oocyst. Micropyle, polar cap, polar granule and oocystic residuum absent. Sporocyst broadly ovoid. Steida-body vestigial and could be visible as a small thickening at the narrower end of the sporocyst measures 11-14 μm by 8-10 μm . Sporocystic residuum distributed throughout the sporocyst. The sporozoites comma-shaped, each with a central nucleus and a globule at the broader end, measuring 8-10 μm by 2-3 μm .

Sporulation time : 4 days.

Type host : Bengal fox, *Vulpes bengalensis* Shaw.

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

220, *Eimeria magna* Perard

(Fig. 177)

1925. *Eimeria magna* Perard, *Ann. Inst. Pasteur.*, 39 : 952.

1925. *Eimeria perforans* var. *magna* Perard, *Ann. Inst. Pasteur.*, 39 : 505.

Description : Oocyst ovoid or ellipsoidal, salmon pink or light yellowish-orange in colour. It is provided with double wall and appears truncated at the micropylar end due to collar-like thickening

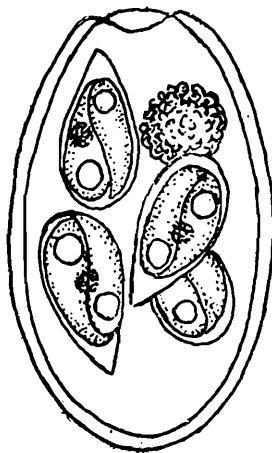


Fig. 177. Mature oocyst of *Eimeria magna*.

of the outer layer around the micropyle of 5-7.5 μm wide. The oocyst measures 31.5-40.5 μm in length with a mean of 37.66 μm and 18-25.5 μm in width with a mean of 23.28 μm . Oocystic residual mass large, measuring 7.5-12.5 μm in diameter. Sporocyst ovoid, measuring 15.5-18.0 μm in length and 7.00-8.5 μm in width. Sporocystic residuum present as a circular or oval large mass of 3-8.5 μm in diameter. Sporozoite elongated, lies head to tail with large refractile body at the broad end and a nucleus at the centre.

Sporulation time : About 3 day.

Type host : Tame Rabbit, *Oryctolagus cuniculus* (= *Oryctolagus* sp.).

Other hosts : Tame Rabbit, *Oryctolagus cuniculus angoriensis* (= *Oryctolagus* sp.), Black-naped hare, *Lepus ruficaudatus* [= *Lepus nigricollis ruficaudatus* (Geoff.)], Gill and Ray (1960).

Distribution : Punjab.

Endogenous stages : Cheissin (1940) and Rutherford (1943) studied the endogenous stages. Schizonts at the first generation are of two types, one measures 14 μm by 10 μm and when fully developed possesses 2-10 curved merozoites each measuring 8.5 μm in length and 3 μm in width. Another schizont measures 24 μm by 17 μm and have 40-60 merozoites each measuring 8.5 μm in length and about 2 μm in width.

There are third type of schizont also measuring about 25-40 μm in diameter and possesses 25-80 merozoites. Fourth or fifth type of schizont measures 25-45 μm in diameter and possesses 30-125 merozoites each measuring 6 μm in length and 2 μm in width. The microgametocyte measures 25-40 μm in length and 20-30 μm in width and produce about 1000 microgametes with long flagellum in each.

Senaud and Cerna (1969) observed multinucleated merozoites during the asexual multiplication of *E. magna* for the first time during the EM study. Cheissin (1940) detected it, on the same species under light microscopy. Speer and Hammond (1971a) traced the schizogonic development in madin-Darby bovine kidney and epitheloid embryonic bovine liver cell cultures. Speer and Dunforth (1976) also studied the gametogenesis in kidney cell culture.

Types : Not known.

Remarks : Levine and Ivens (1972) discussed in detail about rabbit coccidia.

221. Eimeaia malabaricus Joseph

1979. *Eimeria malabaricus* Joseph, *J. Protozool.*, 26 : 36.

Description : Oocyst ellipsoidal to spherical with 2.5 to 3 μm thick wall consisting of 2 layers, outer yellowish brown, striated, and rough ; inner smooth, transparent, of uniform thickness and comprising 1/3 of the total wall thickness. The outer layer apparently divided into thin superficial and deeper thick, brownish region, giving the oocyst wall three-layered appearance. Micropyle and oocystic residuum absent ; polar granule sometimes present. Oocyst measures 35.0-45 μm in length with a mean of 29.8 μm and 24.0-37.0 μm in width with a mean of 32.1 μm . Sporocyst ovoid in shape measuring 16.0-18.0 μm in length and 11.0-12.0 μm in width with a stieda body and coarsely granular residuum. Sporozoites elongated, with large refractile body in each filling 2/3 portion. Each sporozoite measures 19.0-23.0 μm in length with a mean of 21.8 μm and 3.0-4.0 μm in width with a mean of 3.4 μm .

Sporulation time : 7 days at 32-34°C.

Type host : Indian tree squirrel, *Funambulus tristriatus* Waterhouse.

Distribution : Kottayam, Kerala.

Endogenous stages : Unknow.

Types : Not known.

222. Eimeria mathurai Dubey and Pande

1963. *Eimeria mathurai* Dubey and Pande, *Indian J. Microbiol.*, 3 : 103.

Description : Oocyst ellipsoidal or broadly spindle shaped, measuring 20-28 μm by 16-20 μm with a mean of 22 μm by 19 μm , the length-width index ranged from 1.20-1.54. Oocyst wall 1-2 μm thick composed of two layers, the outer smooth, thicker, light yellowish green to pale yellow and inner darker with a shining inner contour. Sporont was nearly as wide as the oocyst. Polar cap, micropyle and oocystic rasiduum absent. Polar granule present. Sporocyst broadly ovoid, measuring 11-13 μm by 7-9 μm with a mean of 11 μm by 8 μm . Sporocystic residuum present. Stieda body prominently visible like a cap of the narrower end. Sporozoites comma-shaped, arranged length wise, each measuring 8-10 μm by 2-3 μm .

Sporulation time : 6 days.

Type host : Jungle cat, *Felis chaus* Guldensteadt.

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : As mentioned under *E. cati*.

223. *Eimeria matsubayashii* Tsunoda

1952. *Eimeria matsubayashii* Tsunoda, *Exp. Rep. Govt. Exp. Sta. Anim. Hyg.*, Tokyo, 25 : 109.

Description : The oocyst ovoidal or ellipsoidal in shape, light-yellow in colour, measuring 23.5-29.5 μm in length and 14.5-19.25 μm in width with a mean of 26.25 μm by 16.5 μm . The shape-index is 1.65. The micropyle is distinct, 2-4 μm (mean 3 μm) wide in diameter. The oocystic wall is of same thickness throughout except about the micropyle towards which it increases in thickness. Oocystic residuum appears prominently as roundish body measuring 4 μm in diameter. Sporocysts are ovoid, each measuring 7 μm in length and 6 μm in width. Sporocystic residual body present as roundish mass. Sporozoite appears as usual with terminally placed refractile globule at the blunt end and a central nucleus.

Sporulation time : According to Tsunoda (1952) 32-48 hrs. at 28°C.

Type host : Tame (=Domestic) Rabbit, *Oryctolagus cuniculus* (Linn.). (= *Oryctolagus* sp.).

Other hosts : Domestic Rabbit, *Oryctolagus* (*Lepus*) (= *Oryctolagus*) sp.), Gill and Ray (1960).

Distribution : Kashipur, Uttar Pradesh and Ludhiana, Punjab.

Endogenous stages : Occurs primarily in the ileum, although the posterior half of the jejunum and rarely the caecum, colon and duodenum may be invaded due to heavy infection and corresponds to those of *E. media* and *E. magna*. Infection of a heavy dose of oocysts gives rise to mild ileitis and occasionally become serious. Rabbits are found diarrhoeic. The prepatent period is 7 days and the patent period is unknown.

Types : Not known.

224. *Eimeria media* Kessel

1929. *Eimeria media* Kessel, *J. Parasit.*, 16 : 100.

1941. *Eimeria flavescens* Marotel and Guilhon, *Rech. Med. vet.*, 117 : 321.

Description : The oocysts are ovoid, each with a somewhat truncated anterior end and a micropyle. It measures 27-36 μm in length and 15-22 μm in width with a mean of 31.2 μm by 18.5 μm in size. The oocyst wall pinkish to orange-pink, is of uniform thickness except towards the micropyle where it becomes thinner. Prominent oocystic residual body about 4-5 μm in diameter is present. Sporocyst ovoidal with sporocystic residual bodies. It is small, round or oval or scattered. Sporozoite is provided with a medium sized refractile globule at the blunt end, and the nucleus is central in position.

Sporulation time : Within 52 hours.

Type host : Tame (= Domestic) rabbit, *Oryctolagus cuniculus* (Linn.) (= *Oryctolagus* sp.).

Other hosts : (i) Black-naped Hare, *Lepus ruficaudatus* (= *Lepus nigricolis ruficaudatus* (Geoff.)).

(ii) Domestic rabbit, *Oryctolagus cuniculus* (= *Oryctolagus* sp.).

Distribution : Mukteswar, Kashipur, Uttar Pradesh ; Ludhiana, Punjab.

Endogenous stages : These stages are found above or below the host cell nuclei in the epithelial cells of the intestinal villi and also in the submucosa [Rutherford (1943), Pellerdy and Babos (1953)]. There are two types of schizogonic generations. The first one are of two types, mature 4 days after inoculation. 'Type A' produces 2-10 merozoites each measuring 6 by 1.5 μm and 'Type B' produces 12-36 merozoites each measuring about 5 by 1.4 μm . Second generation schizonts are also of two types. 'Type A' measures about 7 by 6 μm and produce 2-8 merozoites each measuring 8 by 2 μm . 'Type B' increases about 17 by 10 μm and produces unspecified number of merozoites each measuring about 4 by 1.2 μm . The macrogamete measures about 25 μm by 14 μm . The microgametocyte spherical about 17 μm in diameter and produce biflagellate microgametes each measuring about 2 μm in length. The prepatent period is 5-7 days and the patent period 15-18 days.

Types : Not known.

Remarks : The oocysts found in the *Lepus ruficaudatus* slightly varies in size i.e. length 24.5-39.5 μm width 16-26 μm . Levine and Ivens (1972) expressed a doubt about the occurrence of this species in

Lepus ruficaudatus as reported by Gill and Ray (1960). Ray (1945b) reported this parasite from domestic rabbit.

225. *Eimeria minima* Carvalho

(Fig. 178)

1943. *Eimeria minima* Carvalho, *Iowa St. Coll. J. Sci.*, 18 : 103.

Description : Oocyst sub-spherical, measuring 10-15.5 μm in length and 9-15 μm in breadth with a mean of 14 μm by 11.5 μm . The shape index is 1.2. The colour of the oocyst varies from colourless to light yellow-pink. The oocystic wall is of even thickness without any

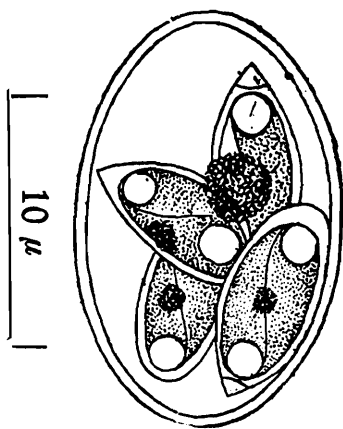


Fig. 178. Mature oocyst of *Eimeria minima*.

micropyle. Polar granules distinct. Sporocyst oval or ovoidal, measuring 5 μm in length and 2.25 μm in width. Sporozoites are usually with terminal small refractile globules.

Sporulation time : According to describer 140-160 hours.

Type Host : Mearn's Cottontail, *Sylvilagus floridanus mearnsi* (J. A. Allen).

Other hosts : Indian hare/Black-naped hare, *Lepus ruficaudatus* [= *Lepus nigricolis ruficaudatus* (Geoff.)], Gill and Ray 1960).

Distribution : Ludhiana, Punjab.

Endogenous stages : Unknown. Prepatent period 6 days and patent period 12 to 16 days.

Types : Not known.

226. *Eimeria mrigai* Pande, Chauhan, Bhatia and Arora
(Fig. 179)

1972. *Eimeria mrigai* Pande, Chauhan, Bhatia and Arora. *Acta vet. hung.*, 22 : 225.

Description : The ellipsoid-ovoid oocyst measuring 39-55 μm by 26-32 μm (mean 48.5 μm by 29.6 μm). The wall is smooth, 1.6-2.3 μm thick and consists of a light yellowish-green, 1.2-1.6 μm thick outer layer and yellowish-brown 0.4-0.7 μm thick layer. The micropyle is 5-8 μm wide and carries a prominent helmet-shaped cap, 13-18 μm to 2-3 μm in size (mean 15.6 μm 2.6 μm). Refractile granules occur both in the unsporulated and sporulated oocysts. Pyramid stage occurs

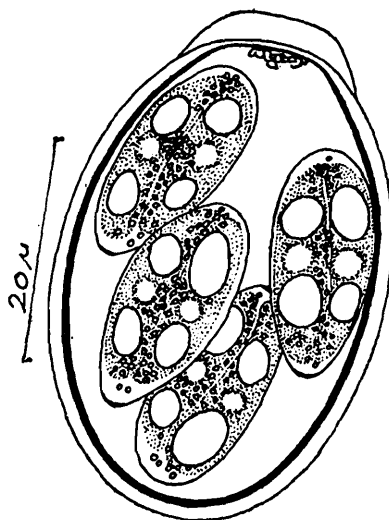


Fig. 179. Mature oocyst of *Eimeria mrigai*.

during the sporogony. Oocystic residuum absent. The ellipsoid sporocyst measuring 19-23 μm by 9-10 μm (mean 21 μm by 9.8 μm) in size and possesses a stieda body. The sporocystic residuum consists of dark granules scattered between the comma-shaped, 16-18 μm by 3.9 μm (mean 17 by 3.9 μm) sporozoites.

Sporulation time : 7 days.

Type host : Black buck, *Antelope cervicapra* Linn.

Other hosts : Unknown.

Distribution : Mathura, Uttar Pradesh (at U. P. College of Veterinary Science Hospital).

Endogenous stages : Mature microgametocyte measures 33 μm by 31 μm in diameter produces many microgametes each measuring 2.2-5

μm long. The macrogamete measures 24-38 μm by 18-27 μm (average 27.5 μm by 22.2 μm). These developmental stages are found in the small intestine, the gametogonic stages are noticed in the jejunum as stated by the describer of the species.

Types : Not known.

227. *Eimeria nagpurensis* Gill and Ray

(Fig. 180)

1960. *Eimeria nagpurensis* Gill and Ray, *Proc. zool. Soc. Calcutta*, 13 : 128.

Description : Oocyst colourless or with slight tint, barrel-shaped, measuring 20.25-26.5 μm in length, 10-15 μm width ; with a mean of 23 μm by 13 μm . The shape index is 1.8. The oocystic wall is thin but prominent and of even thickness throughout. The micropyle absent.

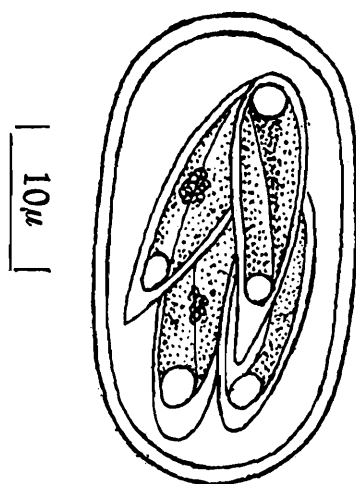


Fig. 180. Mature oocyst of *Eimeria nagpurensis*.

Sporocysts are oat-shaped, anterior-extremity of each is sharply pointed measuring 15 μm by 5 μm . Sporocystic residuum is distinct granular, lying in the centre of sporocyst. Sporozoites are elongated each measuring 12.5 μm by 2 μm . The nucleus is centrally placed. Many refractile globules (each 1.75 μm in diameter) are usually placed terminally at the blunt extremity of the sporozoites.

Type host : Domestic rabbit, *Oryctolagus cuniculus* (Linn.) (= *Oryctolagus* sp.).

Other hosts : Unknown.

Distribution : Nagpur, Madhya Pradesh.

Endogenous stages : Unknown.

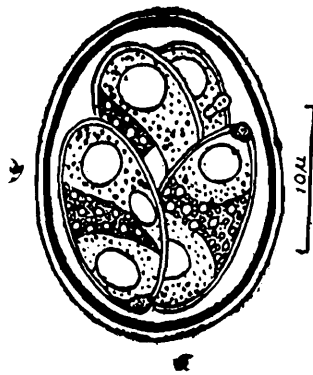
Types : Not known.

228. *Eimeria neodebliecki* Vetterling

(Fig. 181)

1921. *Eimeria brumpti* Cauchemez (partim), *Bull. Soc. Path. Exot.*, 14 : 645.1921. *Eimeria debliecki* Douwes (partim), *Bijdrage tot Kennis van enkele darmprotozoen der huisdieren in het bijzonder bij schaap en varken*. Diss. Utrecht., p. 62.1965. *Eimeria neodebliecki* Vetterling, *J. Parasit.*, 5 : 897.

Description : Oocyst ellipsoidal, occasionally ovoid in shape, measuring 17-26 μm in length and 14-19 μm in width with a mean of 22.1 μm by 16 μm . The length-width ratio ranges from 1.2 to 1.3 with a mean of 1.25. Oocystic wall double-layered, 0.9-1.4 μm in thickness. Outer layer smooth, colourless to pale yellow. The inner layer yellow-

Fig. 181. Mature oocyst of *Eimeria neodebliecki*.

wish-brown. Micropyle and oocystic residuum absent. One or two polar granules occasionally present. Sporocyst broadly ovoid, measuring 9-13 μm by 6-8 μm with a mean of 10.4 μm by 6.6 μm . Stieda body and sporocystic residuum present. Sporozoite banana-shaped, usually lying length wise head to tail.

Sporulation time : 13 days (Pellerdy, 1974) ; 4-6 days (Upadhvay and Ahluwalia, 1977b).

Type host : Domestic pig, *Sub scrofa scrofa* (= *Sus scrofa* Linn.)

Other hosts : From the type host, Wild boar, *Sus scrofa scrofa* (Linn.).

Distribution : Madhya Pradesh ; Aligarh, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : While discussing Vetterling (1965) stated that this species closely resembled to *E. deblickei* Douwes, 1921, but the sporocyst of the species dealtwith was found symmetrical in contrast to the asymmetrical sporocyst of *E. deblickei*. Shrivastav and Shah (1968), Upadhyay, Ahuwalia and Asthana (1977) and Upadhyay and Ahuwalia (1977b) have contributed about this species from India.

229. *Eimeria neoleporis* Carvalho

(Fig. 182)

1942. *Eimeria neoleporis* Carvalho, Iowa. St. Coll. J. Sci., 16 : 409.

1947. *Eimeria coecicola* Cheissin, Dokl. Akad. Nauk USSR, 55 : 177.

Description : Oocyst elongate-ellipsoidal, measuring 30-54 μm in length and 16-22 μm in width, with a mean of 37.5 μm by 19 μm . The shape index is 2.0. Micropylar end slightly attenuated in width. Its colour is yellowish-pink to yellow. The micropyle is present and prominent. The oocyst wall is of same thickness throughout with

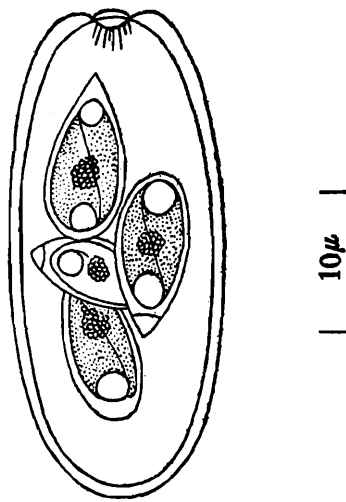


Fig. 182. Mature oocyst of *Eimeria neoleporis*.

micropylar end which slightly increases in thickness. Oocystic residuum absent. Sporocysts are ovoid each measuring 16.5 μm in length 8 μm in width. Sporocystic residuum is spherical, measuring 5-8 μm (mean 6.5 μm) in diameter. Sporozoite is provided with refractile globules of small size and a nucleus is centrally placed.

Sporulation time : 50-75 hours as per original describer.

Type host : Tame (= Domestic) rabbit, *Oryctolagus cuniculus* (Linn.) (= *Oryctolagus* sp.).

Distribution : Kashipur, Uttar Pradesh and Ludhiana, Puniab.

Endogenous stages : The first generation schizont is found in the epithelial cell deep in the crypts of Lieberkuhn and produces 43-48 merozoites. Each schizont measures 20.5 by 3 μm with a residuum. The second generation schizont produces 59-70 merozoites and each measuring 27.5 by 1.5 μm , which produce two types of 3rd generation schizonts after invading the new host cells. The smaller one measuring 18 by 3.5 μm with 14 merozoites and the larger one measuring 31.5 by 1.5 μm produces 60-86 merozoites. The macro and microgametocytes are found on the 12th day after infection. The microgametocytes produce many microgametes of biflagellate in nature. All these informations are due to the contributions made by Carvalho (1942, 1943) and Pellerdy (1974). The oocyst description is mainly on the basis of Gill and Ray (1960).

Types : Not known.

230. *Eimeria newali* Dubey and Pande
(Fig. 183)

1963. *Eimeria newali* Dubey and Pande, *Indian J. Microbiol.*, 3 : 49.

Description : Oocyst ovoidal/ellipsoidal, measures 15-19 by 11-17 μm (mean 19 by 15 μm , the length-width index ranging from 1.16-1.44. Oocyst wall 0.8-1.5 μm wide, composed of two layers, outer thicker and yellowish to orange in colour and the inner one darker with a shining

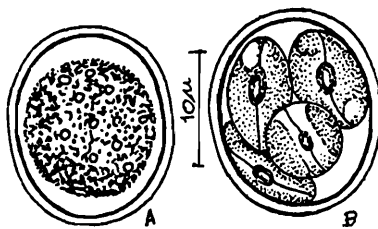


Fig. 183. A, immature and B, mature oocysts of *Eimeria newali*.

contour. Sporont was centrally placed. Micropyle, polar cap, polar granule and oocystic residuum absent. A small unorganised mass is constantly seen in all the oocysts examined. Sporulation completed in 24 hours. Sporocyst nearly ovoid, measuring 8-10 by 6-8 μm (mean 10 μm by 8 μm). Stieda body prominent, at the narrower end as a cap. Sporocysts residuum present. Sporozoite large, comma-shaped, measuring 8-9 by 2-3 μm .

Type host : Indian grey Mongoose, *Herpestis mungo* (= *Herpestis edwardsi* Geoff.).

Other hosts : From the type host, Patnaik and Ray (1965).

Distribution : Mathura, Uttar Pradesh and Orissa.

Type : Not known.

231. ***Eimeria nilgai*** Pande, Bhatia, Chauhan and Garg
(Fig. 184)

1970. *Eimeria nilgai* Pande, Bhatia, Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Description ; Oocyst subspherical in shape measuring 17-24 μm in length and 15-20 μm in width with a mean of 20.85 μm by 17.5 μm . The length-width ratio of the oocyst is 1.1-1.4 with a mean of 1.2. Bilayered oocystic wall is smooth and 1.3 μm thick, the outer layer is yellowish green and the inner one is brown in colour. Micropyle,

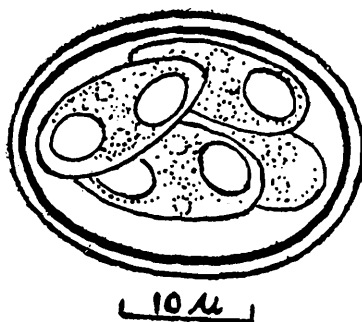


Fig. 184. Mature oocyst of *Eimeria nilgai*.

polar cap, oocystic residuum and polar granule are absent. Sporocysts are broadly ellipsoidal in shape, each measuring 8.5-13.6 μm in length and 3.4-6.0 μm in width with a mean of 10.2 μm by 4.8 μm , with one end slightly narrower than the other. The anterior end is provided with a stieda body visible as a fine dark cap. Sporocystic residuum is present, as a few small granules around the sporozoites. Sporozoite measuring 13.5 μm by 2.6 μm in size, with one end broadly rounded and the other tapering and the former carrying a large refractile globule. The nucleus is centrally placed within the sporozoite.

Type hosts : Nilgai, *Boselapus tragocamelus* Pallas.

Other hosts : From the type host.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) reported this species from the Zoological Garden, Lucknow, Uttar Pradesh afterwards.

232. *Eimeria ninakholyakimovi* Yakimoff and Rastegaieff

(Fig. 185)

1930. *Eimeria nina-kolh-yakimovae* Yakimoff and Rastegaieff, *Arch. Protistenk.*, 70 : 185.

1930. *Eimeria ninakhol-yakimovi* Yakimoff and Rastegaieff, *Arch. Protistenk.*, 70 : 185.

Description : Ovoid to sub-spherical oocyst measures 20.4-26.8 μm in length with a mean of 22.2 μm and 17.0-20.4 μm in breadth with a mean of 18.08 μm . Shape index ranged from 0.83-0.91 (mean 0.84).

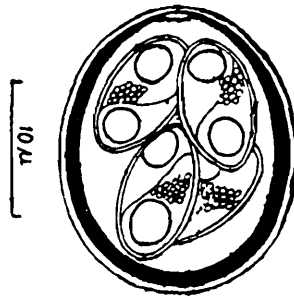


Fig. 185. Mature oocyst of *Eimeria ninakholyakimovi*

Very thin oocystic wall from light to pale yellowish brown or even dark in colour. The micropyle imperceptible and the sporont measures 13.6-14.1 μm at the maximum diameter. Oocystic residuum absent. Sporocyst elongate ovoid, of 9-14 μm by 4-10 μm in size. Stieda body present. Sporocystic residuum present. Sporozoite elongate, lying length wise, head to tail inside the sporocyst, with one or 2 clear globules.

Sporulation time : 60 hours at 20°C.

Dimension of oocysts reported by other authors are as follows :

Oocyst described as oval, measuring 20-22 by 14-16 μm mean 20.7 by 14.8 μm or egg-shaped, measuring 19-25 by 14-21 μm mean 23 by

16.1 μm , originally described from goat ; 16-27 by 13-21 μm , mean 19.8 by 16.5 μm (Balozet, 1932) ; 23-28 by 18-23 μm , mean 25 by 21 μm (Shah and Joshi, 1963) ; 21-28 by 18-24 μm , mean 24.1 by 21.1 μm (Sayin, 1964) ; 20-27 by 15-21 μm , mean 23.6 by 18.3 μm , (Chevalier, 1965) ; from goat and sheep 20-28 by 15-22 μm , mean 23.1 by 18.3 μm (Christensen, 1938a) ; 27-20 by 22-27 μm , mean 28.7 by 24.5 μm (Prasad, 1960) ; 17-25 by 15-21 μm , mean 22.2 by 17.6 μm (Restani, 1966) ; from mouflon 22-29 by 19-22 μm , mean 25.2 by 19.5 μm (Yakimoff, Gousseff and Rastegaieff, 1933) ; 19-28 by 14-23 μm and 16-30 by 13-22 μm and mean 23 by 18 μm from sheep and goats respectively (Levine and Ivens, 1970).

Type host : Domestic goat, *Capra hircus* (Linn.) (= *Capra* sp.)

Other hosts : From the type host and domestic sheep, *Ovis* sp. ; Wild goat ; *Capra aegagrus* (Erxleben) ; Siberian Wild goat, *C. siberica* (Pallas) Alpine ibex, *C. ibex* Linnaeus ; Rocky mountain Bighorn sheep, *O. canadensis* Shaw and some hosts other than *Ovis* and *Capra* which Levine and Ivens (1970) expressed a doubt.

Distribution : Punjab ; Hissar, Haryana ; Madhya Pradesh ; Bombay, Maharashtra ; Uttar Pradesh ; Orissa and West Bengal,

Prevalence : Christensen (1938a) found infection in 3% of sheep from Maryland and Idaho, Jacob (1943) got infection in 5% of sheep from Germany. Balozet (1932) reported it in 35% of sheep and 34% of goats from Tunisia, Svänbaev (1957) obtained infection in 52% of sheep and 31% of goats Kazakhstan. Shah and Joshi (1963) got 12% infection in goats from Madhya Pradesh ; Singh (1964) got 23% infection and Jha and Subramanian (1966) obtained 53% infection in goats of Uttar Pradesh from our country.

Endogenous stages : Schizont measuring 15-35 μm in diameter and contain 40-200 merozoites each measuring 1.5-2 μm . First generation schizonts are globidia, each measuring 290 μm in diameter containing thousand merozoites each measuring 11.9 by 2.1 μm in size. Macrogamete measures 9-18 by 7-13 μm . The microgametocyte sometimes measures 45-50 μm or 20-25 by 15-18 μm . The microgamete is 3-4 μm long with a flagellum of 1-2 μm . All these are due to the work of Balozet (1932) and Sayin (1964) from goats and Lotze (1954) from sheep. Wacha and Hammond (1970) described also two types of schizonts. The giant or globidia measured 290 μm in diameter and second one measured 12 μm in diameter. Singh and Pande, (1967b) also studied them in sheep. The prepatent period 9-15 days on goat (Balozet, 1932) ;

Shumard, 1957, Krylov, 1961, Svanbeav, 1967b, Hammond, Kuta and Miner, 1967 on lamb.

Types : Not known.

Remarks : Further information may be had from Ray (1949), Sharma (1951-52), Rao and Hiregaudar (1954), Ray (1961), Patnaik (1963), Singh (1963), Jha (1966), Jha and Subramanian (1965), Singh and Pande (1967a,b) Bhatia and Pande (1970), Bali (1972), Misra and Mohapatra (1972) and Krishnamurthy and Kshirsagar (1976).

233. *Eimeria nycticebi* Patnaik and Acharjyo

(Fig. 186)

1970. *Eimeria nycticebi* Patnaik and Acharjyo, *Orissa vet J.*, 5 : 13.

Description : Oocyst spherical in shape measuring 15-18 μm in length and 14.5-18 μm in width with a mean of 17 μm by 16.5 μm . The shape index is 1.03. The oocystic wall is smooth and colourless.

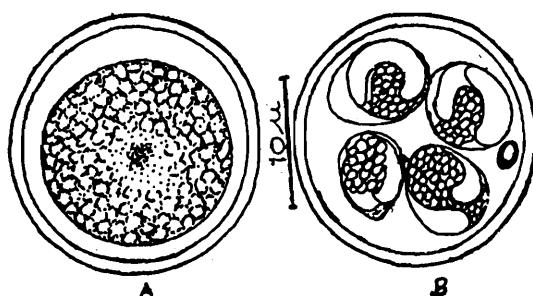


Fig. 186. A, immature and B, mature oocysts of *Eimeria nycticebi*.

There is no evidence of micropyle. The sporont when fresh almost behind a small oocystic residuum. Each sporocyst measures 6-7 μm long and 4-5 μm in width. The almost curved sporozoites lay in a semicircular shape around the granular sporocystic mass.

Sporulation time : 10 days.

Type host : Slow Loris, *Nycticebus coucang* (Boddaert).

Other hosts : Unknown.

Distribution : Nandankanan Zoological Garden, Orissa, the host was brought from Assam as stated by the authors.

Endogenous stages : Unknown.

Types : Not known.

234. *Eimeria oryctolagi* Ray and Banik

1965. *Eimeria oryctolagi* Ray and Banik, *Proc. Indian Sci. Congr.*, p. 465.

Description : Oocyst ellipsoidal in shape measuring 28.5-46.8 μm in length with a mean of 38.7 μm and 12.5-28.5 μm in width with a mean of 19.1 μm . The shape index is 1 : 2. It is provided with a double wall. Micropyle and oocystic residuum present. Sporocyst pyriform, measuring 8.5-14.5 μm in length with a mean of 10.00 μm and 4.5-8.5 μm in width with a mean of 6.00 μm . Stieda body present at the narrow end. Granular sporocystic residuum present. Sporozoite elongated, tapering at one end and measuring 10.5 μm in length.

Sporulation time : 32-48 hours :

Type host : Domestic rabbit, *Oryctolagus cuniculus* Linn. (= *Oryctolagus* sp.)

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) questioned the validity of such incompletely described species made by Ray and Banik, (1965a, b) and noticed similarity with *E. neoleporis*, but the later one is described from Cotton tail, *Sylvilagus* sp., and Gill and Ray (1960) reported it from the domestic rabbit, *Oryctolagus cuniculus* Linn. Carvalho (1942) on the other hand transmitted *E. neoleporis* to the domestic rabbit. However, at present *E. oryctolagi* can be treated as a distinct species of domestic rabbit till further studies.

235. *Eimeria ovina* Levine and Ivens

(Fig. 187)

1970. *Eimeria ovina* Levine and Ivens, *Ill. Biol. Monogr.*, 44 : 124.

Description : The oocyst typically elongated, with two longitudinal sides almost parallel to one another and measuring 23-36 μm in length and 16-24 μm in width a mean of 27 μm by 20 μm . The oocystic wall is smooth and double layered and about 1.3 μm thick. The outer layer is yellowish brown and thicker, while the inner layer is darker and membranous. A micropyle is present, about 1-3 μm high and 4.5-10 μm wide with mean of 2 μm by 7 μm which is covered by a characteristic cone-shaped or dome-shaped micropylar cap. One or more oocystic

polar granules present sometimes as small scattered particles but devoid of any oocystic residuum. Sporocyst elongate-ovoid in shape with one end broader than the other, measuring 11-17 μm in length and 6-9 μm

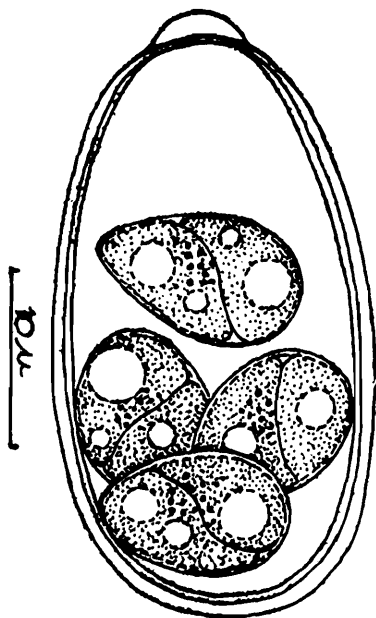


Fig. 187. Mature oocyst of *Eimeria ovina*.

in width with a mean of 17.5 μm . Stieda body absent or rudimentary. Sporocystic residuum present as small granules arranged in rows, groups or rosettes. Sporozoites are elongated in shape lying head to tail within the sporocyst each provided with large clear globule at one end and a smaller one at the other.

Sporulation time : Two to four days.

Dimension of the oocysts reported by other authors are as follows :

29.00 by 21.00 μm (Kamalapur, 1961), 30.00 by 20.00 μm (Jackson, 1964) ; 25.00-36.00 μm by 15.00-45.00 μm (Norton *et al.* 1979) and 31.6-47.9 μm by 18.4-26.5 μm and 10.2-20.4 μm by 7.1-10.2 μm (Krishnamurthy and Bawazir, 1981).

Type host : Domestic sheep, *Ovis arius* (= *Ovis* sp.).

Other hosts : From the type host and (i) Rocky Mountain bighorn sheep, *Ovis canadensis* Shaw, (ii) Agarli, *O. ammon* (Linnaeus), (iii) Mouflon, *O. musimon* Shaw.

Prevalence : Infection commonly reported from sheep. Christensen (1938a) found 90% infection from Idaho, Maryland, New York and Wyoming ; Hammond and Hamilton (1940, 1941) found 94%

infection from northern Utah Shah (1963) got 53% infection in sheep from Illinois and other States, Balozet (1932) got 52% of sheep from Tunisia ; Jacob (1943) detected 58% and Chevalier (1965) reported 17% from Germany ; Joyner *et al.* (1966) found 95% infection from England ; Svanbaev (1957) found 52% from Kazakhstan ; Patyk (1965) got 45% from lambs of aged 1-8 months in Poland ; Merdivenci (1959) found 50% infection in Turkey ; Wiesenhüter (1965) found 94% from Syria and Deom and Mortelmans (1956) found 69% infection from Belgian Congo.

Location : Small intestine.

Distribution : Marathwada, Maharashtra.

Endogenous stages : Lotze (1953) studied the endogenous stages of *E. ovina* (Syn. *E. arloingi*) in experimentally infected lambs and recorded that the sporozoites emerge from the oocysts in the small intestine, enter the crypts of Lieberkuhn, and penetrate through the tunica propria into the antetior of the villi.

Schizont attain maturity after 13-21 days, measuring about 122-146 μm in diameter. The mature one having merozoites each of 9 μm in length and 2 μm breadth. Merozoites come out and enter the epithelial cells of the small intestine. In case of heavy infection they infect all the epithelial cells of the villi. Some of the merozoites give rise to microgametes leaving a large residual mass. Most of the merozoites become macrogametes. After fertilization the macrogamete became oocyst and first appears in the faeces after 20 days.

Types : Not known.

Remarks : From India, Singh and Pande (1967b) found endogenous stages in the small intestine of lamb and thought to be that of the species dealtwith. Krishnamurthy and Bawazir (1981) also reported this species from India.

236. *Eimeria ovoidalis* Ray and Mandal

(Fig. 188)

1961. *Eimeria ovoidalis* Ray and Mandal, *Proc. Indian Sci. Congr.*, p. 411.

Description : Oocyst ovoidal, measuring 32.00-40.00 μm in length with a mean of 35.5 μm and 20-28 μm in width with a mean of 23.8 μm . Micropyle present. Oocystic residuum absent. Sporocyst

oval, measuring 14-16 μm in length and 8-9 μm in width. Sporocystic residual mass coarsely granular. Stieda body present at the

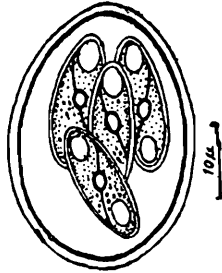


Fig. 188. Mature oocyst of *Eimeria ovoidalis*.

narrow end. Sporozoite ovoidal measuring 8-9 μm in length and 4-6 μm in width.

Sporulation time : 90-120 hours.

Type host : Buffalo calf, *Bubalus bubalis* Linn.

Other hosts : Unknown.

Distribution : Dairy farm in Calcutta, West Bengal.

Prevalence : After obtaining a single infection from a buffalo calf, the authors described the present species from west Bengal. Patnaik (1965c) got 7% infection in the buffaloes at Agra, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The validity of this species remains doubtful as stated by Levine and Ivens (1970). This species has got some resemblance with *E. canadensis*, but the authors Ray and Mandal (1961, 62) failed to compare while describing the species as new. Patnaik (1965c) considered this species as synonym of *E. wyomingensis*.

237. *Eimeria pandei* Patnaik and Ray

(Fig. 189)

1965. *Eimeria pandei* Patnaik and Ray, *Indian J. Anim. Hlth.*, 4 : 33.

1966. *Eimeria pandei* Patnaik and Ray, *Indian J. Anim. Hlth.*, 5 : 203.

Description : Oocyst ovoidal brownish in colour with thick wall, measuring 22.58-24.18 μm in length with a mean of 22.96 μm and

16.61-19.35 μm in width with a mean of 18.60 μm . The length/width ratio varies from 1.05-1.25 with a mean of 1.27. Each sporocyst

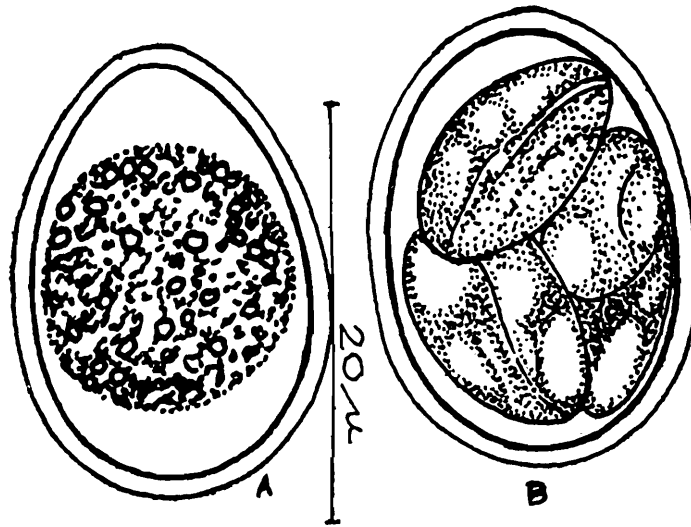


Fig. 189. A, immature and B mature oocysts of *Eimeria pandei*.

measures 11.25 μm in length, 6 μm in width without any stieda body but with sporocystic residuum. Sporozoites elongated in shape.

Sporulation time : About 2 days.

Type host : Indian grey mangoose, *Herpestis edwardsi* Geoff.

Other hosts : Unknown.

Distribution : Orissa.

Endogenous stages : Unknown.

Types : Not known.

238. ***Eimeria parahi*** Pande, Bhatia, Chauhan and Garg
(Fig. 190)

1970. *Eimeria parahi* Pande, Bhatia, Chauhan and Garg, *Indian J. Anim. Sci.*, 40 : 154.

Description : Oocyst subspherical, 16-19.5 μm by 13-15 μm in size (mean 17.7 μm by 14 μm), with the length width ratio of 1.1-1.3 (mean 1.2). Oocystic wall double contoured, 1.3 μm thick, the outer layer is straw-coloured and the inner layer yellowish brown. Micropyle represented by thinning of the wall at one pole. Polar cap absent. Oocystic

residuum and polar granule absent. Sporocyst ellipsoidal, 9.8-10.4 μm by 4.5-5.3 μm in size, (mean 9.3 μm by 4.8 μm), with a minute stieda

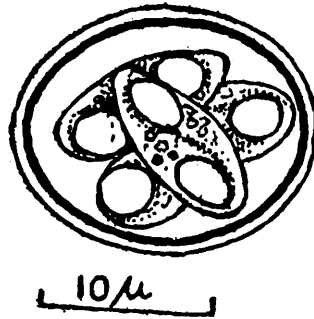


Fig. 190. Mature oocyst of *Eimeria parahi*.

body at the narrower end. Sporozoite elongate-oval, 6.5-8 μm by 2.3 μm in size, with one end broad and the other pointed, the former carrying a large refractile globule with small centrally placed nucleus.

Type host : Hog deer, *Axis porcinus* (Zimmermann),

Other hosts : From the type host, Patnaik and Achariyo (1971) and Bhatia, Chauhan, Arora and Agarwal (1973).

Distribution : Zoological Garden, Lucknow, Uttar Pradesh ; Nandankanan Zoolocal Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

239. *Eimeria parva* Koltan, Mocsy and Vajda

(Fig. 191)

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

1930. *Eimeria galouzi* Yakimoff and Rastegaieff, *Arch. Protistenk.*, 70 : 185.

1933. *Eimeria nana* Yakimoff, *Annls. Soc. belge. Med. trop.*, 13 : 93.

1938. *Eimeria pallida* Christensen, *J. Parasit.*, 24 : 453.

Description : The oocyst measures 13.6-18.7 μm in length and 11.9-15.3 μm in breadth with a mean of 16.2 μm by 13.4 μm . The shape index ranges from 0.72-0.95 μm with a mean of 0.81. The oocyst ellipsoidal, ovoidal or subspherical in shape. The oocystic wall presenting a distinct double contour on account of the two darker refractile lines, measuring 0.8 μm in thickness. The colour of the wall

varying from a faint yellow to a dark brown or even orange. Micropyle and polar cap absent. The finely granular sporont measures $10.2\ \mu\text{m}$ in

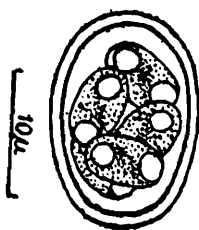


Fig. 191. Mature oocyst of *Eimeria parva*.

the maximum diameter. The sporocyst ellipsoidal, having one end rounded and the other pointed with a definite stieda body. It measures $10.2\ \mu\text{m}$ by $5\ \mu\text{m}$ in size with large amount sporocystic residual body.

Sporulation time : 1-3 days.

Dimension of the oocysts reported by other authors are as follows :

$12-23$ by $10-19\ \mu\text{m}$ (Christensen, 1938a) ; $11-14$ by $9-12\ \mu\text{m}$ (Kotlan Mocsy and Vajda, 1929) ; 17 by $13.5\ \mu\text{m}$ (Balozet, 1932), 18 by $15\ \mu\text{m}$ (Kamalapur, 1961) ; 15 by $14.5\ \mu\text{m}$ (Svanbaev, 1957b) ; $16-23$ by $14-22\ \mu\text{m}$ (Shah and Joshi, 1963) ; $14-15\ \mu\text{m}$ (Singh, 1964) ; 17 by $14.5\ \mu\text{m}$ (Chevalier, 1965).

Type host : Domestic sheep. *Ovis aries* (= *Ovis* sp.).

Other hosts : From the type host and domestic goat, *Copra hircus* (= *Capra* sp.), Asiatic Mouflon, *Ovis orientalis* Gmelin ; Mouflon, *O. musimon* Linnaeus , Argali, *O. ammon* (Linnaeus) ; Big horn sheep, *O. canadensis* Shaw ; Siberian wild goat, *Capra siberica* (= *Capra ibex siberica* (Pallas), Alpine Ibex, *Cibex* Linnaeus.

Distribution : Hissar, Haryana ; Punjab ; Madhya Pradesh ; Uttar Pradesh ; Orissa ; Bombay, Maharashtra and Bihar.

Prevalence : Christensen (1938a) obtained this species in 50% of sheep from Idaho, Maryland and Wyoming. Jacob (1943) got it from 52% sheep and 9% goats from Germany. Balozet (1932) reported it from 21% of sheep and 22% of goats in Tunisia. Svanbaev (1957) reported this species in 9% of sheep while examining them from Kazakhstan.

Endogenous stages : Found in the small intestine, caecum and colon. The schizonts are found as whitish bodies and visible to the naked eye,

each measuring 185-256 μm by 128-179 μm . They are found in the mucosa or far down upto muscularis mucosae. Each schizont produces thousands of merozoites each measuring 10-12 μm long. Smaller schizonts are also found in the superficial epithelial cells each measuring 10-12 μm in diameter and contain 10-12 merozoites each measuring 2.5-3.00 μm long. The Micro and macrogametocyte measuring about 15-19 μm and 10-16 μm , also occur mostly in the caecum and colon. [Kotlan, Pellerdy and Versenyi (1951a,b) and Singh and Pande (1967a,b)].

Types : Not known.

Remarks : Levine and Ivens (1970) expressed a doubt whether this species occurs both in sheep and goat. From India authors like Sharma (1951-52), Rao and Hiregaudar (1954a,b), Ray (1961), Patnaik (1963), Shah and Joshi (1963), Singh (1963, 64) Jha (1966), Jha and Subramanian (1965, 66), Bhatia and Pande (1970), Bali (1972), Misra and Mohapatra (1972) and Krishnamurthy and Kshirsagar (1976) reported this species from sheep and goat.

240. *Eimeria pellita* Supperer

(Fig. 192)

1952. *Eimeria pellita* Supperer, *Osterreich. Zool. Ztschr.*, 3 : 591.

1954. *Eimeria khurodensis* Rao and Hiregaudar, *Bombay vet. Coll. Mag.*, 4 : 24.

Description : The oocysts are ovoid in shape, each measuring 36.2-40.9 μm in length by 26.5-30.2 μm in width with a micropyle on the flattened narrower end. The wall is of uniform thickness, dark

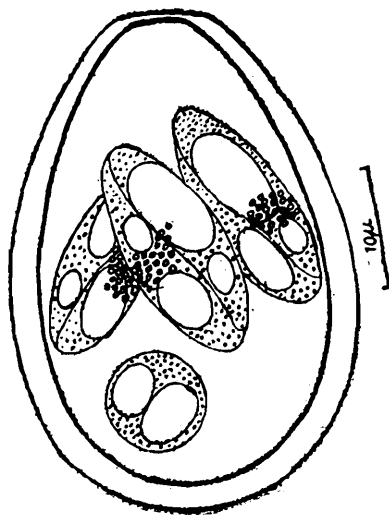


Fig. 192. Mature oocyst of *Eimeria pellita*.

brown in colour, with densely placed numerous protuberances-giving it a velvety appearance. Polar granule and oocystic residuum absent. The sporocysts elongate-ovoid each of 14-8 μm long and 6-8 μm broad. The sporocystic residual body is sharply delineated and measures 7 μm by 5 μm . Stieda body absent, sporocystic residuum present, usually compact. Sporozoite with 2 refractile globules.

Sporulation time : 10-12 days.

Type host : Ox, *Bos taurus* (Linn.).

Other hosts : Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Mathura, Uttar Pradesh ; Bombay, Maharashtra.

Prevalence : From Austria, Supperer (1952) recorded this species in 5% cattle. Joyner *et al.* (1966) got 4.5% infection in England.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Bhatia *et al.* (1968) considered this species as a synonym of *H. bukidnonensis*. But the structure of the oocystic wall and shape of the oocyst are different and due to which Levine and Ivens (1970) denied the synonymy which is probably correct. Rao and Hiregaudar (1954a,b), Hiregaudar and Rao (1966) and Gill (1973) reported this parasite afterwards.

241. *Eimeria perforans* (Leuckart)

(Fig. 193)

1878. *Coccidium cuniculi* Rivolta, *Gior. Anat. Fisiol. Patd. Anim.*, Pisa, 4 : 220.

1879. *Coccidium perforans* Leuckart, *Die Parasiten des Menschen und die von ihnen herrührenden Krankheiten Eie Hand—und Lehrbuch für Naturforscher und Aerzte.*, 2, Aufl. Leipzig u. Heidelberg, 1, Lief., 1-Abt., p. ?

1912. *Eimeria perforans* Sluiter and Swellengrebel, *De Dierlijke Parasiten den Menschen en van Onze Huisdiere*, 2nd ed. Amsterdam, p. ?

1941. *Eimeria nana* Marotel and Guilhon, *Recl. Med. vet.*, 117 : 321.

1942. *Eimeria lugdunumensis* Marotel and Guilhon, *Recl. Med. vet.*, 118 : 270.

Description : The oocysts are ovoid to ellipsoidal in shape with a tendency to become slightly oval, both ends of each oocyst are equally rounded or one end slightly attenuated than the other. The oocysts are colourless to light pink, each measuring 17-32 μm in length and 12.5-19.5 μm in width mean 20.25 μm by 15 μm . The shape index is 1.47. The oocystic wall is thin and of same thickness throughout without any micropyle. Oocystic residual body present as

distinct spherical mass, measuring 2-4 μm (mean 3 μm) in diameter. Sporocyst ovoid to oval, measuring 7.75 μm by 3.75 μm . The

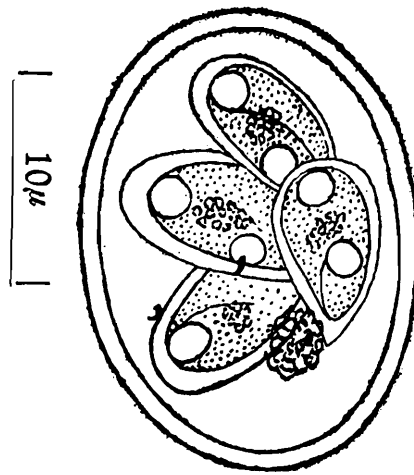


Fig. 193. Mature oocyst of *Eimeria perforans*.

sporocystic residual mass also appears as indistinct spherical body. Sporozoite is having a refractile globule of medium size placed at the blunt extremity and a centrally placed nucleus.

Sporulation time : 48 hours.

Type host : Tame (= Domestic) rabbit, *Oryctolagus cuniculus* (Linn.) (= *Oryctolagus* sp.).

Other hosts : (i) Black-naped Hare, *Lepus ruficaudatus* [= *Lepus nigricolis ruficaudatus* (Geoff.)], (ii) Domestic rabbit, *Oryctolagus cuniculus* Linn. (= *Oryctolagus* sp.).

Distribution : Mukteswar, Kashipur, Uttar Pradesh ; Punjab.

Endogenous stages : The endogenous stages are found above the nuclei of the epithelial cells of the small intestine from the duodenum to the ileum. There are 2 generations of schizonts, the first one measures 57-10 μm in diameter produces 4-8 'Type A' merozoites each measuring 7.2 μm by 1.5 μm . The second one measures 7-8 μm by 4-6 μm and produces 8-24 'Type B' merozoites each measuring 4.3 μm by 1.0 μm . The mature microgametocyte measures 17 by 13 μm in diameter produces large number of microgametes each with 3 flagella (Rutherford, 1943). A striking ultrastructural resemblance between the merozoites of this species and *Toxoplasma* zoites were noted during the ultrastructural study (Scholtyseck and Piekarski, 1965). Other ultrastructural details may be had from Scholtyseck (1965a, b).

Types : Not known.

Remarks : Further report on this species from India may be had from Ray (1945) and Gill and Ray, 1960. Hassan (1970) reported this species from Bangladesh.

242. *Eimeria perminuta* Henry

(Fig. 194)

1931. *Eimeria perminuta* Henry, *Univ. Calif. Publ. Zool.*, 36 : 115.

1931. *Eimeria perminuta* Henry (Lapsus), *Univ. Calif. Publ. Zool.*, 36 : 115.

Description ; Oocyst sub-spherical, sporulated oocyst measures 14-15 μm by 13.0 μm with a mean of 14.5 μm by 13.0 μm , the length-width ratio ranges from 1.0-1.1 with a mean of 1.05. Oocyst wall composed of two layers, about 1.0 μm in total thickness, the outer

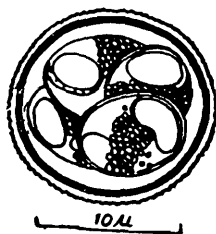


Fig. 194. Mature oocyst of *Eimeria perminuta*.

layer rough, yellow and the inner one smooth, dark yellowish-brown. Micropyle and micropylar cap absent. One or two oocystic polar granules present. Oocystic residuum absent. Sporocyst broadly ovoid, measuring 8 μm by 5-6 μm with a mean of 8 μm by 5.5 μm , the length-width ratio ranges from 1.3-1.6 with a mean of 1.4. Stieda body, sporocystic residuum present ; sporozoite lies length wise, head to tail within the sporocyst ; each containing 2 clear globules.

Sporulation time : 4-7 days (Upadhyay and Ahluwalia, 1977b).

Dimension of the oocysts reported by other authors are as follows :

11-16 by 9-12 μm (Yakimoff, 1933) ; 11-18 by 10-16 μm , (Boch, Pezenburg and Rosenfeld, 1961) ; 11-17 by 10-16 μm (Donciu, 1961) ; 12-15 by 10-13 μm with the mean of 13.3 by 11.7 μm (Vetterling, 1965) ; 11-16 by 10-13 μm (Pellerdy, 1974).

Type host : Domestic Pig, *Sus scrofa domestica* [= *Sus scrofa* (Linn.)].

Other hosts : From the type host.

Distribution : Orissa, Bihar, Uttar Pradesh and Madhya Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Authors like Gill (1960b), Patnaik (1963), Singh (1963), Mishra (1967a, b), Shrivastav and Shah (1968), Upadhyay, Ahluwalia and Asthana (1977) and Upadhyay and Ahluwalia (1977a) have reported this species from India.

243. *Eimeria perminuta mathurai* Mishra

(Fig. 195)

1967. *Eimeria perminuta mathurai*, Mishra, *Indian vet. J.*, 44 : 289.

Description : Oocyst spherical or somewhat ovoid in shape, measuring 13.8-19.9 μm in length and 9.2-16.92 μm in width. The rough

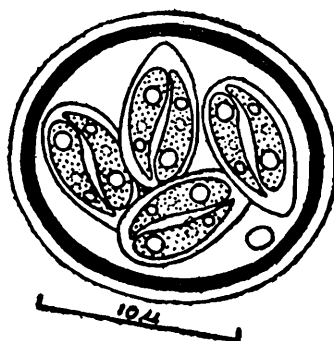


Fig. 195. Mature oocyst of *Eimeria perminuta mathurai*.

bilayered oocystic wall measures 1.0-1.54 μm in thickness. The outer layer of the oocyst is yellowish or greenish yellow while the inner one is greenish or brownish coloured. Oocystic residuum absent. Polar granules present. The sporocyst ellipsoidal in shape, measuring 8.35-11.97 μm in length and 5.38-6.18 μm in width with a mean of 10.77 μm by 6.13 μm . Stieda body absent. Sporocystic residuum present as globular mass.

Sporulation time : 7-9 days.

Type host : Domestic pig, *Sus scrofa* Linn. (= *Sus* sp.).

Other hosts : Unknown.

Locality : Mathura, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

244. *Eimeria petauristae* Ray and Singh

(Fig. 196)

1950. *Eimeria petauristae* Ray and Singh, *Proc. zool. Soc. Calcutta*, 3 : 65.

Description : Oocyst flask-shaped with short neck and a dome-shaped "pseudo micropyle" which forms a transparent cap at the anterior end and disappears, becoming concave, on sporulation. Oocyst wall of two layers ; the outer one rouged, deep brown, and 3.75-6.25 μm thick, the inner one thin, smooth and transparent. The outer

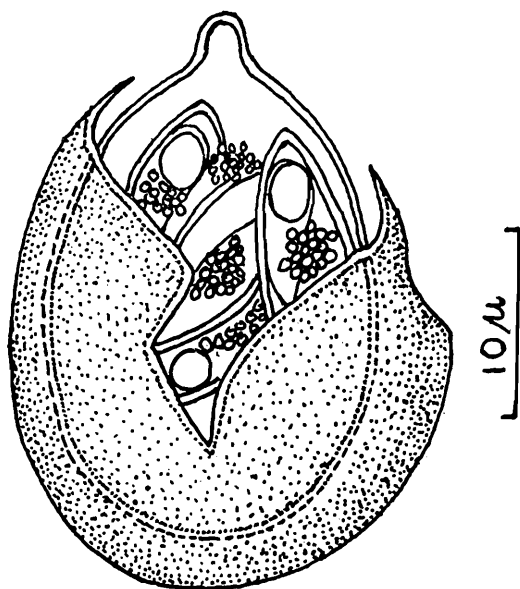


Fig. 196. Mature oocyst of *Eimeria petauristae*.

layer is readily broken away from the inner one by pressure. Oocyst measures 46.5-52.5 μm in length 35.0-40.0 μm in width (mean 49.0 μm by 37.0 μm). The length/width ratio 1.3. Sporocyst naviculoid with one end slightly broader than the other, but without stieda-body. Sporocyst 25.5-31.25 μm in length and 8.75-10.0 μm in width, (mean 28 μm by 9 μm). Sporocyst contains two club-shaped sporozoites each with a vacuole at either end, Small oocystic residuum present but the polar granule is absent. Sporocystic residuum present.

Sporulation time : 10-12 days.

Type host : Common giant Flying squirrel, *Petaurista inornatus* (= *Petaurista petaurista* (Pallas)).

Other hosts : Unknown.

Distribution : Mukteswar, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

245. *Eimeria polita* Pellerdy

(Fig. 197)

1921. *Eimeria deblickei* Douwes (in partim), Bijdrage tot de kennis van enkele darmprotozoen der huisdieren in het bijzonder bij schaap en varken. Diss., Utrecht., p. 62.

1949. *Eimeria polita* Pellerdy, *Acta. vet. hung.*, 1 : 101.

Description : Oocyst ellipsoidal or broadly ovoid, measuring 22-31 μm by 17-22 μm sometimes a little more. Oocystic residuum

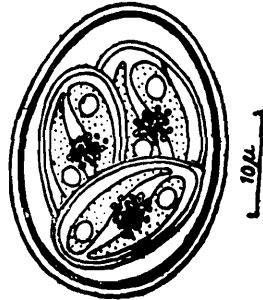


Fig. 197. Mature oocyst of *Eimeria polita*.

absent. The sporocysts are ellipsoidal in shape each measuring 13-19 μm in length with a mean of 16.3 μm and 6-9 μm in width with a mean of 7.6 μm . Sporocystic residuum present. Sporozoites are long each measuring 17-18 μm .

Sporulation time : 8-9 days (Pellerdy, 1974), 7.5 days (Vetterling, 1964).

Dimension of the oocysts reported by other authors are as follows :

24-10 by 20.27 μm and 29-34 by 17-22 μm (Boch, Pezenburg and Rosenfeld, 1961) ; 21-31 by 15-20 μm (Vetterling, 1964) ; 22-29 by

17-26 μm with the mean of 26.8 by 20.5 μm (Rommel, 1970) ; 22-31 by 17-22 μm and 23-27 by 18-21 μm (Pellerdy, 1974).

Type host : Domestic pig, *Sus scrofa domestica* (= *Sus scrofa* Linn).

Other hosts : From the type host.

Distribution : Izatnagar, Uttar Pradesh.

Endogenous stages : Vetterling (1964) studied the life-cycle (endogenous) and found that the first generation schizont develops in the jejunum and attain 8-12 μm in diameter, produces 8-12 μm long merozoite and a polar residuum. The second generation schizont measures 15-20 μm in diameter, produces 32 merozoites each measuring 12 μm but without any residuum. The microgametocyte measures 11-12 μm in diameter produces on maturation 1.5 μm long microgamete. The macrogamete measures 17-22 μm in diameter. Centurier (1970) experimentally infected with the pure strain of this species and traced the life-cycle having a little morphological differences in measurements of the different stages as obtained by Vetterling (*loc. cit.*).

Prepatent period : 8-9 days (Pellerdy, 1949) 9-11 days (Centurier, 1970).

Types : Not known.

Remarks : As in the remarks under *E. cerdonis*. Gill (1960) and Mishra (1967a,b) reported this parasite from India.

246. *Eimeria porci* Vetterling

(Fig. 198)

1921. *Eimeria debliccki* Douwes (partim) Bijdrage tot de Kennis van enkele darmprotozoen der huisdieren in het bijzonder bij schaap en varken. Diss., Utrecht., p. 62.

1965. *Eimeria porci* Vetterling, *J. Parasit.*, 51 : 897.

Description : Oocyst pear-shaped, distinctly narrow at the anterior end, measuring 20-27 μm by 14-18 μm with a mean of 23.5 μm by 16.7 μm . The length-width ratio ranges from 1.4 to 1.5 with a mean of 1.45. Oocystic wall double layered about 1.2 μm thick with a smooth yellowish-brown outer and smooth, dark brown inner layer. Micropyle

and micropylar cap absent. Oocystic residuum absent. Polar granules present. Sporocyst broadly ovoid, measuring 9-11 μm by 7-8 μm with a mean of 9.5 μm by 7.3 μm . The length/width ratio ranged from

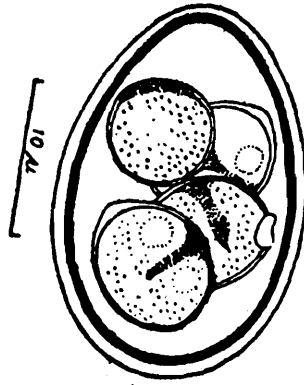


Fig. 198. Mature oocyst of *Eimeria porci*.

1.2 to 1.4 with a mean of 1.3. Stieda body present. Sporozoites lie length-wise, head or tail in sporocysts each with one or two clear globules.

Sporulation time : 9 days.

Type host : Domestic pig, *Sus scrofa domestica* [= *Sus scrofa* (Linn.)]

Other hosts : From the type host.

Distribution : Madhya Pradesh ; Aligarh, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

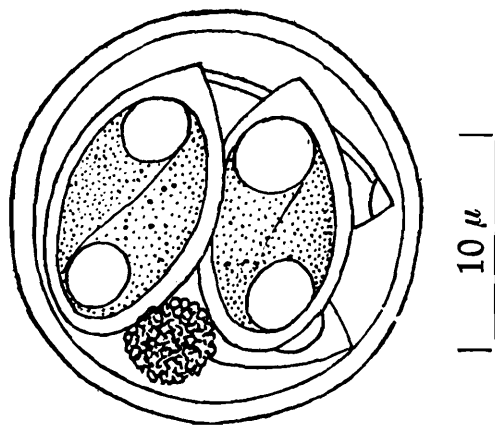
Remarks : This is one of the species of 'debliecki' group and the author differentiates it from *E. debliecki* by its short, broadly ovoid sporocysts with a sparse and finely granular residuum. Pellerdy (1974) stated that the inclusion of *E. polita* as synonym of *E. porci* in his supplementum I., catalogue of the suborder Eimeriidea published in (1969) was not valid and Vetterling (1965) did the similar mistake in synonymising the former with the latter. He further commented that the oocysts found by Shrivastav and Shah (1968) did not correspond to Vetterling's species (*E. porci*). Mandal (1980) has suggested to treat this species as distinct. Further report on the occurrence of this species in swine from India may be had from Shrivastav and Shah (1968) and Upadhyay, Ahluwalia and Asthana (1977).

247. *Eimeria punjabensis* Gill and Ray

(Fig. 199)

1960. *Eimeria punjabensis* Gill and Ray, *Proc. zool. Soc. Calcutta*, 13 : 128.

Description : The oocyst almost spherical in shape, light yellow in colour, measuring 20-23.75 μm in length and 19.5-22.5 μm in width with a mean of 22.5 μm by 22 μm . The shape index is about 1.0. Micropyle absent. The oocystic wall is of even thickness through, light yellow

Fig. 199. Mature oocyst of *Eimeria punjabensis*.

or with salmon tint. The oocystic residuum present distinctly about 5 μm diameter. Sporocyst ovoidal, measuring 12.5 μm in length and 8.5 μm in width with a stieda body. Sporocystic residual body absent. Sporozoite elongated with one end wider than the other, lie length-wise head to tail within the sporocyst. Each wider end is provided with a large refractile globule measuring 5 μm in diameter. The nucleus is centrally placed.

Sporulation time : Unknown.

Type host : Indian hare/Black-naped hare, *Lepus reficaudatus* = *Lepus nigricolis ruficaudatus* (Geoff.)].

Other hosts : Unknown.

Distribution : Ludhiana, Punjab.

Endogenous stages : Unknown.

Types : Not known.

248. *Eimeria rajasthani* Dubey and Pande
(Fig. 200)

1963. *Eimeria rajasthani* Dubey and Pande, *Curr. Sci.*, 32 : 273.

Description : Oocyst ellipsoidal, measuring 34-39 μm in length with a mean of 36.00 μm and 25-27 μm in width with a mean of 26 μm . The shape-index varies from 1.30-1.44. Double layered, micropyle not visible provided with a well defined cap. Oocystic residuum absent.

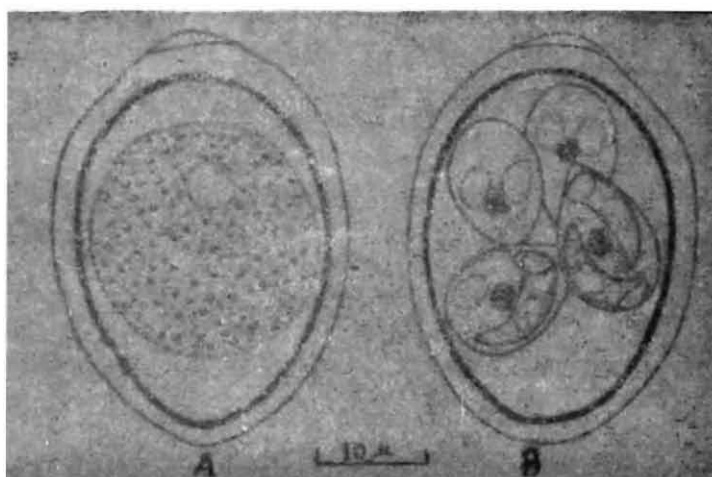


Fig. 200. A, immature and B, mature oocysts of *Eimeria rajasthani*.

Sporocyst almost ovoid with prominent stieda body. It measures 14-15 μm in length with a mean of 15 μm and 8-11 μm in width with a mean of 11.00 μm . Sporocystic residuum present. Sporozoite elongated measuring 10-14 μm in length and 3-4 μm in width with two or more prominent globules.

Sporulation time : About 7 days.

Type host : One humped camel, *Camelus dromedarius* (Linn.).

Other hosts : Unknown.

Distribution : Bikanir, Rajasthan.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Dubey and Pande (1964a) reported once more from India.

249. *Eimeria ramgai* Pande, Bhatia, Chauhan and Garg
(Fig. 201)

1970. *Eimeria ramgai* Pande, Bhatia, Chauhan and Garg., *Indian J. Anim. Sci.*, 40 : 154.

Description : Oocyst ovoid, measuring 17-24 μm by 14-20 μm in size, mean 20 μm by 16.8 μm . Length/width ratio 1.1-1.3, mean 1.2.

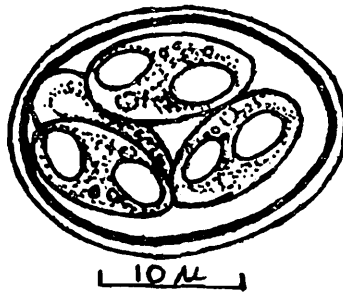


Fig. 201. Mature oocyst of *Eimeria ramgai*.

Oocystic wall 1-1.5 μm thick, double contoured, the outer layer is of light yellowish and the inner brown in colour. Micropyle and polar cap absent. Sporocyst broadly ellipsoidal, with one end narrower and 10-13 μm by 4-5 μm in size, mean 11 μm by 4.5 μm . Stieda body absent. Sporocystic residuum presents as scattered granules. Sporozoite measuring 9 μm by 2.4 μm in size, with one end broadly rounded and the other tapering, the former carrying a large refractile globule and a small centrally placed nucleus, with another smaller refractile globule, lying between it and the pointed extremity.

Type host : Mouse deer, *Tragulus minima* Erxleben.

Other hosts : From the type host, Patnaik and Acharjyo (1971).

Distribution : Zoological Garden, Lucknow, Uttar Pradesh, Nandankanan Zoological Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

250. *Eimeria robertsoni* (Madsen)
(Fig. 202)

1938. *Eimeria magna* var. *robertsoni* Madsen, *Medd. Om. Gronland*, 116 : 6

1938. *Eimeria perforans* var. *groenlandica* Madsen (partim) *Medd. Om. Gronland.*, 116 : 6.

1943. *Eimeria magna* forma *townsendii* Carvalho (partim), *Iowa St. Coll. J. Sci.*, 18 : 103.

1943. *Eimeria robertsoni* Carvalho, *Iowa St. Coll. J. Sci.*, 18 : 103.

Distribution : The oocyst ovoid to ellipsoidal in shape, light pink with yellowish tint in colour, measuring 33-44 μm in length and 21-32.5 μm in width with a mean of 39.25 μm by 25.5 μm . The shape index 1.6. The micropyle present, prominent, large, measuring 5-8 μm , mean 6.5 μm in diameter. The oocystic wall gradually increases to about double the thickness towards the micropyle where it forms

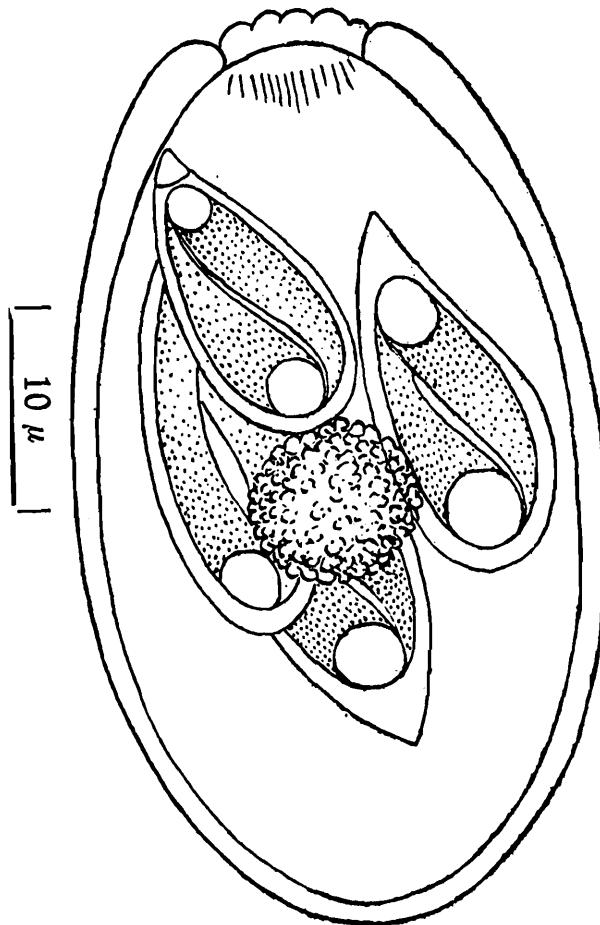


Fig. 202. Mature oocyst of *Eimeria robertsoni*.

prominent shoulder. Oocystic residuum present as large spherical mass measuring 8-14 μm , mean 10.5 μm in diameter. Sporocyst ovoidal to oval, the anterior end relatively sharper, measuring 18.5 μm in length and 6.2 μm in width. Sporocystic residual body absent. Sporozoites are elongated, refractile globules large and terminal in position and the nucleus is central in position.

Sporulation time : 48 hours.

Type host : Greenland Hare, *Lepus arcticus groenlandicus* Rhoads.

Other hosts : (i) White-tailed Jack rabbit, *Lepus townsendi campanius* Hollister. (ii) European Hare, *L. europaeus* Pallas. (iii) Black-naped Hare, *Campanius ruficaudatus* [= *Lepus nigricolis ruficaudatus* (Geoff.)], Gill and Ray, 1960.

Distribution : Kashipur, Uttar Pradesh ; Ludhiana, Punjab.

Endogenous stages : Unknown.

Types : Not known.

251. *Eimeria ruficaudati* Gill and Ray

(Fig. 203)

1960. *Eimeria ruficaudati* Gill and Ray, *Proc. zool. Soc. Calcutta*, 13 : 128.

Description : The oocyst cylindrical in shape and light yellowish-pink in colour, measuring 28-35 μm in length and 12-15 μm in width with a mean of 31.25 μm by 17.5 μm . The shape-index

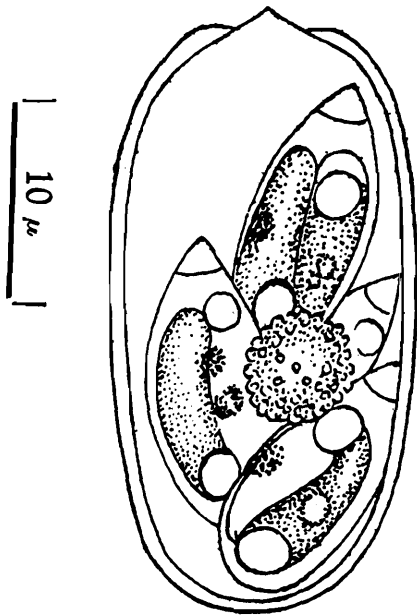


Fig. 203. Mature oocyst of *Eimeria ruficaudati*.

2.3. The oocystic wall thin and evenly thick throughout except the micropylar end where it gradually tapers. The micropyle is distinctly present, bounded by a bent line, with fine pointed tip in the centre which in some specimens appears to form a triangular opening. The oocystic residuum present as round body measuring

4-6 μm in diameter with a mean of 5 μm . Sporocyst ovoidal, anterior end bluntly pointed. Sporocystic residual body present as spherical mass measuring 2 μm in diameter. Sporozoites are medium sized each with a refractile globule at the rounded end, nucleus central in position.

Sporulation time : 66 hours.

Type host : Black-naped Hare, *Lepus ruficaudatus* [= *Lepus nigricolis ruficaudatus* (Geoff.)].

Other hosts : Unknown.

Distribution : Kashipur, Uttar Pradesh ; Ludhiana, Punjab.

Endogenous stages : Unknown.

Types : Not known.

242. *Eimeria sardari* Bhatia, Chauhan, Arora and Agarwal
(Fig. 204)

1973. *Eimeria sardari* Bhatia, Chauhan, Arora and Agarwal, *Indian J. Anim. Sci.*, 43 : 944.

Description : Oocyst elongate-ellipsoidal in shape, measuring 28-30.6 μm in length and 13.3-14.6 μm in width, mean 29.4 μm by

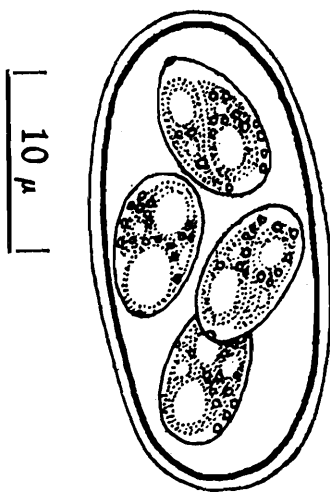


Fig. 204. Mature oocyst of *Eimeria sardari*.

14.1 μm , with outer yellowish green and inner yellowish-brown layers. Micropyle and polar cap absent. Length-width ratio ranges between

2.0 and 2.3 (mean 2.1). Oocystic residuum and polar granule absent. Sporocyst ellipsoidal, measuring 10.6-12.0 μm in length 6.6-8.0 μm in width, mean 11.0 μm by 7.3 μm having a vestigial stieda body at the narrower pole. Sporocystic residuum present as few scattered dark granules. Sporozoites elongated, with two refractile globules in each, one on either side.

Sporulation time : Unknown.

Type host : Barking deer, *Munthiacus muntjak* (Zimmermann).

Other hosts : Unknown.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

253. *Eimeria sardinae* (Thelohan)

- 1890. *Coccidium sardinae*, Thelohan, *C. r. hebdom. Seanc. Acad. Sci.*, Paris, 110 : 1214.
- 1919. *Coccidium oxyspora* Dobell, *Parasitology*, 11 : 147.
- 1919. *Eimeria oxyspora*, Castellani and Chalmers, *Manual of Tropical Medicine*. Third edition, London, P. 476.
- 1920. *Eimeria* sp., Snijders, *Parasitology*, 12 : 427.
- 1922. *Eimeria oxyspora*, Dobell, *Coccidiosis*. In Byam & Archibald, *The Practice of Medicine in the Tropics*. London, II, P. 1496.
- 1926. *Eimeria sardinae*, Wenyon, *Protozoology*, 2 vols. Baillere Tindal and Cox, London p. 851.

Description : Oocyst round to spherical in shape measuring 36 to 52 μm in diameter. Oocystic wall transparent and double layered, in natural light it is pale yellowish in colour. A small oocystic residual mass is always present. Sporocyst long, sharply pointed at both ends (naviculoid) and possessing a tough endospore and deciduous epispore, the remains of which gives the spore a frilled appearance. Sporocyst measures 30-32 μm in length and 5-7 μm in width. A sporocystic residuum present. Sporozoite spindle-shaped and tapering towards both ends, the posterior end containing the nucleus.

Sporulation time : Unknown.

Type host : Herring, *Clupea harengus*,

Other hosts : (i) Sardine, *Sardina pilchardus* (ii) Man, *Homo sapiens* Linn.

Distribution : India and Ceylon.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Though the host of this species is a fish but Dobell (1919) reported it from man who had been in South Africa, India and Ceylon. Afterwards Thomson and Robertson (1926) did some experiments and found that the oocysts in case of human coccidiosis are identical to those of *E. sardinae*.

254. *Eimeria scabra* Henry

(Fig. 205)

1931. *Eimeria scabra* Henry, *Univ. Calif. Publ. Zool.*, 36 : 115.

1931. *Eimeria scabra* Henry (lapsus), *Univ. Calif. Publ. Zool.*, 36 : 115.

1961. *Eimeria romaniae* Donciu, in R. P. R. Bucuresti, Ed. *Acad. Rep. Pop. Rom.*, Bucurest, pp. 89.

Description : Oocyst ellipsoidal to somewhat ovoid, slightly flattened at the micropylar end. Sporulated oocyst measures 27-32 μm by 19-24 μm in size, with a mean of 28.2 μm by 20.3 μm , the length/width ratio ranges from 1.2-1.4 with a mean of 1.3. Oocyst wall composed of two layers about 1.5 μm in total thickness, with a rough pigmented brown outer layer, having radial striations and a smooth, brownish-

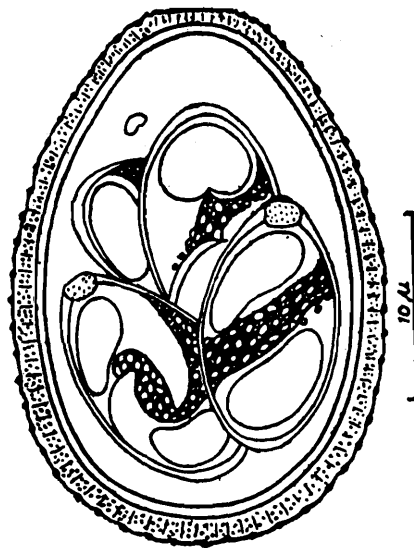


Fig. 205. Mature oocyst of *Eimeria scabra*.

yellow inner one. Micropyle present, 3.5-4.5 μm in size. Micropylar cap absent. In one or two oocysts, polar granules present. Oocystic residuum absent. Sporocyst ovoid with stieda body measuring 14-18 μm by 7-8 μm in size with a mean of 15.2 μm by 8 μm ; the

length width ratio ranges from 2.0-2.5, with a mean of 2.2. Sporocystic residuum present. Sporozoite elongated, lying head to tail within the sporocyst, each containing 2 clear globules.

Dimension of the oocysts reported by other authors are as follows :

25-36 by 17-25 μm (Kutzer, 1960) ; 24-42 by 20-24 μm with the mean of 31.9 by 22.5 μm (Vetterling, 1965) ; 22-36 by 16-26 μm (Pellerdy, 1974).

Type host : Domestic Pig, *Sus scrofa domestica* [= *Sus scrofa* (Linn.)].

Other hosts : From the type host.

Distribution : Mhow, Madhya Pradesh ; Izatnagar, Aligarh, Uttar Pradesh ; Orissa and Bihar.

Endogenous stages : The endogenous stages are known is due to the contribution made by Rommel and Ipczynski (1967). The first generation schizont measures 12-19 μm by 11-17 μm and produces 16-24 merozoites each measuring 11-15 μm by 1.5-2 μm in size sometimes with residuum. Second generation schizont measures 10-20 μm by 9-15 μm produces 14-22 merozoites each measuring 9-17 μm by 2-4 μm with a large polar residuum. The third one measures 16-27 μm produces 14-28 merozoities each measuring 12-19 μm by 2-4 μm with residuum. The microgameocyte measures 17-34 μm by 14-22 μm . The comma-shaped microgamete measuring 4.4-2.5 μm by 6-1 μm possesses two flagella in each. The macrogamete measures 14-23 μm by 9-16 μm with a large nucleus and contain cytoplasmic granules.

Types : Not known.

Remarks : Though Pellerdy (1965, 1963) retained *E. romaniae* but Vetterling (1965) synonymised it with the species dealtwith. The present author is of same opinion to synonymise *E. romaniae* with *E. scarba* Henry. Further information on this species from India may be had from Gill (1960b), Patnaik (1963), Sinha (1963), Mishra (1967a), Shrivastav and Shah (1968) and Upadhyay, Ahuwalia and Asthana (1977).

255. *Eimeria spinosa* Henry (Fig. 206)

1931. *Eimeria spinosa* Henry, Univ. Calif. Publ. Zool., 36 : 115.

Description : The oocysts ellipsoidal in shape and measuring 16-22.4 μm by 12.8-16 μm . The wall is brown and its entire surface

is covered by 1 μm high spines at 1 μm distance from one another. Following the contraction of the coarse-granulated cytoplasm to a rounded sporont a polar granule makes its appearance in the oocyst.

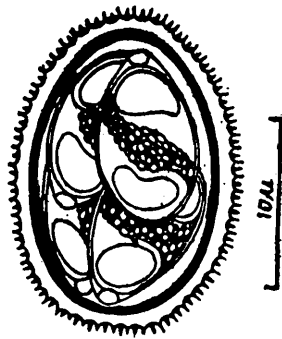


Fig. 206. Mature oocyst of *Eimeria spinosa*.

The sporont as a rule lies asymmetrically nearer to one of the poles. The sporocyst measures 9.1-11.7 μm by 5.2-6.5 μm , sometimes difficult to observe due to the dark colour of the oocyst. Stieda body remains at one end. The sporocystic residual body is granular.

Sporulation time : At room temperature it begins on the 10th day and is completed by about 15th day.

Dimension of the oocysts reported by other authors are as follows :

14-26 μm by 14-.21 μm (Boch, Pezenburg and Rosenfeld, 1961) ; 11-22 μm by 10-13 μm (Wiesenhütter, 1962a) ; 16-22 μm by 13-16 μm (Pellerdy, 1974).

Type host : Domestic pig, *Sus scrofa* (Linn.)

Other hosts : From the type host, Gill (1960), Patnaik (1963) and Shrivastav and Shah (1968).

Distribution : Karnal, Haryana ; Madhya Pradesh ; Orissa and West Bengal.

Endogenous stages : Wiesenhütter (1962a) found that the schizogonic development took place in the epithelial cells of the small intestine. Mature schizont measures 8-10 μm and produces nearly 20 merozoites, each measuring 4-6 μm by 1-1.5 μm in size. The microgametocyte measures 6-8 μm produces 3 μm long microgamete. The macrogametocyte measures 7-9 μm in diameter with centrally or eccentrically placed nucleus in each. The cytoplasm is coarsely granular, the macrogamete measures 10-12 μm in diameter.

Types : Not known.

256, *Eimeria stiedai* (Lindemann)

(Fig. 207)

1865. *Monocystis stiedae* Lindemann, *Bull. Soc. Imp. nat. Moscow*, 38 : 381.
 1878. *Psorospermium cuniculi* Rivolta, *Geor. Anat. Fisiol. Patol. Anim.*, Pisa, 4 : 229.
 1879. *Coccidium oviforme* Leuckart, *Die Parasiten des Menschen und die von ihnen herrührenden Krankheiten. Die Hand-und Lehrbuch für Naturforscher und Aerzte.* 2 Aufl. Leipzig u. Heidelberg, 1, 1 Life., 1 Abt., P. ?
 1899. *Coccidium cuniculi* Labbe, *Sporozoa*, In *Das Tierreich*. Berlin, p. ?
 1904. *Eimeria cuniculi* Wassielewsky, *Studien und Mikrophotogramme zur Kenntnis der Pathogen Protozoen*. Leipzig. p. ?
 1907. *Eimeria stiedai* Kisskalt and Hartmann, *Practicum der Bakteriologie Protozoologie*, Jena, P. ?
 1911. *Eimeria oviformis* Fantham, *The Grouse in Health and in Disease*, London, 1 : 235.
 1933. *Eimeria stiedae* var. *cuniculi* Graham, *Ill. Agric. Exp. St. Circ.*, p. 401.

Description : Oocyst ovoidal to ellipsoidal in shape with micropylar end slightly narrower, measuring 26-40 μm in length and 16-24 μm in width a mean of 35.75 μm by 21 μm . The shape index 1.85.

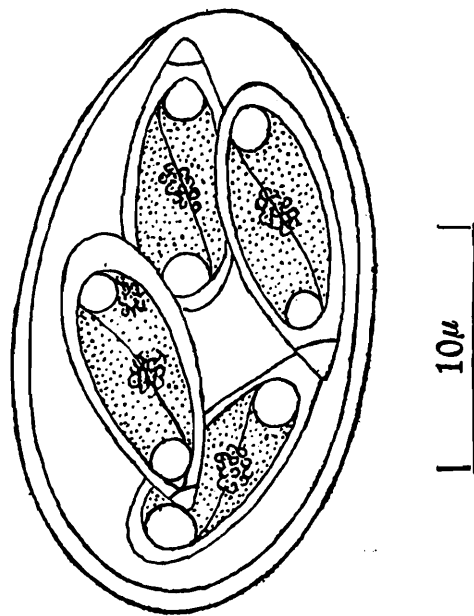


Fig. 207. Mature oocyst of *Eimeria stiedai*.

The colour of the oocyst is light pink to reddish orange, sometimes yellowish. The micropyle is present, prominent, thin, convex and continuous with the contour of the wall. The oocystic wall is thin, uniform throughout but thinning towards the micropyle. Oocystic residuum absent. Sporocyst ovoid to ellipsoid, measuring 17 μm in

length and 9 μm in width. Sporocystic residuum present as oval to spherical body, measuring 6 μm in diameter.

Sporulation time : 72 hours.

Type host : Snowshoe, *Lepus americanus*.

Other hosts : (i) Tame rabbit, *Oryctolagus cuniculis* (= *Oryctolagus* sp.) (ii) Alpine Hare (= Varying Hare) *Lepus timidus* Linn. (iii) Eastern Cottontail, *Sylvilagus floridanus mallurus* (Thomas) (iv) Mearn's Cotton tail, *Sylvilagus floridanus mearnsi* (J. A. Allen) (v) Cotton tail, *Sylvilagus nuttallii* (*S. floridanus*) *grangeri*.

Distribution : Mukteswar, Uttar Pradesh ; Kashmir and Ludhiana, Punjab.

Endogenous stages : The sporozoites after being excysted in the intestine pass through the lymph nodes ultimately reach the liver or reach via hepatic portal system. They enter the epithelial cells of the bile ducts and develop above the host cell nucleus. There are also 6 generations of schizogony. Each generation of schizont produces two types of merozoites, pulp 'Type A' and slender 'Type B'. The prepatent period is 14 days and the patent period is uncertain. (Metzner, 1903), Smetana, 1933, Minning 1936, Horton, 1967 ; Pellerdy and Durr 1970, Owen, 1970 and Fitzgerald, 1970). By means of Electron microscopy, while studying the schizogony, multinucleated merozoites have been observed in *E. stiedai* by Cerna and Senaud (1971) at the time of intestinal asexual reproduction. The reason is unknown to the authors. However they expressed a doubt in this regard and stated that it might be the future microgamete or new schizont might be developed from the multinucleated merozoite.

Dasgupta (1958, 59, 60 and 1961a, b) studied the different cytochemical reactions in the developmental stages of *E. stiedai*. After obtaining the large number of Feulgen positive bodies in the sporoblast the author (1958, 59) suggested to believe that these bodies represent the nuclei corresponding to those of the hypothetical ancestral form.

Type : Not known.

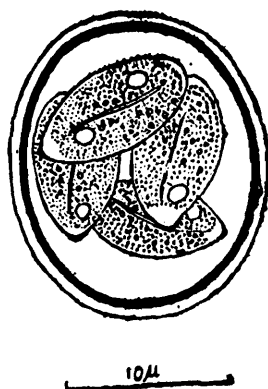
Remarks : *E. stiedai* appears to be the first unicellular organism seen by Leeuwenhock, 1674 in a rabbit liver. Authors like Ray (1945) and Gill and Ray (1960) have reported this parasite from India and Hassan (1970) reported it from Bangladesh.

257. *Eimeria subspherica* Christensen

(Fig. 208)

1941. *Eimeria subspherica* Christensen, *J. Parasit.*, 27 : 203.

Description : The oocyst colourless, subspherical (rarely spherical) in shape. The oocystic wall is smooth, pale yellowish sometimes double layered, 0.7-1.0 μm thick. The oocyst measures 9-14 μm in length and 8-12 μm in width with a mean of 11 μm by 10.4 μm . Micro-

Fig. 208. Mature oocyst of *Eimeria subspherica*.

pyle, oocystic residuum, polar granules absent. The sporocyst elongate-ovoid with small stieda body, measuring 7-10 μm in length and 5-4 μm in width, with a mean of 8 μm by 3.5 μm , containing no sporocystic residuum. Sporozoite wider at one end than the other, lying length-wise head to tail within the sporocyst. Each sporozoite is provided with a clear globule at the larger end.

Sporulation time : 4-5 days.

Type host : Ox, *Bos taurus* (Linn.)

Other hosts : (i) Buffalo, *Babulus bubalis* Linn. (ii) Indian Cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Agra, Mathura, Izatnagar, Uttar Pradesh and Karnal, Haryana.

Prevalance : From Wisconsin, Hasche and Todd (1959a) detected 11% infection in cattle. Szanto, Mohan and Levine (1964) observed this species in 8% calves in Illinois. From Oregon 8% cattle was found to be infected with this species as detected by Nyberg, Halfer and Knapp (1967). From Costa Rica, Ruiz and Oritz (1961) obtained 3% infection. Balconi (1963) reported 12% infection in cattle from

Guatemala. Joyner *et al.* (1966) reported 28% infection in cattle from England and Vassiliades (1969) got 6% infection in cattle from Senegal. Patnaik (1965) got 21% infection from Buffalo at Agra, Uttar Pradesh ; Bhatia *et al.* (1968) also reported 16% infection from the buffalo at Mathura, Uttar Pradesh. From Turkey, Sayin (1969) reported 15% infection in buffalo.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Authors like Gill (1960b, 68), Patnaik (1963), Patnaik and Pande (1965) and Bhatia, Pande, Chauhan and Garg (1971) reported this parasite from India.

258. ***Eimeria suncus*** Ahluwalia, Singh, Arora, Mandal and Sarkar
(Fig. 209)

1979. *Eimeria suncus* Ahluwalia, *et al.*, *Acta Protozool.*, 18 : 451.

Description : Oocyst almost subspherical in shape measuring 18.2-21.8 μm in length with a mean of 19.50 μm and 15.5-16.8 μm in width with a mean of 15.2 μm . It is provided with smooth bilayered wall of yellowish in colour, measuring 1.9-1.65 μm in thickness and the outer being thinner. A clear micropylar cap is visible on the wall of

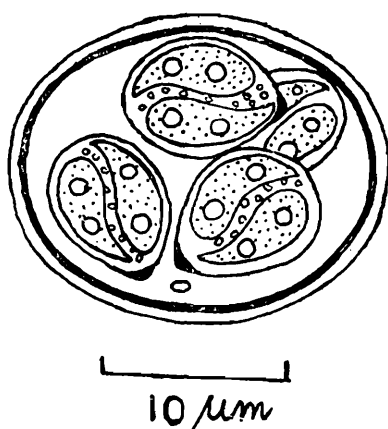


Fig. 209. Mature oocyst of *Eimeria suncus*.

the oocyst. Oocystic residuum and polar granules absent. Sporocyst lemon-shaped, measuring 9.5-11.2 μm in length with a mean of 10.5 μm and 6.5-8.8 μm in width with a mean of 7.8 μm . It is provided with a nipple like protuberance having a slightly thickened area at one end. Sporocystic residuum appeared as beaded like globular mass scattered within the sporocyst. Sporozoites are almost comma-shaped, each measuring 4.00-5.5 μm in length with a mean of 4.5 μm and 3.2-3.8 μm

in width with a mean of $3.5\ \mu\text{m}$. Each end of the sporozoite is provided with a clear refractile area and the bigger one is found at the wider end.

Type host : House-shrew, *Suncus murinus murinus* Linn.

Other host : Unknown.

Distribution : Mathura, Uttar Pradesh and Calcutta, West B ngal.

Endogenous stages : Ahluwalia *et. al.* (1979) attempted to study the the endogenous stages of *E. suncus* and noticed the macrogametocytes, each measuring $14\ \mu\text{m}$ by $12.56\ \mu\text{m}$ with large peripheral plastic granules, in the columnar epithelial cells of small intestine but could not trace the schizont.

Types : Lying in the Collection of Dept. of Parasitology, Mathura Veterinary College, Mathura, Uttar Pradesh.

259. *Eimeria sylvilagi* Carini
(Fig. 210)

1940. *Eimeria sylvilagi* Carini *Arch. Biol.*, (S. Paulo), 24 : 218.

Description : The oocyst ovoid or elongated with tapering towards both ends, more so towards the micropyle and light-yellowish to yellow

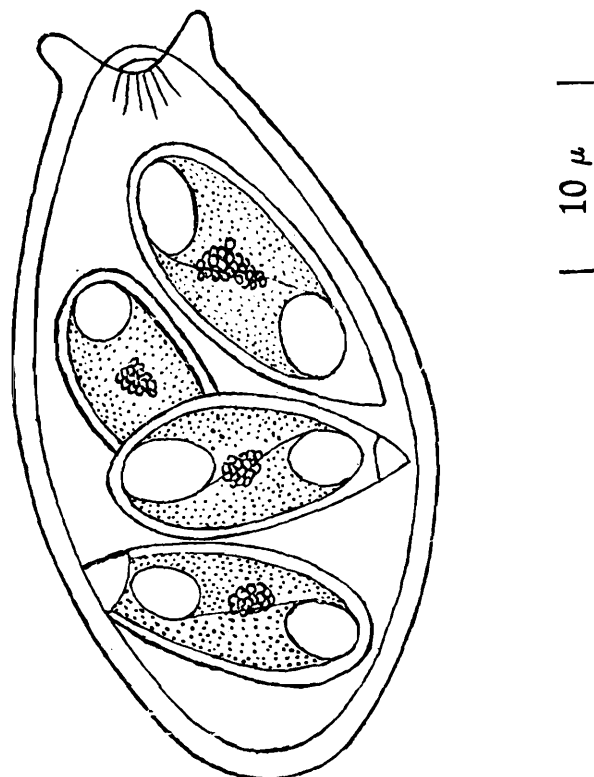


Fig. 210. Mature oocyst of *Eimeria sylvilagi*.

in colour. It measures $21\text{--}39\ \mu\text{m}$ in length and $16\text{--}24\ \mu\text{m}$ in width with a mean of $31\ \mu\text{m}$ by $19\ \mu\text{m}$. The micropyle present prominently,

measuring 6 μm in width. The oocystic wall thin uniformly thick but protrudes suddenly at the micropyle to form bordering lappets. No oocystic residuum present. Sporocyst ellipsoidal to oval in shape, measuring 16 μm in length and 7 μm in width. Stieda-body prominently present. Sporocystic residual body represented by a free scattered granules in the centre of the Sporocyst. In the sporozoite, the refractile globule large and nucleus centrally placed.

Sporulation time : 55-80 hours according to original describer.

Type host : Brazilian Hare, *Sylvilagus brasiliensis minensis* ?

Other hosts : (i) Mearn's Cotton tail, *Sylvilagus floridanus mearnsi* (J. A. Allen), (ii) Black-naped Hare, *Lepus ruficaudatus* [= *Lepus nigricollis ruficaudatus* (Geoff.)], (iii) Domestic Rabbit, *Oryctolagus cuniculus* (= *Oryctolagus* sp.).

Distribution : Kashipur, Uttar Pradesh ; Ludhiana, Punjab.

Endogenous stages : All these are known due to the work of Hsuck (1970). There are two types of schizogonic generations in the epithelial cells and lamina propria of the jejunum and ileum. First generation schizont produces curved, banana-shaped 2-14 merozoites each measuring 9 μm by 2 μm and pointed at both ends. The second generation schizont produces 3-86 merozoites each measuring 12 μm by 3 μm . Mature microgametocytes are almost spherical each measuring 10-26 μm by 9-25 μm and produces many biflagellate microgametes. Mature macrogamete measures 15-26 μm by 10-12 μm . The prepatent period is 6-8 days and the patent period is 6-18 days.

Types : Not known.

Remarks : Gill and Ray (1960) reported this parasite from India.

260. *Eimeria tirupatiensis* Sivanarayan and Venkataratnam (Fig. 211)

1969. *Eimeria tirupatiensis* Sivanarayan and Venkataratnam, *Indian vet. J.* 46 : 477.

Description : The oocyst usually elongated ovoid, less often ellipsoid and 37-44 μm by 25-31 μm mean 40.1 μm and 28.5 μm in size. The oocyst wall is bilayered, with a smooth pinkish outer layer about 1 μm thick and a brownish inner layer about 0.9 μm . The mound-shaped micropylar cap is 1.5-4 μm high by 8.5-11 μm wide, mean 2.2 μm by 9.4 μm . The oocyst possesses one to three polar granules, but no residuum. The ellipsoid or ovoid sporocyst has a stieda body and

measures 11-16 μm by 9-11 μm , mean 14.1 μm by 9.6 μm . A granular sporocystic residuum is interspersed between the sporozoites. The

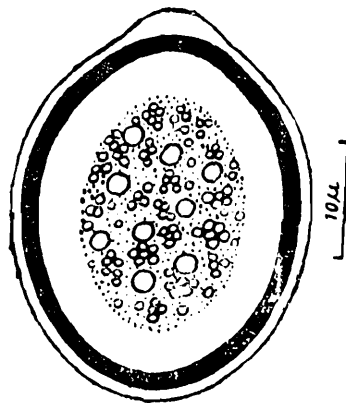


Fig. 211. Mature oocyst of *Eimeria tirupatiensis*.

sporozoites measures 11-16 μm by 4.5-7 μm , mean 13.7 by 5 μm and carry two to three refractile globules.

Sporulation time : 4 days.

Type host : Domestic goat, *Capra hircus* (= *Capra* sp.).

Other hosts : Not known.

Distribution : Tirupati, Andhra Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Levine and Ivens (1970) in their monograph on 'The Coccidian Parasites (Protozoa : Sporozoa) on Ruminants', p. 270 stated that this species resembles to some extent with *E. christensenii* and *E. ahsata* but the present one is unique due to the presence of a stieda body in the sporocyst. Therefore it can be retained as distinct species.

261. *Eimeria tragocameli* Bhatia

(Fig. 212)

1968. *Eimeria tragocameli* Bhatia, *Indian J. Microbiol.*, 8 : 249.

Description : Ovoid to ellipsoidal oocyst, 20-29 μm by 16-20 μm in size, mean 24.4 μm by 18.7 μm , the length-width ratio is 1.11-1.55 mean 1.3. The 1.3-1.5 μm thick oocystic wall, thin at the narrower end suggestive of a micropyle; the outer greenish-yellow layer of 1.0 μm thickness and a thin light-brown inner layer. The sporont is

full of globules of different sizes. Oocystic residuum and polar granule absent. [On the seventh day, the sporoblasts exhibited, at each end a prominent globule, the characteristic praechute-shaped cap which however, disappeared on differentiation on the sporozoites]. The ovoid

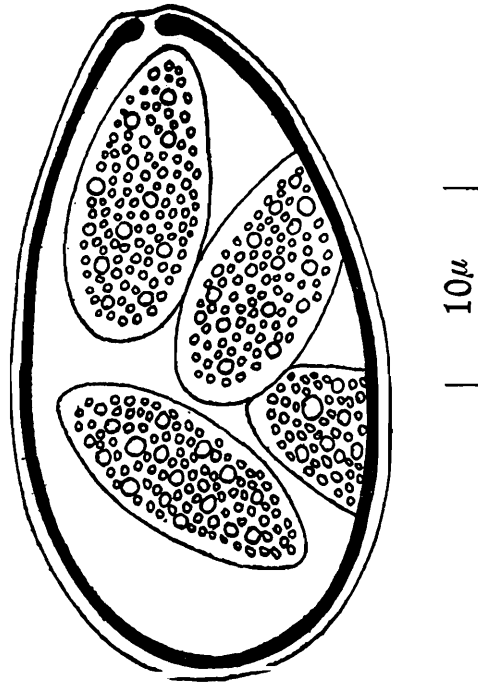


Fig. 212. Mature oocyst of *Eimeria tragocameli*.

sporocyst, with one end somewhat narrower, measured 10.0-13.3 μm by 5.3-6.6 μm , mean 11.6 μm by 6.2 μm in size. Steida body present as a flat-darkened cap. Sporocystic residuum occurred in two or three groups of scattered granules. The banana-shaped sporozoite, with one end tapering and other broadly rounded, measuring 9-10 μm by 2.6 μm in size, contained three or four refractile globules of different sizes, the largest one lying towards the broader end.

Sporulation time : 10 days.

Type host : Nilgai, *Boselepus tragocamelus* Pallas.

Other hosts : From the type host.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pande, Bhatia, Chauhan and Garg (1970) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) reported this parasite from India afterwards.

262. *Eimeria tuberculata* Krishnamurthy and Kshirsagar
(Fig. 213)

1980. *Eimeria tuberculata* Krishnamurthy and Kshirsagar, *Arch. Protistenk.*, 123 : 215.

Description : Oocyst subspherical in shape measuring 36.8-43.2 μm in length with a mean of 39.73 μm and 32.0-38.4 μm in width with

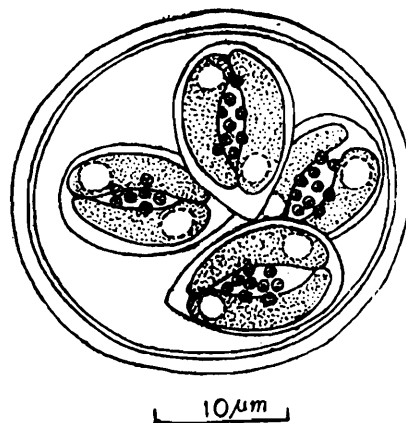


Fig. 213. Mature oocyst of *Eimeria tuberculata*.

a mean of 36.10 μm . The length/width ratio of the oocyst is 1.04-1.15 with a mean of 1.10. The oocystic wall is trilayered measuring about 3.2 μm in thickness. The transparent outer layer is comparatively thin than the darker middle layer measuring about 2 μm thick and it shows typically tuberculate with several small tubercles of slightly varying sizes distributed uniformly all over its surface. The inner wall is about 1.0 μm thick and yellowish brown in colour. The oocyst is devoid of micropyle and micropylar cap. Polar granule and oocystic residuum absent. The sporulated oocyst contains four oval or egg-shaped sporocysts, each with one end rounded and the other slightly pointed. The sporocyst measures 19.2-22.3 μm in length with a mean of 20.00 μm and 12.0-14.4 μm in width with a mean of 13.10 μm . The length/width ratio of the sporocyst is 1.5-1.7 with a mean of 1.62. The sporocystic residuum is in the form of several granules distributed around the centre of sporozoites. The sporozoite is typically elongated, banana-shaped and carry a fairly large refractile body at one end.

Sporulation time : 80-86 hours.

Type host : Rat, *Rattus rattus rattus*.

Other host : Unknown.

Distribution : Aurangabad, Maharashtra.

Endogenous stages : Unknown.

Types : Not known.

Remarks : There is no such subspecies like (*rattus*) of rat which is found within the Indian limit.

263. *Eimeria wassilewskyi* Rastegaieff
(Fig. 214)

1930. *Eimeria wassilewskyi* Rastegaieff, *Arch. Protistenk.*, 71 : 377.

Description : Oocyst egg-shaped, measuring $17.5\ \mu\text{m}$ - $19.5\ \mu\text{m}$ in length with a mean of $18.5\ \mu\text{m}$ and $13.5\ \mu\text{m}$ - $15.5\ \mu\text{m}$ in width with a mean of $14.24\ \mu\text{m}$. The shape index is 1.3. It is provided with double wall of 0.75 - $1.00\ \mu\text{m}$ in thickness, the outer being thinner than the inner one and of yellowish in colour. The cytoplasmic mass is almost spherical, situated at the middle and appears like refractile globule of 7.5 - $8.5\ \mu\text{m}$ in diameter. A micropyle is seen at the anterior end of the oocyst measuring 3.5 - $4.5\ \mu\text{m}$ in the course of development, residual mass is seen as a spherical body measuring $3.75\ \mu\text{m}$

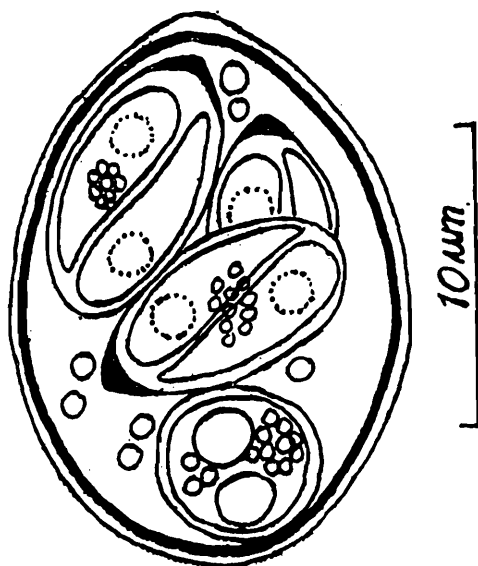


Fig. 214. Mature oocyst of *Eimeria wasielewskyi*.

in diameter and ultimately dispersed as 4-8 refractile bodies. The sporocyst is broadly elliptical in shape with tapering anterior end having a clear shiny area but without any distinct knob. The sporocyst measures 8.5 - $10.5\ \mu\text{m}$ in length, mean $9.00\ \mu\text{m}$ and 3.5 - $5.5\ \mu\text{m}$ in width, mean $4.5\ \mu\text{m}$. The sporocystic residuum is present as globular concentrated central mass with a few scattered granules. The sporozoite elongated, tapering at anterior end, almost blunt at the posterior, measuring 7.00 - $8.0\ \mu\text{m}$ in length (mean $7.5\ \mu\text{m}$) and 2.00 - $3.00\ \mu\text{m}$ in

width ; a hyaline refractile area is present at the broader end of the sporozoite, but the position of the nucleus is not clear.

Sporulation time : 2-3 days.

Type host : Spotted Deer, *Axis axis* (Erxleben).

Other hosts : From the type host and (i) Red Deer, *Cervus e. eliphus* Linnaeus (ii) Sika Deer, *Cervus nippon hortulorum* Temminck.

Distribution : Andaman Islands, Nandankanan Zoological Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

Remarks : The details about the taxonomic status of this species can be had from Mandal and Nair (1974). Patnaik and Acharjyo (1971) reported this parasite from Orissa.

264. *Eimeria wyomingensis* Huizinga and Winger

(Fig. 215)

1942. *Eimeria wyomingensis* Huizinga and Winger, *Trans. Amer. Micr. Soc.*, 61 : 131.

1956. *Eimeria mundaragi* Hiregaudar, *Curr. Sci.*, 25 : 197.

Description : Oocyst egg-shaped, 37-44 μm in length and 26-31 μm in width with a mean of 41 μm by 28 μm ; length-width ratio 1.4-1.65, mean 1.48. Oocystic wall thick, yellowish brown, double layered the outer coat rough of 1.99 μm thickness, heavily and uniformly punctate and the inner one of 0.66 μm in thickness.

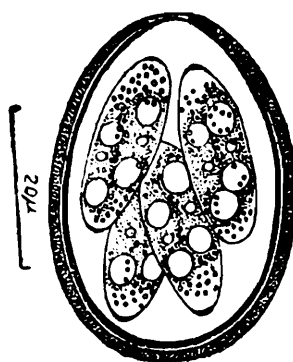


Fig. 215. Mature oocyst of *Eimeria wyomingensis*.

Micropyle present, measuring 4.0-6.6 μm mean 5.0 μm wide. Oocystic residuum and polar granules absent. Sporocyst elongate-ovoid, with one end narrower, measuring 21-24 μm by 8-9 μm ; mean 22.0 μm by

8.6 μm in size. Sporocystic residuum granular, the granules lying along the sporozoites or concentrated towards pole. Sporozoite elongate, measuring 7-8 μm in length and 5 μm at the broadest diameter, with two large refractile globules—one at the wider end and the other towards the narrower end, with the nucleus between them.

Sporulation time : 6-7 days.

Dimension of the oocysts as reported by other authors are as follows :

36-46 by 26-32 μm with the mean of 40 by 28 μm (Huizinga and Winger, 1942) ; 37-41 by 22-26 μm with the mean of 38.3 by 24.8 μm (Patnaik, 1965c) ; 37-45 by 26-31 μm with the mean of 40.3 by 28.1 μm (Pellerdy, 1974).

Type host : Ox, *Bos taurus* (Linn).

Other hosts : (i) Domestic buffalo, *Bubalus bubalis* Linn. (= *Bubalus* sp.), (ii) Indian cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Agra, Mathura, Izatnager, Uttar Pradesh ; Karnal, Haryana.

Prevalence : Szanto, Mohan and Levine (1964) found 60% infection in cow calves from Illionis, Patyk (1965) found 1% infection in calves from Poland, Joyner *et al.* (1966) found the same in 14% of cattle from England ; Bhatia *et al.*, (1968) obtained 5% infection in buffaloes from Mathura, Uttar Pradesh and Sayin (1969) got 0.7% infection in buffaloes from Turkey.

Endogenous stages : Unknown.

Types : Not known.

Remarks : From India authors like Gill (1960a, 68 and 73) and Patnaik (1963) have reported further on this species.

265. *Eimeria yakimovi* Rastegaieff (Fig. 216)

1930. *Eimeria yakimovi* Rastegaieff, *Arch. Protistenk.*, 71 : 377.

Description : Oocyst egg-shaped measuring 27-36 μm by 20-25 μm in size, mean 32 by 23 μm ; with the length-width ratio of 1.1-1.5, mean 1.3. Oocystic wall smooth, measuring 1.0-1.5 μm thick, mean 1.3 μm , double contoured, with the outer layer yellowish-green and the inner of dark yellow brown in colour. Micropyle perceptible as a thin area in the oocystic wall at the narrower end over an area of 5-7 μm , mean 6 μm . Polar cap absent. Oocystic residuum and polar granule absent. Sporulation completed in 7 to 12 days. Sporocyst ellipsoidal ; with

slightly narrow extremities, and of 13-17 μm by 6-8 μm in size, mean 14 μm by 7 μm . Stieda body present as a small dark cap. Sporocystic residuum is present as a few scattered granules around sporozoites.

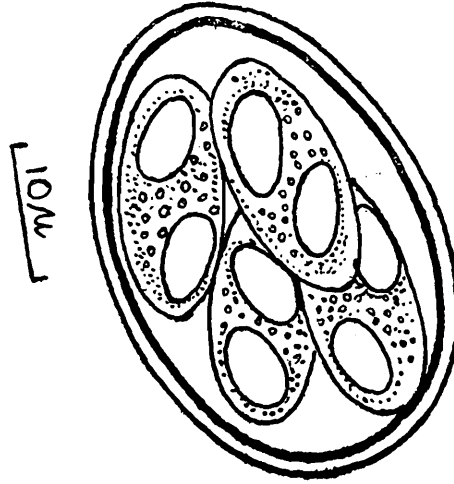


Fig. 216. Mature oocyst of *Eimeria yakimovi*.

Sporozoite measures 11-15 μm by 4-5 μm in size, mean 12 μm by 4.5 μm , with one end broad and the other pointed, the former carrying a large refractile globule and a small nucleus in the centre.

Type host : Nilgai, *Boselapus tragocamelus* Pallas.

Other hosts : Unknown.

Distribution : Zoological Garden, Lucknow, Uttar Pradesh ; Nandankanan Zoological Garden, Orissa.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pande, Bhatia, Chauhan and Garg (1970), Patnaik and Acharjyo (1971) and Chauhan, Bhatia, Arora, Agarwal and Ahluwalia (1973) reported this species from India.

266. *Eimeria zuernii* (Rivolta) (Fig. 217)

- 1878. *Cryptospermium zurni*, Rivolta, *Geor. Anat. Fisiol. of Patol. Anim.*, Pisa, 4 : 220.
- 1891. *Coccidium zurnii* Railliet and Lucet, *Bull. Soc. zool. Fr.*, 16 : 246.
- 1908. *Coccidium bovis* Zublin (partim), *Schweizer. Arch. Tierheilk.*, 50 : 123.
- 1909. *Eimeria zurnii* Martin, *Rev. vet. (Toulouse)*, 34 : 201.
- 1912. *Eimeria bovis* Fiebiger (partim) *Die tierischen Parasiten der Haus-und Nutztiers. Wein und Leipzig*, xvi+424 pp.
- 1912. *Eimeria canadensis* Bruce, *J. Am. vet. med. Ass.*, 58 : 638.

Description : Oocyst spherical, subspherical or bluntly ellipsoidal-ovoidal in shape, measuring 14-22 μm in length and 13-19 μm in width

with a mean of $17\ \mu\text{m}$ by $16\ \mu\text{m}$ and the length-width ratio is 1.0-1.2 with a mean of 1.12. Oocystic wall smooth, double-layered, light yellowish-green, $1.5\ \mu\text{m}$ thick. Micropyle undetectable. Micropylar cap absent. Oocystic residuum and polar granule absent. Sporocyst

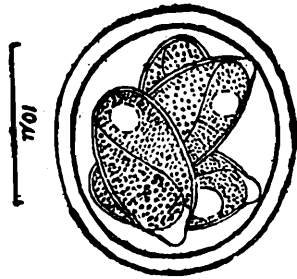


Fig. 217. Mature oocyst of *Eimeria zuernii*.

elongate-ovoid, measuring $8.0-10.5\ \mu\text{m}$ in length and $5.0-7.0\ \mu\text{m}$ in width with a mean of $9.9\ \mu\text{m}$ by $6.0\ \mu\text{m}$ with rounded ends. Stieda body present as a faintly darkened cap over the narrower anterior end. Sporocystic residuum present at loosely scattered granules. Sporozoite measuring $9\ \mu\text{m}$ by $3\ \mu\text{m}$ in size, with a refractile globule lying behind the wider rounded end, the other end being abruptly pointed, having the nucleus in its middle. Prepatent period is about 19 days.

Sporulation time : 3-4 days.

Dimension of the oocyst reported by other authors are as follows :

15-22 by 13-18 μm with the mean of 17.8 by 15.6 μm (Martin, 1909) ; 13-29 by 12-20 μm with the mean of 20.9 by 16.4 μm (Wenyon, 1926) ; 17.6 by 15.5 μm (Richardson and Kendall, 1957) ; 12-26 by 12-16 μm with the mean of 17.6 by 14.6 μm (Davis and Bowman, 1957) ; 14-21 by 10-17 μm with the mean of 17.1 by 14.6 μm (Cordero del Campillo, 1960) ; 16-20 by 15-18 μm with the mean of 18 by 17 μm (Nyberg and Hammond, 1965) ; 12-29 by 10-21 μm with the mean of 17-20 by 14-17 μm (Levine and Ivans, 1970).

Type host : Ox, *Bos taurus* (Linn.).

Other hosts : (i) Domestic/Indian buffalo, *Bubalus bubalis* Linn. (= *Bubalus* sp.) (ii) Indian Cattle, *Bos indicus* (= *Bos* sp.).

Distribution : Izatnagas, Agra, Mathura, Uttar Pradesh ; Orissa ; Karnal, Haryana.

Prevalence : Tubangui (1931) found 11% infection in zebues and 9% in carabaos from Philippines ; Yakimoff, Gouseff and Rastegaieff (1932) found 13% from oxen in Uzbekistan ; Yakimoff (1933) found

18% in Oxen, 6% in zubues and 37% in buffaloes from Azerbaidzhnl. Marchenko (1937) found infection 20% from cattle in North Caucasus ; Torres and Ramos (1939) got 38% in cattle from Brazil ; Boughton (1945) obtained 42% in bovine from United States ; Supperer (1952) observed 11% in cattle from Austria ; Watanabe and Iwata (1956) got 3% infection in cattle from Japan ; Hasche and Todd (1959a) received 26% infection in cattle from Wisconsin. Ruiz (1959) obtained 1% infection in cattle and Riuz and Ortiz (1961) observed 2% in calves from Costa Rica ; Balconi (1963) reported 25% in cattle from Guatemala ; Szanto, Mohan and Levine (1964) observed 37% infection in cow calves from Illinois ; Chroust (1964) got 83% infection in cattle from Czechoslovakia, Patnaik (1965c) reported 36% infection in buffalo from Agra, Uttar Pradesh ; Patyk (1965) reported 16% infection in calves from Poland ; Joyner *et al.* (1966) observed 64% in cattle from England ; Nyberg, Helfer and Knaff (1967) reported 23% infection in cattle from Oregon ; Svanbaev (1967a) received 30% infection in cattle from Kazakhstan ; Bhatia *et al.* (1968) got 16% infection in buffaloes from Mathura, Uttar Pradesh ; Jacobson and Werley (1969) observed 6% infection in calves and 5% in cattle from Montana ; Sayin (1969) observed 49% in buffaloes from Turkey ; Vassiliades (1969) got 38% infection in cattle from Senegal.

Endogenous stages : Davis and Bowman (1957) obtained mature schizont measuring about $13.2\ \mu\text{m}$ by $9.6\ \mu\text{m}$ with 24-36 merozoites arranged encircling the central residuum of $2.1\ \mu\text{m}$ in diameter. Each merozoite measures $12.2\ \mu\text{m}$ by $5.4\ \mu\text{m}$ with a nucleus near the tapering end and two refractile globules. The schizonts are found mainly along the entire length of the small intestine including the caecum and colon. The macrogametes appeared 12 days after the inoculation and each measuring $13.5\ \mu\text{m}$ by $10.6\ \mu\text{m}$ with a centrally placed nucleus having irregular karyosome and cytoplasmic granules. The microgametocyte measures $13.8\ \mu\text{m}$ by $9.7\ \mu\text{m}$ with comma-shaped microgametes arranged in rows along the periphery. Both the macro and microgametocytes established in the terminal segment of the small intestine, caecum, colon and rectum. Mature oocysts appeared in the faeces 19-20 days after infection. Prepatent period was estimated about 18 days and 15 days by Pellerdy (1965) and Svanbaev (1967a) respectively,

Types : Not known.

Remarks : The controversy about the spelling of the specific name has vividly been discussed by Levine and Ivens (1967) and Pellerdy (1974). Hence instead of 'zurni' it should be spelt as 'zuernii' and

followed as such. Further information on this species may be had from Cooper (1926a,b), Wenyon (1926), Bhatia (1938), Gill 1960a, 68) and Levine and Ivens (1970).

267. *Eimeria* sp.

1968. *Eimeria* sp. Bhatia, *Indian J. Microbiol.*, 8 : 249.

Description : A large and typically egg-shaped oocyst, with a size of 40 μm by 25.3 μm showing at the narrower end a distinct micropyle of 1.0 μm width. A thick but smooth oocystic wall consisting of the inner brownish layer of 0.65 μm thickness, with a slight thickening towards the micropyle, with the outer yellowish-green of 1.0 μm thickness. An oocystic residuum and a polar granule absent. Four spindle-shaped sporoblasts, each with bluntly narrower extremities, full of dark granules, each sporoblast measures 16.0-17.3 μm by 8.0-9.3 μm size, developed in three days.

Host : Spotted deer, *Axis axis* (Erxleben).

Other hosts : Unknown.

Distribution : Lucknow, Uttar Pradesh.

Endogenous stages : Unknown.

Remarks : It is very difficult to give any specific status of this parasite due to the inadequate description given by the author. Except *E. wassilewskyi* from the Spotted deer, other species from this host create doubt about their validity.

vii. Genus *Wenyonella* Hoare, 1933

1933. *Wenyonella* Hoare, *Parasitology*, 25 : 359. Type species : *africana* Hoare.

Oocyst provided with four sporocysts each having four sporozoites.

Type host : *Boadon* (*Boadon*) *lineatus* Reptilia : Ophidia.

In total seven species from bird and one species from mammal have been reported.

(a) PARASITES OF BIRDS

Key to the species

1. Oocyst pitcher-shaped	...	<i>W. gagari</i>
2. Oocyst not pitcher-shaped		
(A) Sporocyst vial-shaped	...	<i>W. gallinae</i>
(B) Sporocyst oval or ovoid		
(i) Sporocyst with residuum		

- (x) Size of oocyst large 13-20 μm by 10-14 μm
- | | | |
|---|-----|----------------------|
| (i) Size of sporocyst 10.5-12.8 μm | ... | <i>W. columbae</i> |
| (ii) Size of sporocyst 6.7-9.3 μm | ... | <i>W. pellerdyi</i> |
| (y) Size of oocyst small 11-18 μm by 7-11 μm | | <i>W. anatis</i> |
| (ii) Sporocyst without residuum | | |
| (a) Size of oocyst large above 19 μm by 18 μm | | <i>W. mackinnoni</i> |
| (b) Size of oocyst small below 19 μm by 16 μm | | <i>W. bahli</i> |

208. *Wenyonella anatis* Pande, Bhatia and Srivastava

(Fig. 218)

1965. *Wenyonella anatis* Pande, Bhatia and Srivastava, *Sci. Cult.*, 31 : 383.

Description : Oocyst oval, with double wall of equal thickness. It measures 11.5-17.5 μm in length with a mean of 14.5 μm and

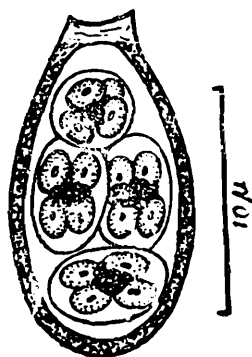


Fig. 218. Mature oocyst of *Eimeria anatis*.

7.5-10.5 μm in width with a mean of 8.8 μm . The shape index is 1.6. Cytoplasm coarsely granular and occupies the entire space of the oocyst. Micropyle and oocystic residuum present. Sporocyst ovoid in shape, measures 5.7-7.2 μm in length with a mean of 6.4 μm and 4.3-5.3 μm in width with a mean of 4.8 μm . The shape index is 1.3. Sporocystic residuum present as coarsely granular mass of dark appearance. Sporozoites are ovoid each with nucleus at the middle, having narrow anterior end with broad posterior end. Sporozoite measures 2.8 μm by 2 μm . The shape index is 1.4.

Sporulation time : 48-62 hours.

Dimension of the oocysts reported by other authors are as follows :

11-17 by 7-10 μm (Pellerdy, 1974).

Type host : Domestic duck, *Anas platyrhyncha domestica* (= *Anas* sp.).

Other hosts : From the type host, Mandal (1976).

Distribution : Mathura, Uttar Pradesh, Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

269. ***Wenyonella bahli* Misra**

(Fig. 219)

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

Description : Oocyst subspherical or ovoid with double envelop of equal thickness and measures 15.5-17.5 μm in length with a mean of

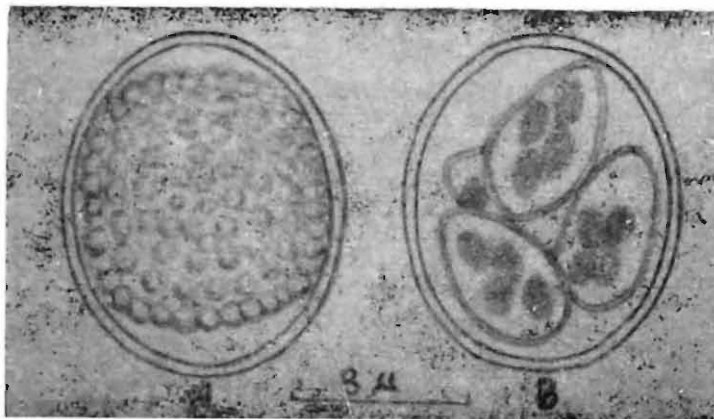


Fig. 219. A, immature and B mature oocysts of *Wenyonella bahli*.

16.5 μm and 14.5-15.5 μm in width with a mean of 14.9 μm . The shape index is 1.1. Cytoplasm compact, rounded in shape with several refractile globule. Oocystic residuum and micropyle absent. Sporocyst egg-shaped without any knob, measures 5.7-7.8 μm in length with a mean of 6.5 μm and 3.5-4.8 μm in width with a mean of 4.3 μm . The shape index is 1.3. Sporocystic residuum absent. Sporozoite ovoid and measures 2.6-3.00 μm in length.

Sporulation time : 36-48 hours.

Type host : Common Quail, *Coturnix communis* [= *Coturnix c. coturnix* (Linn.)].

Other hosts : From the type host, Mandal (1976).

Distribution : Lucknow, Uttar Pradesh and Shillong, Meghalaya.

Endogenous stages : Unknown.

Types : Not known.

270. ***Wenyonella columbae*** Haldar and Ray Chaudhury

(Fig. 220)

1974. *Wenyonella columbae*, Haldar and Ray Chaudhury, *Arch. Protistenk.*, 116 : 251.

Description : Oocyst spherical or slightly oval in shape measuring 21.3-26.5 μm in length with a mean of 23.8 μm and 20.6-25.8 μm in breadth with a mean of 23.0 μm . The oocystic wall is bilayered of which the inner one is slightly thicker than the outer wall. The

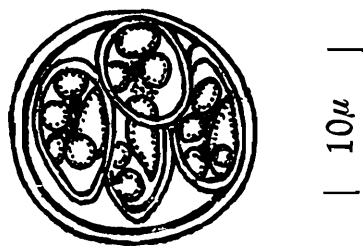


Fig. 220. Mature oocyt of *Wenyonella columbae*.

cytoplasm is almost filled up with the fine as well as some coarse granules. Micropyle and oocystic residuum absent. Sporocysts four in number, each measuring 10.5-12.8 μm in length with a mean of 11.6 μm and 6.4-8.6 μm in width with a mean of 7.5 μm . Sporocystic residuum is present at the centre and appears as a small cluster or refractile granules while there is no trace of stieda body. There are four sporozoites in each sporocyst. The sporozoites are elongated bodies each with a broad posterior end and a gradually tapering, anterior extremity measuring 4.5 μm in length in the average.

Sporulation time : 144-192 hours.

Type host : Domestic pigeon, *Columba livia intermedia* Strickl.

Other host : Unknown.

Distribution : Calcutta and Kalyani, West Bengal.

Endogenous stages : Unknown.

Types : Likely to be present in the collection of the Protozoology Laboratory, Kalyani University, West Bengal.

271. *Wenyonella gagari* Sarkar and Ray

1968. *Wenyonella gagari* Sarkar and Ray, *Proc. Indian Sci. Congr.*, p. 499.

Description : Oocyst pitcher-shaped having three layers of $1.8\ \mu\text{m}$ in thickness. The outer being yellow, middle greenish and the inner yellowish pink. At narrow pole there is a prominent micropyle of $4.8\ \mu\text{m}$ in diameter with fluted 4-6 ridges at its outer broader. Oocyst measures $22.8\text{-}26.4\ \mu\text{m}$ in length and $16.8\text{-}19.2\ \mu\text{m}$ in width with a mean of $24.0\ \mu\text{m}$ and $18.5\ \mu\text{m}$ respectively. Oocystic residuum absent. Four sporocysts are vial-shaped each measuring $13.2\text{-}15.6\ \mu\text{m}$ in length and $7.2\text{-}9.6\ \mu\text{m}$ in width with a mean of 13.8 and $8.4\ \mu\text{m}$ respectively. Sporocystic residuum present as a small cluster of minute refractile granules, 'Stieda' body present. Sporozoites club-shaped each measuring $9.6\ \mu\text{m}$ in length and $3.6\ \mu\text{m}$ in width at broader end. It possesses a large vacuole at the broader pole.

Sporulation time : 24-48 hours.

Dimension of the oocysts reported by other authors are as follows :

23-26 by 17-19 μm with a mean of 24 μm by 18.5 μm (Pellerdy, 1974).

Type host : Domestic duck, *Anas boschus* Linnaeus [= *Anas p. platyrhynchos* (Linn.)] (= *Anas* sp.).

Other hosts : Unknown.

Distribution : Basirhat, West Bengal; known only from type locality, Sarkar (1968).

Endogenous stages : Unknown.

Types : Not known.

272. *Wenyonella gallinae* Ray

1945. *Wenyonella gallinae* Ray, *Curr. Sci.*, 14 : 275.

Description : Oocyst oval or egg-shaped with double envelop, the outer being thicker than the inner one. Oocyst measures $28.5\text{-}34.5\ \mu\text{m}$ in length with a mean of $31.5\ \mu\text{m}$ and $19.5\text{-}21.5\ \mu\text{m}$ in width with a mean of $20.5\ \mu\text{m}$. The shape index is 1.5. Micropyle present. Oocystic residuum absent. Cytoplasm granular and fills up the oocyst. Sporocyst vial-shaped or pyriform in shape, measuring $17.5\text{-}19.5\ \mu\text{m}$ in length with a mean of $18.5\ \mu\text{m}$ and $7.5\text{-}9.2\ \mu\text{m}$ in width with a mean of $8.3\ \mu\text{m}$. The shape index is 2.2. Sporocystic residuum present as granular mass. Sporozoites club shaped.

Sporulation time : 4-6 days at 28°C.

Type host : Domestic fowl, *Gallus gallus domesticus* (= *Gallus* sp.)

Other hosts : Unknown.

Distribution : Mukteswar, Uttar Pradesh.

Endogenous stages : Unknown. The prepatent period lasts for 7 days and the patent period is about 3 days.

Types : Not known.

Remarks : Ray (1945a) infected three young chicknes with sporulated oocysts of the species dealt with. It revealed that the prepatent period lasted for seven days in one bird and eight days in the rest two. Oocysts were discharged for three days. From the slight pastiness and discolouration of the dropping, the author inferred certain degree of pathogenicity.

273. *Wenyonella mackinnoni* Misra

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

Description : Oocyst spherical or ovoid in shape. The spherical form measurss 19-23 μm and the ovoid from measures 23.8-26.2 μm by 18.0-21.5 μm . The cysts wall consists of two layers-an outer layer thin and colourless and an inner layer comparatively thicken and brownish in colour. Protoplasm of the freshly discharged oocysts is filled up with refractile granule of reserve materials but later on it becomes condensed and has a more or less spherical contour, measures on an average, 15.5 μm in diameter. Micropyle and the polar inclusion (granules ?) absent in the oocyst. No oocystic residuum is seen after formation of the sporocysts. Sporocysts ovoid, measures 10.2 by 7.4 μm with a lens-shaped knob at one end. Sporocystic residuum absent. Sporozoite measures 8.2 μm long, club-shaped and irregularly arranged.

Sporulation time : 4-6 days at room temperature.

Type host : Wagtail, *Motacilla alba* Linn.

Other hosts : From the type host, Mandal (1976).

Distribution : Lucknow, Uttar Pradesh ; Shillong, Meghalaya.

Endogenous stages : The microgametocyte measures 20.5 μm by 15.6 μm in size, found in the small intestine. It produces many microgametes each measuring 3.8 μm in length and provided with double

flagella. The macrogamete measures $28.5\ \mu\text{m}$ by $16\ \mu\text{m}$ in size with a granular cytoplasm and a distinct nuclear karyosome (Misra, 1947).

Types : Not known.

274. *Wenyonella pellerdyi* Bhatia and Pande

1966. *Wenyonella pellerdyi* Bhatia and Pande, *Acta vet. hung.*, 16 : 335.

Description : Oocyst ellipsoidal to ovoidal, punctate measuring $13.3\text{--}19.3\ \mu\text{m}$ in length with a mean of $17.6\ \mu\text{m}$ and $10.0\text{--}13.3\ \mu\text{m}$ in width with a mean of $12.7\ \mu\text{m}$. It is provided with double wall of $1.0\text{--}1.3\ \mu\text{m}$ in thickness and colourless in nature. Micropyle broad, $2.0\text{--}2.5\ \mu\text{m}$ wide. Oocystic residuum absent. A polar granule is present.

Sporocyst ovoid measuring $6.7\text{--}9.3\ \mu\text{m}$ in length with a mean of $8.0\ \mu\text{m}$ and $4.0\text{--}8.0\ \mu\text{m}$ in width with a mean of $5.7\ \mu\text{m}$. Stieda body absent. Sporocystic residuum is present as dark granules in a compact mass. Sporozoite elongated, measuring $5.0\text{--}7.0$ in length with a mean of $6.0\ \mu\text{m}$ and $2.0\text{--}3.0\ \mu\text{m}$ in width with a mean of $2.5\ \mu\text{m}$. A prominent globule is present at the broadly rounded end, the other end being pointed.

Sporulation time : 48 hours.

Type host : Blue-winged Teal (= Gargany) *Anas querquedula* (Linn.)

Other hosts : Unknown.

Distribution : Gorakhpur, Uttar Pradesh.

Endogenous stages : Some sections of the middle intestine show the characteristic oocysts and macrogametocytes in the cells of the villar epithelium. The former measuring $12.0\text{--}16.4\ \mu\text{m}$ in length and $8.2\text{--}10.5\ \mu\text{m}$ in width and the later $12.0\text{--}13.4\ \mu\text{m}$ in length and $8.2\text{--}10.2\ \mu\text{m}$ in width. The authors stated that this diminution in size is due to fixation.

Types : Not known.

(B) PARASITES OF MAMMALS

275. *Wenyonella hoarei* Ray and Das Gupta

(Fig. 221)

1935. *Wenyonella hoarei* Ray and Das Gupta, *Sci. Cult.*, 1 : 112.

Description : Oocyst spherical, double layered, the outer thinner than the inner thick one. The cytoplasm vacular and appears highly

granular. It measures 14.5-18.5 μm in diameter with a mean of 16.8 μm . Oocystic residuum absent, micropyle present. The sporocyst ovoid, with a lens-shaped knob at the pointed anterior end. It measures 9.5-11.5 μm in length with a mean of 10.5 μm and 7.4-9.3 μm in width with

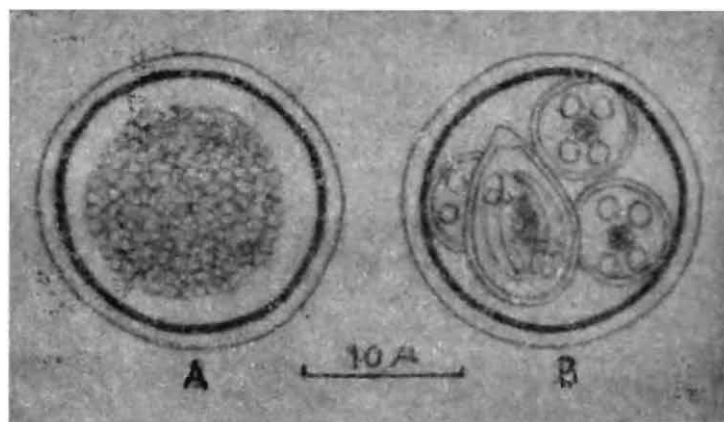


Fig. 221. A, immature and B, mature oocysts of *Wenyonella hoarei*.

a mean of 8.4 μm . The shape index is 1.2. The sporocystic residuum is present as a compact mass. The sporozoite elongated with bluntly pointed anterior end. It measures 7.4 μm in length and 1.5 μm in width. The shape index is 4.8. They lie in pairs on each side of the sporocystic mass a head to tail arrangement.

Sporulation time : 7 days.

Type host : Indian squirrel, *Sciurus* sp.

Other host : From the type host.

Distribution : Botanical Garden, Shibpur, West Bengal.

Endogenous stages : The schizonts lie in the epithelial cells and produce two types of merozoite one measuring 6 by 2 μm . The dark staining granules are present near the nucleus and the cytoplasm is hyaline. The other measuring 8 by 2 μm having granular cytoplasm. Both are tapering at one end and broad at the other. The authors [Ray and Das Gupta (1935a)] suggested that the smaller merozoite may be the predecessors of male gamete and the bigger ones may produce female gamete. The microgametocyte produces biflagellated microgametes and left a distinct residuum. The microgametes were found congregate around the micropolar end of the mature macrogamete.

Types : Not known.

Remarks : The describers (1937a) reported this species again from India.

viii. Genus **Octosporella** Ray and Raghavachari, 1942

1942. *Octosporella* Ray and Raghavachari. *Proc. Indian Sci. Congr.*, p. 170. Type species : *mabiae* Ray and Raghavachari.

Oocyst having eight sporocysts each provided with two sporozoites.

Type host : *Mabuya* sp., Reptilia : Lacertilia

Monotypically represented only from reptiles.

276. **Octosporella mabuae** Ray and Raghavachari

1942. *Octosporella mabuae* Ray and Raghavachari, *Proc. Indian Sci. Congr.*, p. 170.

Description : Oocyst develops eight sporocysts (octosporocystid) and each sporocyst is provided with 2 sporozoites (dizoic). Spherical oocyst measures 14-16 μm in diameter. No oocystic residuum is present. Sporocyst spindle-shaped, measuring 8.4 μm by 4.2 μm . Each sporocyst contains two sickle-shaped sporozoites and a central residual mass.

Sporulation time : 48 hours.

Type host : Skink, *Mabuya* sp.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous stages : Unknown.

Types : Not known.

Remarks : Pellerdy (1974) has made a comment that as no male stages had been traced out, this species might come under the genus **Eimeria**. Mandal (1976) further stated that he could not come across any such parasite after examining about thirty examples of Skink from different localities.

ix. Genus **Pythonella** Ray and Das Gupta, 1927

1937. *Pythonella* Ray and Das Gupta, *Proc. Indian Sci. Congr.*, p. 292. Type species : *bengalensis* Ray and Das Gupta.

Oocyst having sixteen sporocysts each is provided with four sporozoites.

Type host : *Python* sp. Reptillia : Ophidia.

Monotypically represented, reported only from reptile.

(A) PARASITE OF REPTILES

277. *Pythonella bengalensis* Ray and Das Gupta

1937. *Pythonella bengalensis* Ray and Das Gupta, *Proc. Indian Sci. Congr.*, p. 292.

Description : Oocyst develops sixteen sporocysts (heccaidecasporocystid), each containing four sporozoites (tetrazoic sporocyst). Spherical oocyst measures 25-30 μm in diameter and develops eight primary sporoblasts which divide again to form sixteen sporocysts. Each sporocyst measuring 8-10 μm by 6.7 μm with four syorozoites and a central residuum.

Sporulation time : 7 to 10 days.

Type host : Indian Python, *Python* sp.

Other hosts : Unknown.

Distribution : Calcutta, West Bengal.

Endogenous : Unknown.

Types : Not known.

Remarks : Mandal (1976) could not come across any specimen examining seventeen examples of Python from the type locality. Moreover 6 specimens of Python from Lucknow Zoo have also been examined afterward by the same author but could not come across this parasite. However, Duszynski (1969) recorded *P. scoloporus* the second species of the genus (Host : *Scoloporus squamosus*) from Costa Rica.

XII. HOST-PARASITE INDEX

Class : MYRIAPODA

Order : CHILOPODA

1. *Mecistocephalus punctifrons* Necop, Centipede : *Eimeria mecistophori*

Class : INSECTA

Order : DIPTERA

1. *Culex* sp. Mosquito : *Eimeria* sp.

Class : PISCES

Order : RAJIFORMES

1. *Aeteobatis narinari* [= *Aetobatus flagellum* (Schn.)] Eagle Ray
Eimeria southwelli

Order : CLUPEIFORMES

1. *Alosa sardina*.....Herring : *Eimeria clupearum*
2. *Clupea harengus*.....Herring : *Eimeria clupearum*, *Eimeria sardinae*
3. *Coilia dussumieri* Val., Taper-tail anchovy : *Eimeria* sp.
4. *Engraulis encrasicolus*.....Anchovy : *Eimeria clupearum*
5. *Engraulis mystax* (Bloch & Schn.), Must ached anchovy :
Eimeria sp.
6. *Etrumeus micropus* Val., Round herring : *Eimeria clupearum*
7. *Notopterus notopterus* (Pallas), Feather Back : *Eimeria notopteri*
8. *Notopterus chitala* (Ham.), Humped Feather Back : *Eimeria notopteri*
9. *Sardina melanosticta*.....Sardine : *Eimeria clupearum*
10. *Sardina* (= *Clupea*) *pilchardus*, Sardine : *Eimeria clupearum*,
Eimeria sardinae
11. *Sprattus* (= *Clupea*) *sprattus*.....Spart : *Eimeria clupearum*

Order : PERCIFORMES

1. *Epinephelus diacanthus* (Val.), Six-barred reef-cod : *Eimeria* sp.
2. *Epinephelus tauvina* (Forsskal), Greasy reef-cod : *Eimeria* sp.
3. *Scomber scomber*.....Mackerel : *Eimeria clupearum*
4. *Sillago sihama* (Forsskal), Silver whiting : *Eimeria* sp.
5. *Trichurus sarala* Cuvier, Small headed ribbon fish : *Eimeria* sp.
6. *Otolithus ruber* Schneider, Rosy few fish : *Eimeria* sp.

Order : CYPRINIFORMES

1. *Burbus ambassis* [= *Puntius ambassis* (Day)], Barb : *Eimeria ambassi*
2. *Glossogobius guris* (Hamilton), Gobid fish : *Eimeria glossogobii*

Order : LAIMINIFORMES

1. *Scoliodon sorrakowah* (Cuvier), Light Tip Shark : *Eimeria southwelli*

2. *Zygaena* (= *Sphyrna*) *blochii* (Cuvier), Arrow headed or Hammer headed shark : *Eimeria zygaenae*

Order : BATRACHEIDIFORMES

1. *Batrachus grunniens* (Einn.), Form fish : *Eimeria* sp.

Order : MYCTOPHIFORMES

1. *Harpadon nehereus* (Ham.) Bombay Duck : *Eimeria harpodoni*

Order : SILURIFORMES

1. *Plotosus canius* Ham. and Buch., Canine cat-fish/Eel : *Eimeria* sp.

Class : AMPHIBIA

Order : ANURA

1. *Bufo himalayanus* Baulenger, Himalayan Toad : *Eimeria himalayana*
2. *Bufo melanostictus* Schn., Indian Common Toad : *Eimeria laminata*, *Isospora wenyoni*
3. *Bufo stomaticus* Lutken, Morbed Toad : *Isospora stomaticae*
4. *Rana cyanophlyctis* Schn., Skipping frog : *Eimeria cyanophlyctis*

Class : REPTILIA

Order : SQUAMATA

(A) Sub-order : LACERTILIA

1. *Calotes versicolor* (Daudin), Garden Lizard or Blood Sucker : *Isospora calotesi*
2. *Gekko gecko* (Linn.), Takhak : *Caryospora gekkonis*, *Eimeria bongaonensis*
3. *Hemidactylus flaviviridis* (Ruppell), House lizard : *Eimeria flaviviridis*, *Eimeria hemidactyli*, *Eimeria knowlesi*, *Isospora knowlesi*
4. *Mabuya* sp., Skink : *Eimeria minetti*, *Octosporella mabuiae*
5. *Ptyctolaemus* sp., Lizard : *Isospora rayi*
6. *Varanus monitor* [= *Varanus bengalensis* (Daudin)], Monitor Lizard : *Eimeria varani*

(B) Sub-order : OPHIDIA

1. *Enhydriis enhydriis* (Schn.), Fresh water snake : *Caryospora bengalensis*, *Eimeria fibrilosa*
2. *Naja naja* (Linn.), Asiatic or Indian Cobra : *Isospora minuta*, *Eimeria najae*
3. *Natrix* (= *Xenochrophis*) *piscator* (Schn.), Checkered Keelback : *Eimeria gupti*, *Eimeria piscatori*
4. *Natrix platyceps* (Blyth.), Gass snake : *Isospora dirumpens*
5. *Natrix stolata* [= *Amphiesma stolata* (Linn.)¹], Striped Keelback : *Eimeria stolatae*
6. *Python* sp., Indian Python : *Pythonella bengalensis*

Order : CHELONIA

1. *Emyda granosa* [= *Lissemys punctata granosa* (Schoepff)], Indian Flap-shelled Turtle : *Eimeria legari*
2. *Lissemys punctata* (Bonnaterre), Fresh water Turtle ; *Eimeria innominata*, *Eimeria irregularis*, *Eimeria koormae*
3. *Trionyx gangeticus* (Cuvier), Gangetic Turtle, *Eimeria trionyxae*, *Eimeria triangularis*

Order : CROCODILIA

1. *Gavialis gangeticus* (Gmelin), Gharial : *Eimeria kermoganti*

Class : AVES

Order : CICONIFORMES

1. *Pseudobis papilosa* (Temminck), Black Ibis ; *Eimeria bazi*

Order : ANSERIFORMES

1. *Aix galericulata* (Linn.), Mandarin Duck : *Isospora mandari*
2. *Anas platyrhynchos platyrhynchos* (Linn.) Mallard : *Eimeria battakhi*, *Wenyonella anatis*, *Eimeria anatis*
3. *Anas boschus* (= *Anas* sp.), Domestic Duck, *Wenyonella gagari*
4. *Anas querquedula* (Linn.), Blue winged Teal/Gargany Teal *Wenyonella pellerdyi*
5. *Anas* sp., Khaki Cambel duck (Domestic duck) : *Isospora* sp.,
6. *Anas strepera* (Linn.) Gadwall : *Tyzzeria pellerdyi*

7. *Anser indicus* (Latham), Wild goose/Bar-headed goose : *Tyzzeria pellerdyi*
8. *Aythya nyroca*, White-eyed Pochard : *Tyzzeria pellerdyi*
9. *Chenicus* (= *Nettapus*) *coromandelianus* (Gmelin), Cotton Teal : *Tyzzeria alleni*, *Tyzzeria chenicusae*
10. *Nettapus coromandelianus* (Gmelin), Cotton Teal : *Tyzzeria alleni*

Order : FALCONIFORMES

1. *Gyps bengalensis* (Gmelin), Indian White-backed Vulture : *Isospora gyphi*
2. *Milvus migrans* (Boddaert), Pariah Kite : *Isospora cheeli*

Order : GALLIFORMES

1. *Agriocharis ocellata* (Cuvier), Ocellated Turkey : *Eimeria gallopavonis*
2. *Alectoris graeca* (Meisner), Chukar Partridge : *Eimeria alectorae*
3. *Caecobis chukor* (J. E. Gray) = *Alectoris graeca* (Meisner) Chukar Partridge : *Eimeria teetari*
4. *Chrysolophus amherstiae* (Lead beater), Lady Amherst's Pheasant : *Eimeria adenoeides*, *Eimeria meleagridis*, *Eimeria meleagrimitis*
5. *Chrysolophus pictus* (Linn.), Golden Pheasant : *Eimeria picta*
6. *Colinus v. virgineanus* (Linn.), Bobwhite : *Eimeria acervulina*, *Eimeria dispersa*
7. *Coturnix coturnix coturnix* (Linn.), Common Grey Quail : *Eimeria coturnicis*, *Eimeria bateri*, *Eimeria dispersa*, *Wenyonella bahli*
8. *Francolinus francolinus* (Linn.), Black Partridge : *Eimeria teetari*, *Eimeria* sp., *Eimeria francolini*
9. *Francolinus pondicerianus* (Gmelin), Grey Partridge : *Eimeria teetari*
10. *Gallus domesticus* (= *Gallus* sp.), Domestic Fowl : *Eimeria acervulina*, *Eimeria brunetti*, *Eimeria hagani*, *Eimeria mitis*, *Eimeria necatrix*, *Eimeria praecox*, *Eimeria tenella*, *I. gallinae*, **Isospora* sp., *Eimeria mivati*, *Eimeria maxima*, *Eimeria dispersa*, *Wenyonella gallinae*

* Mentioned as a report but the species is doubtful (vide Pellerdy, 1974)

11. *Gallus gallus* (Linn.), Red Jungle Fowl : *Eimeria dubeyi*, *Eimeria vanmurghavi*
12. *Gallus soneratti* (Temminck), Grey Jungle Fowl : *Isospora choudari*, *Eimeria vanmurghavi*
13. *Gennaecus horsefieldi* [= *Lophura leucomelana* (Latham)], Kalij Pheasant : *Eimeria gennaescus*
14. *Lophortyx californica californica* (Shaw), California Valley Quail : *Eimeria acervulina*
15. *Lophura leucomelana* (Latham), Kalij Pheasant : *Eimeria lophuri*, *Eimeria* sp.
16. *Lophura nycthemera nippone* (= *Lophura* sp.), Kalij Pheasant : *Eimeria picta*
17. *Meleagris gallopavo gallopavo* Linn. (= *Meleagris* sp.), Domestic Turkey : *Eimeria meleagridis*, *Eimeria meleagrimitis*, *Eimeria adenoides*, *Eimeria dispersa*, *Eimeria innocua*, *Eimeria gallopavonis*
18. *Meleagris mexicana* Govid., Wild Turkey (Mexican) : *Eimeria meleagridis*, *Eimeria meleagrimitis*, *Eimeria dispersa*.
19. *Numida meleagris* Linn., Guinea Fowl : *Eimeria gorakhpuri* (= *Eimeria gorakhpurensis*)
20. *Oreortyx picta picta* (Douglas), Plumed Quail : *Eimeria acervulina*
21. *Pavo cristatus* (Linn.), Common Pea Fowl : *Isospora mayuri*, *Eimeria mandali*, *Eimeria patnaiki*, *Eimeria pavonis*, *Eimeria pavonina*, *Eimeria mayuri*
22. *Pavo muticus* (Linn.), Burmese Pea Fowl : *Isospora mayuri*, *Eimeria mayuri*
23. *Phasianus C. colchicus* Linn., Korean Pheasant/Common Ring-necked Pheasant : *Isospora koreani*, *Eimeria dispersa*.
24. *Phasianus colchicus torquatus* Gmelin, Chinese Ring-necked Pheasant : *Eimeria dispersa*
25. *Phasianus colchicus versicolor* Vieillot, Japanese green Pheasant : *Isospora* sp.
26. *Polyplectron bicoloratus bakeri* (Linn.), Peacock Pheasant : *Eimeria bhutanensis*
27. *Tetrastes bonasia* Linnaeus, Hazel hen : *Eimeria dispersa*

Order : GRUIFORMES

1. *Amaurornis phoenicurus* (Pennant), White breasted Water-hen : *Eimeria dauki*
2. *Anthropoides vergo* (Linn.), Demoiselle Crane : *Eimeria grusi*

3. *Bellercia regulorum* (= *Belearica pavonina regulorum* (Bennett)]
Crowned Crane : *Isospora bellericae*
4. *Fulica atra atra* Linn. Coot : *Eimeria* sp.
5. *Grus antigone* (Linn.), Sarus Crane : *Eimeria grusi*

Order : CHARADRIIFORMES

1. *Charadrius asiaticus* (Pallas), Sand Plover : *Eimeria charadrii*
2. *Gallinago gallinago* [= *Capella gallinago gallinago* (Linn.)] Fantail
Snipe : *Eimeria gallinagoi*
3. *Numenius arquata* (Linn.), Curlew : *Eimeria numenii*
4. *Pluvialis apricaria* (Linn.), Golden Plover : *Eimeria roscoviensis*
pluvialina
5. *Prophyrio prophyrio* (Linn.), Purple Moorhen : *Eimeria* sp.
6. *Vanellus malabaricus* (Boddaert), Yellow-wattled Lapwing :
Eimeria vanelli

Order : COLUMBIFORMES

1. *Columba domestica* (= *Columba* sp.), Domestic Pigeon : *Eimeria*
labbeana, *Eimeria* sp.
2. *Columba intermedia* [= *Columba livia intermedia* (Strickland)],
Blue rock pigeon : *Eimeria columbae*, *Eimeria tropicalis*, *Eimeria*
kapotci, *Eimeria columberum*, *Eimeria labbeana*, *Wenyonella*
columbae
3. *Sphenocercus sphenocercus* (= *Treron* sp.), Kokla green Pigeon :
Eimeria sphenocercae
4. *Streptopelia decaota* (Frivaldszky), Indian Ring Dove : *Eimeria*
choudari
5. *Streptopelia orientalis* (Latham) Rufous Turtle Dove, *Eimeria*
labbeana

Order : CORACIIFORMES

1. *Upupa epops orientalis* (Reichenbach) Hoope/Hudhud : *Isospora*
upupae

Order : PSITTACIFORMES

1. *Melopsittacus undulatus* Shaw, Budgrigar : *Isospora melopsittacus*. *Isospora* sp.

2. *Psittacula eupatria nepalensis* Hodgson, Large Indian Parakeet : *Isospora psittaculae*

Order : PICIFORMES

1. *Cyanops* (= *Megalaima*) *asiatica asiatica* (Latham), Blue throated Barbet : *Eimeria barbeta*
2. *Megalaima haemacephala* (Muller), Crimson breasted Barbet : *Isospora megalaimae*
3. *Thereicryx zeylanicus caniceps* [= *Megalaima zeylanica caniceps* (Franklin)] Northern Green Barbet : *Isospora zosteropis*

Order : PASSERIFORMES

1. *Acridotheres ginginianus* (Latham), Bank Mayna : *Isospora ginginiana* ; *Isospora lacazei*
2. *Acridotheres tristis tristis* (Linn.), Common Mayna : *Isospora ginginiana*, *Isospora gingiana tristis*, *Isospora lacazei*, *Isospora rajuli*
3. *Aethiopsar* (= *Acridotheres*) *fuscus fuscus* (Wagler), Jungle Mayna : *Dorisa aethiopsaris*
4. *Aegithalos concinnus rubricapillus*, Sikkim Red headed Tit : *Isospora concinnus*.
5. *Amandava amandava* [= *Estrilda amandava* (Linn.)], Red Munia : *Dorisa hareni*.
6. *Copsychus saularis* (Linn.), Magpie Robin : *Isospora lacazei*.
7. *Corvus macrorhyncus iutermidius* (Adams), Jungle crow : *Isospora corvae*
8. *Corvus splendens* (Vieillot), House crow : *Isospora bengalensis*
9. *Crypsirina* (= *Dendrocitta*) *vagabunda* (Latham), Indian Tree Pie : *Dorisa vagabundae*
10. *Culicicapa ceylonensis catochrysea* Oberholser, Common Himalayan grey headed flycatcher : *Isospora ceylonensis*
11. *Dicrurus macrocercus* (= *D. adsimilis*) *macrocarcus* (Vieillot), Black Drongo : *Isospora upupae*
12. *Elathea* (= *Pycnonotus*) *jocosus emeria* (Linn.), Red Whiskered Bulbul : *Isospora psittaculae*
13. *Emberiza bruniceps* (Brandt.), Red headed Bunting : *Isospora emberizae*

14. *Garrulax lineatus lineatus* (Vigors), Streaked Laughing Thrush ; *Isospora garrulae*
15. *Garrulus glandarius bispecularis* (Vigors), Jay : *Isospora garrulnsae*
16. *Gracula religiosa* (Linn.), Hill Mayna : *Isospora graculi*, *Isospora* sp.
17. *Leioptila capistrata*, Black headed Sibia, *Isospora capistrata*
18. *Lonchura malabarica* (Linn.), Whitethroated Munia : *Dorisa chakrabartyi*, *Shivatoshella lonchurae*
19. *Lonchura punctulata* (Linn.), Spotted Munia : *Isospora lonchurae* *Dorisa chakrabartyi*, *Shivatoshella lonchurae*
20. *Motacilla alba alba* (Linn.), Pied or White Wagtail : *Eimeria lucknowensis*, *Eimeria roscoviensis* *pluvialina*, *Wenyonella mackinnoni*, *Isospora* sp.
21. *Munia atricapilla* (= *Lonchura malacca*) *rubroniger* (Hodgson), Chestnut bellied Munia (= Nepal Black headed Munia) : *Dorisa hareni*
22. *Munia* (= *Lonchura*) *malacca malacca* (Linn.), Black headed Munia : *Dorisa hareni*, *Eimeria malaccae*, *Isospora muniae*
23. *Purus dichrous* (Hodgson), Brown crested Tit : *Isospora parusae*
24. *Passer domesticus* (Linn.), House sparrow : *Isospora lacazei*, *Dorisa passeris*
25. *Ploceus philippinus* (Linn.), Baya/Weaverbird : *Isospora lacazei*
26. *Pycnonotus cafer* (Linn.), Red-Vented Bulbul : *Isospora lacazei*
27. *Pycnonotus jocosus* (Linn.), Red. Whiskered Bulbul : *Isospora pycnonotae*, *Isospora* sp., *Eimeria* sp.
28. *Seicercus xanthoschistos* (Gray headed Flycatcher : *Eimeria* sp., *Isospora seicercusae*
29. *Sturnia malabarica malabarica* [= *Sturnus malabaricus malabaricus* (Gmelin)], Grey headed Mayna : *Isospora struniae*, *Isospora malabaricae*
30. *Sturnia* (= *Sturnus*) *contra* (Linn.), Pied Mayna : *Isospora lonchurae*, *Isospora lacazei*
31. *Temenuchus* (= *Sturnus*) *pagodrum* (Gmelin), Black headed/ Brahminy Mayna : *Isospora temenuchii*
32. *Uroloncha* (= *Lonchura*) *malabarica* (Linn.), Whitethroated Munia : *Dorisa hareni*
33. *Uroloncha* (= *Lonchura*) *punctulata* (Linn.)/Spotted Munia : *Dorisa hareni*
34. *Zosterops palpebrosa palperosa* (Timminck), White eye : *Isospora zosteropis*, *Dorisa mandali*

Class : MAMMALIA

Order : INSECTIVORA

1. *Suncus murinus soccatus* (Hodgson), House Shrew : *Eimeria darjeelingensis*
2. *Suncus m. murinus* Linn., House Shrew : *Eimeria suncus*

Order : CHIROPTERA

1. *Taphozous melanopogon* (Temminck , Black headed Tomb bat : *Eimeria andamanensis*
2. *Harpicephalus harpia lasyurus* (Hodgeon) Hairywinged Bat : *Dorisa harpia*

Order : RODENTIA

1. *Funambulus palmarum* (Linn.), Indian Plam Squirrel : *Eimeria malabaricus*
2. *Funambulus tristrlatus* Water House, Indian Tree Squirrel : *Eimeria malabaricus*
3. *Sciurus* sp, Squirrel, *Wenyonella hoarei*
4. *Petaurista inornatus* [= *Petaurista petaurista* (Pallas)], Common giant flying Squirrel : *Eimeria petauristae*
5. *Rattus rattus rattus*, Commom Rat. *Eimeria levinei*, *Eimeria tuberculata*, *Isospora krishnamurthyi*, *Isospora aurangabadensis*

Order : LAGOMORPHA

1. *Campanius ruficudatus* [= *Lepus nigricolis ruficaudatus* (Geoff.)], Black napp ed Hare : *Eimeria robertsoni*
2. *Lepus americanas* Erxleben, Snowshoe Rabbit : *Eimeria stiedai*
3. *Lepus arcticus groenlandicus* Rhoads, Greenland Hare : *Eimeria robertsoni*, *Eimeria hungarica*
4. *Lepus europaeus* Pallas, European Hare : *Eimeria robertsoni*; *Eimeria hungarica*
5. *Lepus timidus* Linn., Alpine (Varying) hare : *Eimeria stiedae*
6. *Lepus townsendi campanius* (Hollister), White-tailed Jack rabbit : *Eimeria robertsoni*
7. *Lepus ruficaudatus* [= *Lepus nigricollis ruficaudatus* (Geoff.)] Indian hare [= Black-napped hare] : *Eimeria irresidua*, *Eimeria leporis*, *Eimeria media*, *Eimeria minima*, *Eimeria perforans*, *Eimeria Punjabensis*, *Eimeria ruficaudati*, *Eimeria sylvilagi*, *Eimeria magna*

8. *Oryctolagus cuniculus*, Linn. (= *Oryctolagus* sp.), Domestic Rabbit : *Eimeria nagpurensis*, *Eimeria oryctolagi*, *Eimeria matsubayashii*, *Eimeria intestinalis*, *Eimeria perforans*, *Eimeria media*, *Eimeria stiedae*, *Eimeria irresidua*, *Eimeria hungarica*, *Eimeria magna*, *Eimeria neoleporis*, *Eimeria sylvilagi*
9. *Sylvilagus brasiliensis minensis*, Brazilian hare : *Eimeria sylvilagi*
10. *Sylvilagus floridanus mallurus* (Thomas), Eastern Cotton tail : *Eimeria stiedae*
11. *Sylvilagus floridanus mearnsi* (J. A. Allen), Mearn's Cotton tail : *Eimeria minima*, *Eimeria sylvilagi*, *Eimeria stiedae*, *Eimeria neoleporis*
12. *Sylvilagus nuttalli* (G. *floridanus*) *grangeri*...Cotton tail : *Eimeria stiedae*

Order : CARNIVORA

1. *Ailurus fulgens* S. cuvier, Red Panda, *Eimeria ailuri*
2. *Canis aureus* Linn., Asiatic Jackle : *Isospora tropicalis*
3. *Canis aureus naria*, Jackle : *Eimeria aurei*
4. *Canis familiaris* Linn. (= *Canis* sp.), Domestic dog : *Eimeria canis*, *Isospora bigemina*, *Isospora canis*, *Isospora revolta*
5. *Canis dingo* Link, Dingo : *Isospora rivolta*
6. *Felis catus* (= *F. domestica* Linn = *Felis* sp.), Domestic cat : *Eimeria cati*, *Isospora bigemina*, *Isospora felis*, *Isospora rivolta*
7. *Felis bengalensis* Keer, Leopard Cat : *Isospora nandankananeni*, *Isospora felina*
8. *Felis chaus* (Guldenstaedt), Jungle Cat : *Eimeria cati*, *Eimeria hammondi*, *Eimeria mathurai*, *Eimeria felina*, *Isospora rivolta*
9. *Halogale ungulate rufula* [= *Halogale pervula undulata* (Peters)], Dwarf-Mongoose, *Isospora hoarei*, *Isospora garnhami*
10. *Herpestes auropunctatus* Hodgson, Small Indian Mongoose : *Eimeria pandei*
11. *Herpestes mungo* (= *Herpestes edwardsi* Geoff.), Indian Grey Mongoose : *Isospora dubeyi*, *Isospora hoarei*, *Isospora garnhami*, *Eimeria newali*, *Eimeria pandei*
12. *Hyaena striata* (= *Hyaena hyaena* Linn.), Striped Hyaena : *Isospora levinei*
13. *Melursus ursinus* Linn., Sloth Bear : *Isospora ursi*
14. *Neofelis nebulosa* Linn., Clouded Leopard : *Isospora leopardi*
15. *Panthera tigris* Linn., Tiger : *Isospora* sp.

16. *Panthera leo* Linn., Lion : *Isospora leonina*, *Isospora mohini*, *Isospora pantheri*, *Isospora* sp. (2) *Eimeria felina*
17. *Panthera pardus* (Linn.), Leopard : *Isospora pardusi*
18. *Vulpes bengalensis* Shaw, Bengal Fox : *Isospora buriatica*, *Eimeria lomarii*
19. *Vulpes corsac* (Linnaeus), Corsac Fox, *Isospora buriatica*

Order : Artiodactyla

1. *Ammotragus lervia* (= *Ovis tragelaphus*) (Paller), Barbary sheep : *Eimeria faurei*, *Eimeria parva*
2. *Antilope cervicapra* (Linn.), Black buck : *Eimeria antilocervi*, *Eimeria cheetali*, *Eimeria mrigai*
3. *Axis axis* (Erxleben), Chital or Spotted deer : *Eimeria wasielewskyi*, *Eimeria cheetali*, *Eimeria cervis*, *Eimeria* sp.
4. *Axis porcinus* (Zimmermann), Hog deer : *Eimeria parahi*
5. *Bos indicus* Linn. (= *Bos* sp.), Indian Cattle : *Eimeria bukidnonensis*, *Eimeria canadensis*, *Eimeria alabamensis*, *Eimeria auburnensis*, *Eimeria brasiliensis*, *Eimeria cylindrica*, *Eimeria wyomingensis*, *Eimeria zuernii*, *Eimeria bareillyi*, *Eimeria bovis*, *Eimeria ellipsoidalis*, *Eimeria pellita*, *Eimeria subspherica*
6. *Bos gaurus* (H. Smith), Gaur or Indian Bison : *Eimeria bovis*, *Eimeria gaurusi*
7. *Bos taurus* (Linn.), Domestic cattle : *Eimeria bovis*, *Eimeria brasiliensis*, *Eimeria cylindrica*, *Eimeria pellita*, *Eimeria subspherica*, *Eimeria wyomingensis*, *Eimeria zuernii*, *Eimeria alabamensis*, *Eimeria ellipsoidalis*, *Eimeria canadensis*, *Eimeria auburnensis*, *Isospora* sp., *Eimeria* sp.
8. *Bubalus bubalis* Linn., Indian buffalo : *Eimeria bareillyi*, *Eimeria alabamensis*, *Eimeria zuernii*, *Eimeria auburnensis*, *Eimeria bovis*, *Eimeria ellipsoidalis*, *Eimeria brasiliensis*, *Eimeria cylindrica*, *Eimeria canadensis*, *Eimeria bukidnonensis*, *Eimeria wyomingensis*, *Eimeria subspherica*, *Eimeria ovoidalis*
9. *Boselaphus tragocamelus* Pallas, Nilgai : *Eimeria tragocomeli*, *Eimeria nilgai*, *Eimeria yakimovi*
10. *Camelus bactrianus* (Linn.), Bactrian or Two humped Camel : *Eimeria cameli*, *Eimeria dromedarii*
11. *Camelus dromedarius* (Linn.) One humped Camel : *Eimeria rajasthanii*, *Eimeria dromedarii*, *Eimeria cameli*
12. *Capra aegagrus* (Erxleben) Wild goat : *Eimeria ninakholyakimovi*, *Eimeria crandallis*

13. *Capra hircus* (Linn.), (= *Capra* sp.), Domestic goat : *Eimeria arloingi*, *Eimeria ninakohlyakimovi*, *Eimeria ahsata*, *Eimeria granulosa*, *Eimeria tirrupatiensis*, *Eimeria faurei*, *Eimeria christenseni*, *Eimeria intricata*, *Eimeria crandallis*, *Eimeria parva*
14. *Capra ibex* (Linn.), Ibex/Ladakh goat/Alpine Ibex : *Eimeria arloingi*, *Eimeria crandallis*, *Eimeria ninakholyakimovi*, *Eimeria parva*, *E. faurei*
15. *Capra siberica* (Pallas) Siberian Wild goat : *Eimeria ninakholyakimovi*, *Eimeria parva*, *Eimeria crandallis*, *E. faurei*
16. *Capreolus capreolus* (Linn.), Roe deer : *Eimeria intricata*
17. *Cervus elaphus elaphus* Linn., Red Deer, *Eimeria wasielewskyi*
18. *Cervus nippon hortulorum* Temminck, Sika Deer : *Eimeria wasielewskyi*
19. *Dama dama* (Linn.), Fallow deer : *Eimeria intricata*.
20. *Gazella gazella* (Pallas), Mountain Gazell : *Eimeria chinkari*, *Eimeria cheetali*
21. *Muntiacus muntjak* (Zimmermann), Barking deer : *Eimeria dawari*, *Eimeria sardari*, *Eimeria* sp.
22. *Ovis ammon* Linnaeus, Argali : *Eimeria arloingi*, *Eimeria parva*, *Eimeria intricata*, *Eimeria crandallis*, *Eimeria faurei*
23. *Ovis aries* (Linn.) (= *Ovis* sp.), Domestic sheep : *Eimeria faurei*, *Eimeria crandallis*, *Eimeria intricata*, *Eimeria parva*, *Eimeria ninakohlyakimovi*, *Eimeria granulosa*, *Eimeria arloingi*, *Eimeria ovina*, *Eimeria ahsata*
24. *Ovis canadensis* Shaw, Rocky Mountain Bighorn Sheep : *Eimeria arloingi*, *Eimeria crandallis*, *Eimeria ninakholyakimovi*, *Eimeria parva*, *Eimeria intricata*, *Eimeria granulosa*, *Eimeria ahsata*
25. *Ovis musimon* (Pallas), Mouflon : *Eimeria arloingi*, *Eimeria parva*, *Eimeria intricata*, *Eimeria crandallis*
26. *Ovis orientalis* (Gmelin), Asiatic Mouflon Oriental sheep ; *Eimeria parva*, *Eimeria faurei*
27. *Rupicapra rupicapra* (Linn.), Chamois : *Eimeria faurei*
28. *Sus scrofa domestica* [= *Sus* sp.] Domestic Pig : *Isospora suis* *Isospora* sp. *Eimeria cerdonis*, *Eimeria deblickei*, *Eimeria polita*, *Eimeria perminuta*, *Eimeria scabra*, *Eimeria spinosa*, *Eimeria porci*, *Eimeria neodeblickei*
29. *Sus scrofa scrofa* Linn., Wild bore : *Isospora suis*, *Eimeria neodeblickei*
30. *Tetracerus quadricornis* Blainville, Four horned antelope/Chousingha : *Eimeria chousinghi*
31. *Tragulius minima* Erxleben, Mouse deer : *Eimeria ramgai*

Order : PERISSODACTYLA

1. *Equus asianus* Linnaeus; Donkey : *Eimeria leuckarti*
2. *Equus caballus* Linnaeus : Domestic horse : *Eimeria leuckarti*
3. *Hippopotamus amphibius* Hippopotamus : *Isospora hippopotami*

Order : PRIMATE

1. *Nycticebus coucang* (Bosdant), Slow loris : *Eimeria chousinghi*, *Eimeria nycticebi*
2. *Macaca radiata* (Geoff.), Bonnet Monkey : *Isospora* sp.
3. *Homo sapiens* Linn. Man : *Isospora belli*, *Isospora hominis*, *Eimeria sardinae*, *Eimeria clupearum*

XIII PARASITE-HOST INDEX

1. *Tyzzeria alleni* Chakravarty and Basu, 1947.
Host : *Nettapus cromandelianus*, Cotton Teal, Aves : Anseriformes
2. *Tyzzeria chenicusae* Ray and Sarkar, 1967.
Host : *Chenicus* (= *Nettapus*) *cromandelianus*, Cotton Teal, Aves : Anseriformes
3. *Tyzzeria pellerdyi* Bhatia and Pande, 1966.
Host : (i) *Anser indicus*, Wild goose/Bar-headed goose, Aves : Anseriformes
(ii) *Anas strepera*, Gadwall, Aves : Anseriformes
(iii) *Anthya nyroca*, White-eyed Pochard, Aves : Anseriformes
4. *Caryospora bengalensis* Mandal, 1976.
Host : *Enhydris enhydris*, Fresh-water snake, Reptilia : Ophidia
5. *Cryospora gekkonis* Chakravarty and Kar, 1947.
Host : *Gekko gekko*, Takhak, Reptilia : Lacertilia
6. *Isospora aurangabadensis* Kshirsagar, 1980.
Host : *Rattus rattus rattus* Linn., Common Rat, Mammalia : Rodentia
7. *Isospora bellericae* Banik and Ray, 1962.
Host : *Bellerica regulorum* (= *Belearica pavonina regulorum*), Crowned Crane, Aves : Gruiformes
8. *Isospora belli* Wenyon, 1923.
Host : *Homo sapiens*, Man, Mammalia : Primate
9. *Isospora bengalensis* Mandal and Chakravarty, 1964.
Host : *Corvus splendens*, House crow, Aves : Passeriformes.

10. *Isospora bigemina* (Stiles, 1891) Luhe, 1906.
 Host : (i) *Canis familiaris* (= *Canis* sp.), Domestic dog }
 (ii) *Felis catus* (= *F. domestica* = *Felis* sp.), Domestic cat and Pap, white Alsatian. } Mammalia : Carnivora
11. *Isospora buriatica* Yakimoff and Matschoulsky, 1940.
 Host : (i) *Vulpes bengalensis*, Bengal Fox }
 (ii) *Vulpes corsac*, Corsac Fox } Mammalia : Carnivora
12. *Isospora calotesi* Bhatia, 1938.
 Host : *Calotes versicolor*, Garden Lizard/Blood sucker, Reptilia : Lacer-tilia
13. *Isospora concinnus* Sinha and Sinha, 1979.
 Host : *Acquithalos concinnus rubricapillus*, Sikkim Red-headed Tit, Avis : Passeriformes
14. *Isospora canis* Nemeseri, 1959.
 Host : *Canis familiaris* (= *Canis* sp.), Domestic dog, Mammalia : Carni-vora
15. *Isospora capistrata* Sinha and Sinha, 1981.
 Host : *Leioptila capistrata*, Black headed Sibia, Avies : Passeriformes
16. *Isospora ceylonensis* Sinha et al. 1978.
 Host : *Culicicapa ceylonensis caochrysea*, Common Himalayan grey headed flycatcher, Avies : Passeriformes
17. *Isospora cheeli* Bhatia, Pande and Garg, 1970.
 Host : *Milvus migrans*, Pariah Kite, Aves : Falconiformes
18. *Isosporo choudari*, Bhatia, Chauhan, Arora and Agarwal, 1972.
 Host : *Gallus soneratti*, Grey jungle fowl, Aves : Galliformes
19. *Isospora corvae* Ray, Shivnani Oommen and Bhaskaran, 1952.
 Host : *Corvus macrorhynchus intermedius*, Jungle Crow, Aves : Passeri-formes
20. *Isospora dirumpens* Hoare, 1933.
 Host : *Natrix platyceps*, Grass snake, Reptilia : Ophidia
21. *Isospora dubeyi* Patnaik and Ray, 1965.
 Host : *Herpestes mungo* (= *Harpestes edwardsi* Geoff.) Indian Grey Mongoose, Mammalia : Carnivora.

22. *Isospora emberizae* Mandal and Chakravarty, 1964.
Host : *Emberiza brunniceps*, Red headed bunting, Aves : Passeriformes.
23. *Isospora felina* Patnaik and Acharjyo, 1971.
Host : *Felis bengalensis*, Leopard cat, Mammalia : Carnivora
24. *Isospora felis* (Wasielewsky, 1904) Wenyon, 1923.
Host : *Felis catus* (*F. domestica* = *Felis* sp.) Domestic Cat, Mammalia :
- *25. *Isospora gallinae* Scholtyseck, 1954*.
Host : *Gallus demosticus* (= *Gallus* sp.), Domestic Fowl, Aves : Galliformes.
26. *Isospora garnhami* Bary, 1954,
Host : (i) *Herpestis mungo* (= *Herpestis edwardsi*), Indian Grey Mongoose, Mammalia : Carnivora.
(ii) *Halogala ungulata rufula* (= *Halogel permula undulata*), Dwarf Mongoose, Mammalia : Carnivora.
27. *Isospora garrulae* Ray, Shivanani, Oommen and Bhaskaran, 1952.
Host : *Garrulax lineatus lineatus* Streaked-Laughing thrush, Aves : Passeriformes.
28. *Isospora garrulusae* Ray, Shivani, Oommen and Bhaskaran, 1952.
Host : *Garrulus glandarius bispecularis*, Jay, Aves : Passeriformes.
29. *Isospora ginginiana* Chakravarty and Kar, 1944,
Host : *Acridotheres ginginianus*, Bank Mayna, Aves : Passeriformes.
30. *Isospora ginginiana tristis* Chakravarty and Kar, 1947.
Host : *Acridotheres tristis tristis*, Common Mayna, Aves : Passeriformes
31. *Isospora graculi* Bhatia, Chauhan, Arora and Agarwal, 1973.
Host : *Acridotheres tristis tristis*, Common Mayna, Aves : Passeriformes.
31. *Isospora graculi* Bhatia, Chauhan, Arora and Agarwal, 1973.
Host : *Gracula raligiosa*, Hill Mayna, Aves : Passeriformes.
32. *Isospora gypsi* Patnaik and Mohanty, 1969.
Host : *Gyps bengalensis*, Indian white-backed Vulture, Aves : Falconiformes.
33. *Isospora hippopotami* Agarwal *et al.* 1981.
Host : *Hippopotamus amphibius* Linn. Mammalia : Perissodactyla.

* Mentioned the species, but the entity of this species is doubtful (vide Pellerday, 1974) due to which the species has not included in the description part.

34. *Isospora hoarei* Bray, 1954.
 Host : (i) *Halogale ungulata rufula* (= *Halogale pervula ungulata*), Dwarf Mongosse } Mammalia : Carnivora
 (ii) *Herpestis mungo* (= *Herpestis edwardsii*), Indian Grey Mongoose
35. *Isospora hominis* (Railliet and Lucet, 1891), Wenyon, 1923.
 Host : *Homo sapiens*, Man, Mammalia : Primate
36. *Isospora koreani* Bhatia, Chauhan, Arora and Agarwal, 1972.
 Host : *Phasianus c. colchicus*, Korean Pheasant/Common ring-necked Pheasant, Aves : Galliformes.
37. *Isospora knowlesi* Ray and Das Gupta, 1937.
 Host : *Hemidactylus flaviviridis*, House Lizard, Reptilia : Lacertilia.
38. *Isospora locazei* (Labbe, 1893).
 Host : (i) *Ploceus philippinus* Baya/Weaver bird, Aves : Passeriformes.
 (ii) *Copsychus saularis*, Magpie Robin, Aves : Passeriformes.
 (iii) *Passer domesticus* House Sparrow, Aves : Passeriformes.
 (iv) *Pycnonotus cafer*, Red vented Bulbul, Aves : Passeriformes.
 (v) *Sturnia* = *Sturnus contra*, Pied Mayna, Aves : Passeriformes
 (vi) *Acridotheres tristis tristis*, Common Mayna, Aves : Passeriformes
 (vii) *Acridotheres ginginianus*, Bank Mayna, Aves : Passeriformes
39. *Isospora krishnamurthyi* Kshrisagar, 1980.
 Host : *Rattus r. rattus** Rat : Mammalia : Rodentia.
40. *Isospora leonina* Mandal and Ray, 1960.
 Host : *Panthera leo*, Indian Lion, Mammalia : Carnivora
41. *Isospora leopardi* Agarwal *et al.* 1981.
 Host : *Neofelis nebulosa*, Clouded Leopard, Mammalia : Carnivora.
42. *Isospora levinei*, Dubey, 1963.
 Host : *Hyaena striata* (= *Hyaena hyaena hyaena*), Striped Hyaena Mammalia : Carnivora.
43. *Isospora lonchurae* Mandal and Chakravarty, 1964.
 Host : (i) *Lonchura punctulata*, Spotted Munia, Aves : Passeriformes
 (ii) *Sturnia* (= *Sturnus*) *contra*, Pied Munia, Aves : Passeriformes.
44. *Isospora malabaricae* Swarup and Chauhan, 1975.
 Host : *Sturnia malabarica malabarica* [= *Sturnus malabaricus malabaricus*] Grey headed Mayna, Aves : Passeriformes.

* There is no subspecies like 'rattus' in India.

45. *Isospora mandari* Bhatia, Chauhan, Arora and Agarwal, 1972.
Host : *Aix galericulata*, Mandarin Duck, Aves : Anseriformes.
46. *Isospora mayuri* Patnaik, 1966.
Host : (i) *Pavo cristatus* Common Pea fowl }
(ii) *Pavo muticus* Burmese Peafowl } Aves : Galliformes
47. *Isospora megalaimae* Mandal, Chakravarty, 1964.
Host : *Megalaima haemacephala*, Crimson breasted Barbet, Aves : Piciformes.
48. *Isospora melopsittacus* Bhatia, Chauhan, Arora and Agarwal, 1973.
Host : *Melopsittacus undulatus*, Budgrigar, Aves : Psittaciformes.
49. *Isospora minuta* Mitra and Das Gupta, 1938.
Host : *Naja naja*, Asiatic or Indian Cobra, Reptilla : Ophidia.
50. *Isospora mohini* Agarwal *et. al.* 1981.
Host : *Panthera leo* Lion, Mammalia : Carnivora.
51. *Isospora muniae* Chakravarty and Kar, 1944.
Host : *Munia* (= *Lonchura*) *malacca*, Black headed Munia, Aves : Passeriformes.
52. *Isospora nandankanani* Patnaik and Acharjyo, 1976.
Host : *Fellis bengalensis*, Leopard Cat, Mammalia : Carnivora.
53. *Isospora pantheri* Agarwal, *et al.* 1981.
Host : *Panthera leo*, Lion, Mammalia : Carnivora.
54. *Isospora pardusi* Patnaik and Acharjyo, 1971.
Host : *Panthera pardus*, Leopard, Mammalia : Carnivora.
55. *Isospora parusae* Ray and Shivanani, Oommen and Bhaskaran, 1952.
Host : *Parus dichrous*, Brown crested tit, Aves : Passeriformes.
56. *Isospora psittaculae* Chakravarty and Kar, 1947.
Host : (i) *Psittacula eupatria nepalensis* Large Indian Parakeet,
Aves : Psittaciformes.
(ii) *Elathea* (= *Pycnonotus*) *jocosus emeria*, Red-whiskered Bulbul, Aves : Passeriformes.
57. *Isospora pycnonotae* Mandal and Chakravarty, 1964.
Host : *Pycnonotus jocosus* Red-Cheeked/Whiskered Bulbul, Aves : Passeriformes.
58. *Isospora rajuli* Satyanarayancharyulu, Subbarao and Christopher, 1969.
Host : *Acridotheres tristis tristis*, Common Mayna, Aves : Passeriformes

59. *Isospora rayi* Mandal, 1966.
Host : *Ptyctolaemus* sp. Lizard, Reptilia : Lacertilia.
60. *Isospora rivolta* (Grassi, 1879) Wenyon, 1923.
Host : (i) *Canis dingo*, Dingo.
(ii) *Canis familiaris* (– *Canis* sp.), Domestic dog.
(iii) *Felis catus* (= *F. domestica* = *Felis* sp.), Domestic cat.
(iv) *Felis chaus*, Jungle Cat. } Mammalia : Carnivora
61. *Isospora* sp. Shah and Joshi, 1965.
Host : *Gallus domesticus* (= *Gallus* sp.), Domestic fowl, Aves : Galliformes
- *62. *Isospora* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.
Host : *Pycnonotus jocosus*, Red-Whiskered Bulbul, Aves : Passeriformes.
63. *Isospora* sp. Bhatia, 1968.
Host : *Anas* sp. Khaki Camble duck, Aves : Anseriformes.
64. *Isospora* sp. Cooper and Gulati, 1926.
Host : *Bos taurus*, Domestic cattle, Mammalia : Artiodactyla.
65. *Isospora* sp. Pande, Bhatia, Chauhan and Garg, 1970.
Host : *Panthera leo*, Lion, Mammalia : Carnivora.
- *66. *Isospora* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.
Host : *Melopsittacus undulatus*, Budgrigar, Aves : Psittaciformes.
67. *Isospora* sp. Bhatia, Chauhan, Arora and Agarwal, 1972.
Host : *Macaca radiata*, Bonnet Monkey, Mammalia : Primate.
68. *Isospora* sp. Srivastava and Shaw, 1968.
Host : *Sus scrofa* (= *Sus* sp.), Domestic Pig, Mammalia : Artiodactyla.
- *69. *Isospora* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.
Host : *Panthera leo*, Lion, Mammalia : Carnivora.
- *70. *Isospora* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.
Host : *Panthera tigris*, Tiger, Mammalia : Carnivora.
- *71. *Isospora* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.
Host : **Phasianus colchicus versicolor*, Japanese Green Pheasant.

* Reported but description not available.

- *72. *Isospora* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.
Host : *Gracula religiosa*, Hill Mayna, Aves : Passeriformes.
73. *Isospora* sp. Misra, 1947.
Host : *Motacilla alba*, Pied or White Wagtail, Aves : Passeriformes.
74. *Isospora seicercusae* Ray, Shivnani, Oommen and Bhaskaran, 1952.
Host : *Seicercus xanthoschistos*, Grey headed Flycatcher, Aves : Passeriformes.
75. *Isospora stomaticae* Chakravarty and Kar, 1944.
Host : *Bufo stomaticus*, Morbed Toad, Amphibia : Anura.
76. *Isospora sturniae* Chakravarty and Kar, 1947.
Host : *Sturnia malabarica malabarica* (= *Sturnus malabaricus malabaricus*), Grey headed Mayna : Aves : Passeriformes.
77. *Isospora suis* Biester and Murray, 1934.
Host : (i) *Sus scrofa domestica* (= *Sus* sp.), Domestic pig.
(ii) *Sus scrofa scrofa*, Wild Bore, Mammalia : Artiodactyla.
78. *Isospora temenuchii* Chakravarty and Kar, 1944.
Host : *Temenuchus* (= *Sturnus*) *pagoderum*, Black headed/Brahminy Mayna, Aves : Passeriformes.
79. *Isospora tropicalis* Mukherjee and Krassner, 1965.
Host : *Canis aureus*, Asiatic Jackle, Mammalia : Carnivora.
80. *Isospora upupae* Chakravarty and Kar, 1947.
Host : (i) *Upupa epopos orientalis* Hoope/Hudhud, Aves : Coraciiformes.
(ii) *Dicrurus macrocercus* (= *adsimilis*) *macrocarus*, Black Drongo, Aves : Passeriformes.
81. *Isospora ursi* Agarwal *et al.* 1981.
Host : *Melursus ursinus*, Sloth Bear, Mammalia : Carnivora.
82. *Isospora wenyoni* Ray and Das Gupta, 1935.
Host : *Bufo melanostictus*, Indian Common toad, Amphibia : Anura.
83. *Isospora zosteropsis* Chakravarty and Kar, 1947.
Host : (i) *Zosterops palpebrosa palpebrosa*, White eye, Aves : Passeriformes.
(ii) *Thereiceryx zeylanicus caniceps* (= *Megalaima zeylanica caniceps*), Northern Green Barbet, Aves : Piciformes.

* Reported but description not available.

84. *Dorisa aethopsaris* Chakravarty and Kar, 1947.
Host : *Aethiopsar* (= *Acridotheres*) *fuscus fuscus*, Jungle Mayna, Aves : Passeriformes.
85. *Dorisa chakrabartyi* Ray and Sarkar, 1967.
Host : (i) *Lonchura malabarica*, White throated Munia, Aves : Passeriformes.
(ii) *Lonchura punctulata*, Spotted Munia, Aves : Passeriformes.
86. *Dorisa hareni* Chakravarty and Kar, 1944.
Host : (i) *Munia* (= *Lonchura*) *malacca*, Black headed Munia.
(ii) *Munia atricapilla* (= *Lonchura malacca*) *rubroniger*, Chestnut Bellied Munia (= Nepal Black headed Munia).
(iii) *Amandava amandava* (= *Estrilda amandava*), Red Munia.
(iv) *Uroloncha* (= *Lonchura*) *malabarica*, White throated Munia.
(v) *Uroloncha* (= *Lonchura*) *punctulata*, Spotted Munia. } Aves : Passeriformes.
87. *Dorisa harpia* Sinha, 1979.
Host : *Harpicephalus harpia lasyurus*, Hairy Winged Bat, Mammalia : Chiroptera.
88. *Dorisa mandali* Ray and Sarkar, 1967.
Host : *Zosterops palpebrosa palpebrosa*, White eye, Aves : Passeriformes.
89. *Dorisa passeris* Ray and Sarkar, 1967.
Host : *Passer domesticus*, House Sparrow, Aves : Passeriformes.
90. *Dorisa vagabundae* Mandal and Chakravarty, 1963.
Host : *Crypsirina* (= *Dendrocitta*) *vagabunda*, Indian tree pie, Aves : Passeriformes.
91. *Shivatoshella lonchurae* Ray and Sarkar, 1967.
Host : (i) *Lonchura puntulata*, Spotted Munia, Aves : Passeriformes.
(ii) *Lonchura malabarica*, White throated Munia, Aves : Passeriformes.
92. *Eimeria acervulina* Tyzzer, 1929.
Host : (i) *Gallus domesticus* (= *Gallus* sp.) Domestic fowl, Aves : Galliformes.
(ii) *Colinus v. virgineanus*, Bobwhite, Aves : Galliformes.
(iii) *Lophortyx c. californica*, California Valley Quail, Aves : Galliformes.
(iv) *Oreortyx picta picta*, Plumed Quail, Aves : Galliformes.

93. *Eimeria adenoeides* Moore and Brown, 1951.
 (i) *Chrysolophus amherstiae*, Lady Amherst's Pheasant.
 (ii) *Meleagris g. gallopavo* (= *Meleagris* sp.), Domestic Turkey. } Aves : Galliformes.
94. *Eimeria ahsata* Honess, 1942.
 Host : (i) *Ovis canadensis*, Rocky Mountain bighorn sheep.
 (ii) *Ovis* sp. Domestic sheep.
 (iii) *Capra hircus* (= *Capra* sp.) Domestic goat. } Mammalia : Artiodactyla.
95. *Eimeria ailuri* Agarwal *et al.* 1981.
 Host : *Ailurus fulgens* S. Cuvier, Red Panda, Mammalia : Carnivora.
96. *Eimeria alabamensis* Christensen, 1941.
 Host : (i) *Bos taurus*, Domestic cattle.
 (ii) *Bos indicus* (= *Bos* sp.) Indian cattle.
 (iii) *Bubalus bubalis*, Indian Buffalo. } Mammalia : Artiodactyla.
97. *Eimeria alectoreae* Ray and Hiregaudar, 1959.
 Host : *Alectoris graeca*, Chuker Partridge, Aves : Galliformes.
98. *Eimeria ambassi* Patnaik and Achriyo, 1972.
 Host : *Burbus ambassi* (= *Puntius ambassis*), Barb, Pisces : Cypriniformes.
99. *Eimeria anatis* Scholtyseck, 1955.
 Host : *Anas platyrhynchos platyrhynchos*, Mallard. Aves : Anseriformes.
100. *Eimeria andamanensis* Mandal and Nair, 1974.
 Host : *Taphozoas melanopogon*, Black-headed Tombbat, Mammalia : Chiroptera.
101. *Eimeria antilocervi* Ray and Mandal, 1960.
 Host : *Antilope cervicapra*, Black buck, Mammalia : Artiodactyla.
102. *Eimeria arloingi* (Marotel, 1905) Martin, 1905.
 Host : (i) *Capra hircus* (= *Capra* sp.), Domestic goat.
 (ii) *Ovis* sp., Domestic sheep.
 (iii) *Capra ibex*, Ladakh goat/Alpine Ibex.
 (iv) *Ovis canadensis*, Rocky mountain bighorn sheep.
 (v) *Ovis musimon* Mouflon.
 (vi) *Ovis ammon*, Argalie. } Mammalia : Artiodactyla.

103. *Eimeria auburnensis* Christensen and Porter, 1939.
 Host : (i) *Bos taurus*, Domestic cattle.
 (ii) *Bos indicus* (= *Bos* sp.) } Mammalia :
 (iii) *Bubalus bubalis*, Indian Buffalo. } Artiodactyla.
104. *Eimeria aurei* Bhatia *et al.* 1979.
 Host : *Canis aureus naria*, Jackle, Mammalia : Carnivora.
105. *Eimeria bandipurensis* Ray, Banik and Mukherjee, 1965.
 Host : *Funambulus palmerum*, Indian Plam Squirrel, Mammalia :
 Rodentia.
106. *Eimeria barbeta* Kar, 1944.
 Host : *Cyanops* (= *Megalaima*) *asiatica asiatica*, Blue throated Barbet,
 Aves : Piciformes.
107. *Eimeria bareillyi* Gill, Chhabra and Lall, 1963.
 Host : (i) *Bubulus bubalis*, Indian buffalo, Mammalia : Artiodactyla.
 (ii) *Bos indicus* (= *Bos* sp.) Indian cattle.
108. *Eimeria bateri* Pandey and Pande, 1965.
 Host : *Coturnix coturnix coturnix*, Common Grey Quil, Aves : Galli-
 formes.
109. *Eimeria battakhi* Dubey and Pande, 1963.
 Host : *Anas p. platyrhynchus domesticus* (- *Anas platyrhyncos platyrhyncos*)
 Mallard, Aves : Anseriformes.
110. *Emeria bazei* Chauhan and Bhatia, 1970.
 Host : *Pseudobis papilosa*, Black Ibis, Aves : Ciconiformes.
111. *Eimeria bhutanensis* Ray and Hiregaudar, 1959.
 Host : *Polyplectron bicoloratus bakeri*, Peasant, Aves : Galliformes.
112. *Eimeria bongaonensis* Sinha and Sinha, 1978.
 Host : *Gekko gecko* Takhok, Reptilia : Lacertilia.
113. *Eimeria bovis* (Zublin, 1908), Gill, 1970.
 Host : (i) *Bos taurus*, Domestic cattle.
 (ii) *Bos indicus* (= *Bos* sp.), Indian cattle. } Mammalia :
 (iii) *Bubalus bubalis*, Indian Buffalo. } Artiodactyla.
 (iv) *Bos gaurus*, Indian Bison or Gour.
114. *Eimeria brasiliensis* Torres and Ramos, 1939.
 Host : (i) *Bos taurus*, Domestic cattle.
 (ii) *Bos indicus* (= *Bos* sp.) Indian cattle. } Mammalia :
 (iii) *Bubalus babulis*, Indian Buffalo. } Artiodactyla.

115. *Eimeria brunetti* Levine, 1942.

Host : *Gallus domesticus* (= *Gallus* sp.) Domestic fowl, Aves : Galliformes.

116. *Eimeria bukidnonensis* Tubangui, 1931.

Host : (i) *Bubalus bubalis*, Indian Buffalo.
 (ii) *Bos indicus* (= *Bos* sp.), Indian cattle. } Mammalia :
 Artiodactyla.

117. *Eimeria cameli* (Henry and Masson, 1932), Reichenow, 1953.

Host : (i) *Camelus dromedarius*, One humped Camel.
 (ii) *Camelus bactrianus*, Bactrian or Two-humped Camel. } Mammalia :
 Artiodactyla.

118. *Eimeria canadensis* Bruce, 1912.

Host : (i) *Bos indicus* (= *Bos* sp.), Indian cattle.
 (ii) *Bos taurus* Domestic cattle.
 (iii) *Bubalus bubalis*, Indian Buffalo. } Mammalia :
 Artiodactyla.

119. *Eimeria canis* Wenyon, 1923.

Host : (i) *Canis familiaris* (= *Canis* sp.), Domestic dog.
 (ii) *Felis catus* (= *F. domestica* = *Felis* sp.) Domestic cat. } Mammalia :
 Carnivora.

120. *Eimeria cati* Yakimoff, 1933.

Host : (i) *Felis catus* (= *F. domestica* = *Felis* sp.) Domestic cat.
 (ii) *Felis chaus*, Jungle cat, Mammalia : } Mammalia :
 Carnivora.

121. *Eimeria cerdonis* Vetterling, 1965.

Host : *Sus scrofa domestica*, (= *Sus* sp.) Domestic pig, Mammalia :
 Artiodactyla.

122. *Eimeria cervis*, Mandal and Choudhury, 1982.

Host : *Axis axis* Spotted deer, Mammalia : Artiodactyla.

123. *Eimeria charadrii* Mandal, 1965.

Host : *Charadrius asiaticus*, Sand plover, Aves : Charadriiformes.

124. *Eimeria chousinghi* Pande, Bhatia, Chauhan and Garg, 1970.

Host : *Tetracerus quadricornis*, Four horned antelope/Chausingha,
 Mammalia : Artiodactyla.

125. *Eimeria cheetali* Bhatia, 1968.

Host : (i) *Antelope cervicapra*, Black buck.
 (ii) *Axis axis*, Spotted deer or Chital.
 (iii) *Gazella gazella*, Mountain Gazell

} Mammalia :
 Artiodactyla

126. *Eimeria chinkari* Bhatia, 1970.

Host : *Gazella gazella*, Mountain Gazell, Mammalia : Artiodactyla.

127. *Eimeria choudaryi* Bhatia, Chauhan, Arora and Agarwal, 1972.

Host : *Streptopelia decaoto*, Indian Ring Dove, Aves : Columbiformes.

128. *Eimeria christenseni* Levine, Ivens and Fritz, 1962.

Host : *Capra hircus* (= *Capra* sp.), Domestic goat, Mammalia : Artiodactyla.

129. *Eimeria clupearum* (Thelohan, 1894) Daflein, 1909.

Host : (i) *Alosa sardina*, Herring.
 (ii) *Clupea harengus*, Herring.
 (iii) *Sardina* (= *Clupea*) *pilchardus*, Sardine.
 (iv) *Sparattus* (= *Clupea*) *sprattus*, Spart.
 (v) *Engraulis encrasicolus*, Anchovy.
 (vi) *Etrumeus micropus*, Round herring.
 (vii) *Sardina melanosticta*, Sardine.
 (viii) *Scomber scomber*, Mackerel, Pisces : Perciformes
 (ix) *Homo sapiens*, Man, Mammalia : Primate

} Pisces :
 Clupeiformes.

130. *Eimeria columbae* Mitra and Das Gupta, 1937.

Host : *Columba intermedia* (*C. livia intermedia*), Blue rock Pigeon.
 Aves : Columbiformes.

131. *Eimeria columbarum* Nieschulz, 1935.

Host : *Columba livia intermedia*, Blue rock Pigeon, Aves : Columbiformes.

132. *Eimeria coturnicis* Chakravarty and Kar, 1947.

Host : *Coturnix coturnix coturnix*, Common Grey Quail, Aves : Galliformes.

133. *Eimeria coucangi* Patnaik and Acharjyo, 1970.

Host : *Nycticebus coucang*, Slow loris, Mammalia : Primate.

134. *Eimeria crandallis*, Honess, 1942.
 Host : (i) *Capra ibex*, Ladakh goat/Alpine Ibex/Ibex
 (ii) *Ovis aries* (= *Ovis* sp.) Domestic sheep.
 (iii) *Ovis c. canadensis*, Rocky Mountain
 bighorn sheep
 (iv) *Capra hircus* (= *Capra* sp.), Domestic goat.
 (v) *Capra aegagrus*, Wild goat.
 (vi) *Capra siberica* Siberian Wild goat.
 (vii) *Ovis amon*, Argali.
 (viii) *Ovis musimon*, Mouflon. } Mammalia :
 Artiodactyla.
135. *Eimeria cyanophlyctis* Chakravarty and Kar, 1944.
 Host : *Rana cyanophlyctis*, Skipping Frog, Amphibia : Anura.
136. *Eimeria cylindrica* Wilson, 1931, Homonym : *Eimeria cylindrica*
 Ray and Das Gupta, 1936.
 Host : (i) *Bos indicus* (= *Bos* sp.) Indian cattle.
 (ii) *Bos taurus*, Domestic cattle.
 (iii) *Bulbalus bubalis*, Indian Buffalo. } Mammalia :
 Artiodactyla
137. *Eimeria darjeelingensis* Sinha and Sinha, 1980.
 Host : *Suncus murinus* House Shrew, Mammalia : Insectivora,
138. *Eimeria dauki* Bhatia and Pande, 1965.
 Host : *Amaurornis phoenicurus*, White-breasted Water-hen, Aves :
 Gruiformes
139. *Eimeria dawari*, Bhatia, Chauhan, Arora and Agarwal, 1974.
 Host : *Muntiacus muntjak*, Barking deer, Mammalia : Artiodactyla.
140. *Eimeria deblickei* Douwes, 1921.
 Host : *Sus scrofa* (= *Sus* sp.), Domestic pig, Mammalia : Artiodactyla.
141. *Eimeria dispersa*, Tyzzer, 1929.
 Host : (i) *Meleagris g. gallopavo* (= *Meleagris*
 sp.), Domestic Turkey
 (ii) *Phasianus colchicus tarquatus*, Chinese
 Ring-necked pheasant
 (iii) *Tetrastes bonasia*, Hazel hen.
 (iv) *Colinus v. virgineanus*, Bobwhite.
 (v) *Coturnix c. coturnix*, Common Grey
 Quail.
 (vi) *Gallus domesticus* (= *Gallus* sp.), Do-
 mestic fowl.
 (vii) *Meleagris mexicana*, Mexican Turkey.
 (viii) *Phasianus c. colchicus*, Common Ring-
 necked Pheasant. } Aves :
 Galliformes.

142. *Eimeria dromedarii* Yakimoff and Matschoulsky, 1939.

- Host : (i) *Camelus dromedarius*, One humped camel. } Mammalia :
 (ii) *Camelus bactrianus* Bactrian or two humped camel. } Artiodactyla.

143. *Eimeria dubeyi* Bhatia, 1970.

- Host : *Gallus gallus*, Red jungle fowl, Aves : Galliformes.

144. *Eimeria ellipsoidalis* Becker and Frye, 1929.

- Host : (i) *Bos indicus* (= *Bos* sp.), Indian cattle. } Mammalia :
 (ii) *Bos taurus*, Domestic cattle. } Artiodactyla.
 (iii) *Bubalus bubalis*, Indian Buffalo.

145. *Eimeria faurei* (Moussu and Marotel, 1902) Martin, 1909.

- Host : (i) *Capra hircus* (= *Capra* sp.), Domestic goat. }
 (ii) *Ovis aries* (= *Ovis* sp.), Domestic sheep. }
 (iii) *Ammotragus lervia* (= *Ovis tragelaphus*). Barbary sheep. }
 (iv) *Capra ibex*, Ladakh goat/Alpine Ibex/Ibex. } Mammalia :
 (v) *Capra siberica*, Siberian Wild goat. } Artiodactyla.
 (vi) *Ovis ammon*, Argali.
 (vii) *Ovis musimon*, Mouflon.
 (viii) *Ovis orientalis*, Oriental sheep.
 (ix) *Rupicapra rupicapra*, Chamois.

146. *Eimeria felina* Nieschulz, 1924.

- Host : (i) *Panthera leo*, Lion. }
 (ii) *Felis chaus*, Jungle cat. } Mammalia : Carnivora.

147. *Eimeria fibrilosa* Mandal, 1976.

- Host : *Enhydris enhydris*, Fresh water snake, Reptilia : Ophidia.

148. *Eimeria flaviviridis* Setna and Bana, 1935.

- Host : *Hemidactylus flaviviridis*, House lizard, Reptilia : Lacertilia.

149. *Eimeria francolini* Mohan and Chauhan, 1976.

- Host : *Francolinus francolinus* Black Partridge, Aves : Galliformes.

150. *Eimeria gallinagoi* Mandal, 1965.

- Host : *Gallinago gallinago* (= *Capella gallinago gallinago*), Fantail Snipe, Aves : Charadriiformes.

151. *Eimeria gallopavonis* Hawkins, 1952.
Host : (i) *Meleagris g. gallopavo* (= *Meleagris* sp.), Domestic Turkey, Aves : Galliformes.
(ii) *Agriocharis ocellata*, Ocellated Turkey, Aves : Galliformes.
152. *Eimeria gaurusi* Patnaik and Acharjyo, 1971.
Host : *Bos gaurus* Gour or Indian Bison, Mammalia : Artiodactyla.
153. *Eimeria gennaescus* Ray and Hiregaudar, 1959.
Host : *Gennaecus horsfieldi* (= *Lophura leucomelina*), Kalij Pheasant, Aves : Galliformes
154. *Eimeria glossogobii* Mukherjee and Haldar, 1980.
Host : *Glossogobius guiris*, Gobid fish, Pisces : Cypriniformes.
155. *Eimeria gorakhpuri* (= *E. gorakhpurensis*) Bhatia and Pande, 1967.
Host : *Numida meleagris*, Guinea Fowl, Aves : Galliformes.
156. *Eimeria granulosa*, Christensen, 1938.
Host : (i) *Ovis canadensis*, Rocky Mountain Bighorn sheep
(ii) *Ovis aries* (= *Ovis* sp.) Domestic sheep.
(iii) *Capra hircus* (= *Capra* sp.), Domestic goat. } Mammals Artiodactyla.
157. *Eimeria grusi* Pande, Bhatia, Chauhan and Garg, 1970.
Host : (i) *Grus antigone*, Sarus crane
(ii) *Anthropoides vergo*, Demoiselle crane } Aves : Gruiformes.
158. *Eimeria gupti* Bhatia, 1938.
Host : *Natrix* (= *Xenochrophis*) *piscator* Checkered Keelback, Reptilia : Ophidia.
159. *Eimeria hagani* Levine, 1938.
Host : *Gallus domesticus* (= *Gallus* sp.), Domestic hen, Aves : Galliformes
160. *Eimeria hammondi* Dubey and Pande, 1963.
Host : *Felis chaus*, Jungle Cat, Mammalia : Carnivora.
161. *Eimeria harpodoni* Setna and Bana, 1935.
Host : *Harpodon nehereus*, Bombay duck, Pisces : Myctophiformes.
162. *Eimeria hemidactyli* Knowles and Das Gupta, 1935.
Host : *Hemidactylus flaviviridis*, House Lizard, Reptilia : Lacertilia.

163. *Eimeria himalayana* Ray and Misra, 1942.
Host : *Bufo himalayanus*, Himalayan toad, Amphibia : Anura.
164. *Eimeria hungarica* Pellerdy, 1959.
Host : (i) *Lepus europaeus*, European Hare. } Mammalia :
(ii) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic rabbit. } Lagomorpha.
- *165. *Eimeria innocua* Moore and Brown, 1952.
Host : *Meleagris g. gallapavo* (= *Meleagris* sp.), Domestic turkey, Aves : Galliformes.
166. *Eimeria innominata* Kar, 1944.
Host : *Lissemys punctata*, Fresh Water Turtle, Reptilia : Chelonia.
167. *Eimeria intestinalis* Cheissin, 1948.
Host : *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic rabbit, Mammalia : Lagomorpha.
168. *Eimeria intricata* Spiegel, 1-25.
Host : (i) *Ovis aries* (*Ovis* sp.) Domestic sheep. }
(ii) *Ovis canadensis*, Rocky mountain Big horn sheep. } Mammalia : Artidactyla.
(iii) *Ovis musimon*, Mouflon. }
(iv) *Ovis ammon*, Argali. }
(v) *Capra hircus* (= *Capra* sp.), Domestic goat. }
(vi) *Capreolus capreolus* Roe deer }
(vii) *Dama dama*, Fallow Deer. }
169. *Eimeria irregularis* Kar, 1944.
Host : *Lissemys punctata*, Fresh Water Turtle, Reptilia : Chelonia.
170. *Eimeria irresidua* Kessal and Jankiewicz, 1931.
Host : (i) *Lepus ruficaudatus* (= *Lepus nigricollis ruficaudatus*), Indian hare, Black-napped hare, Mammalia : Lagomorpha.
(ii) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic hare, Mammalia : Lagomorpha.
171. *Eimeria kapotei* Chatterjee and Ray, 1969.
Host : *Columba livia intermedia*, Blue rock Pigeon, Aves : Columbiformes.
172. *Eimeria kermoganti* (Simond, 1901,) Braun, 1908).
Host : *Gavialis gangeticus*, Gharial, Reptilia : Crocodilia.

173. *Eimeria knowlesi* Bhatia, 1936.
Host : *Hemidactylus flaviviridis*, House lizard, Reptilia : Lacertilia.
174. *Eimeria koormae* Das Gupta, 1938.
Host : *Lissemys punctata*, Fresh Water Turtle, Reptilia : Chelonia.
175. *Eimeria lobbeana* (Labbe, 1896), Pinto, 1938.
Host : (i) *Columba domestica* (= *Columba* sp.), Domestic Pigeon.
(ii) *Columba intermedia* (= *Columba livia intermedia*), Blue rock Pigeon.
(iii) *Streptopelia orientalis*, Rufous Turtle Dove. } Aves : Columbiformis.
176. *Eimeria laminata* Ray, 1935.
Host : *Bufo melanostictus*, Indian Common Toad, Amphibia : Anura.
177. *Eimeria legari* (Simond, 1901), Reichenow, 1921.
Host : *Emyda granosa* (= *Lissemys punctata granosa*), Indian flap-shelled Turtle, Reptilia : Chelonia.
178. *Eimeria leporis* Nieschulz, 1923.
Host : *Lepus ruficaudatus* (= *Lepus nigricollis ruficaudatus*) Indian Black-napped hare, Mammalia : Lagomorpha.
179. *Eimeria leuckarti* (Flesch, 1883).
Host : (i) *Equus asianus*, Donkey. } Mammalia :
(ii) *Eguus caballus*, Horse. } Perissodactyla.
180. *Eimeria levinei*, Krishnamurthy and Kshirsagar, 1980.
Host : *Rattus rattus rattus*, Mammalia : Rodentia.
181. *Eimeria lomarii* Dubey, 1963.
Host : *Vulpes bengalensis*, Bengal Fox, Mammalia : Carnivora.
182. *Eimeria lophurae* Chauhan, Paliwal and Swarup, 1976.
Host : *Lophura lucomelana*, Aves : Galliformes.
183. *Eimeria lucknowensis* Misra, 1947.
Host : *Motacilla alba alba*, Pied White Wagtail, Aves : Passeriformes.
184. *Eimeria magna* Perard, 1925.
Host : (i) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit.
(ii) *Lepus ruficaudatus* (= *L. nigricollis ruficaudatus*), Indian hare/Black-napped hare. } Mammalia : Lagomorpha.
185. *Eimeria mandali* Banik and Ray, 1964.
Host : *Pavo cristatus*, Common peafowl, Aves : Galliformes.

186. *Eimeria malabericus* Joseph, 1979.
Host : *Funambulus tristriatus* Indian Tree Squirrel, Mammalia : Rodentia.
187. *Eimeria malacca* Chakravarty and Kar, 1944.
Host : *Munia* (= *Lonchura*) *malacca*, Black headed Munia.
Aves : Passeriformes.
188. *Eimeria mathurai* Dubey and Pande, 1963.
Host : *Felis chaus*, Jungle Cat, Mammalia : Carnivora.
189. *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit,
Mammalia : Lagomorpha.
190. *Eimeria maxima* Tyzzer, 1929.
Host : *Gallus* sp. Chick, Aves : Galliformes,
191. *Eimeria mayuri* Bhatia and Pande, 1966.
Host : (i) *Pavo cristatus*, Common peafowl. } Aves :
(ii) *Pavo muticus* Burmese peafowl. } Galliformes.
192. *Eimeria mecistophori* Narsimhamurti, 1976.
Host : (i) *Mecistocephalus puntifrons* Centipede, Myriapoda : Chilopoda.
193. *Eimeria media* Kessel, 1929.
Host : (i) *Lepus ruficaudatus* (= *Lepus nigricollis ruficaudatus*), Indian hare/Black-napped hare, Mammalia : Lagomorpha.
(ii) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic rabbit, Mammalia : Lagomorpha.
194. *Eimeria meleagridis* Tyzzer, 1927.
Host : (i) *Meleagris gallopavo gallopavo* }
(= *Meleagris* sp.) Domestic Turkey. } Aves : Galliformes.
(ii) *Meleagris mexicana* Wild Turkey }
(iii) *Chrysolophus amherstiae* Lady }
Amherst's Pheasant }
195. *Eimeria meleagrimitis* Tyzzer, 1929.
Host : (i) *Cyrsolophus amherstiae*, Lady }
Amherst's Pheasant. } Aves : Galliformes.
(ii) *Meleagris gallopavo gallopavo* }
(= *Meleagris* sp.) Domestic Turkey. }
(iii) *Meleagris mexicana*, Wild }
Turkey. }
196. *Eimeria minetti* Ray, Raghavachari and Sapre, 1942.
Host : *Mabuya* sp., Skink, Reptilia : Lacertilia.

197. *Eimeria minima* Carvalho, 1943.
 Host : (i) *Sylvilagus floridanus mearnsii* Mearn's Cotton Tail
 (ii) *Lepus ruficaudatus* (= *Lepus migricollis ruficaudatus*), Indian hare, Black napped hare. } Mammalia :
 Lagomorpha.
198. *Eimeria mitis* Tyzzer, 1929.
 Host : *Gallus domesticus* (= *Gallus* sp.), Domestic Fowl,
 Aves : Galliformes
199. *Eimeria mivati* Edger and Seibold, 1964.
 Host : *Gallus domesticus* (*Gallus* sp.), Domestic fowl,
 Aves : Galliformes
200. *Eimeria mrigai* Pande, Chauhan, Bhatia and Arora, 1972.
 Host : *Antilope cervicapra*, Black buck, Mammalia : Artiodactyla.
201. *Eimeria nagpurensis* Gill and Ray, 1960.
 Host : *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit,
 Mammalia : Lagomorpha.
202. *Eimeria najae* Ray and Das Gupta, 1936.
 Host : *Naja naja*, Asiatic or Indian Cobra, Reptilia ; Ophidia.
203. *Eimeria necatrix* Johnson, 1930.
 Host : *Gallus domesticus* (= *Gallus* sp.), Domestic fowl,
 Aves : Galliformes
204. *Eimeria neodebliecki* Vetterling, 1965.
 Host : (i) *Sus scrofa domestica* (*Sus scrofa* = *Sus* sp.), Domestic pig,
 Mammalia : Artiodactyla.
 (ii) *Sus scrofa*, Wild Bore, Mammalia : Artiodactyla.
205. *Eimeria neoleporis* Carvalho, 1942.
 Host : (i) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit
 (ii) *Sylvilagus floridanus mearnsi*, Mearn's Cotton Tail } Mammalia :
 Lagomorpha
206. *Eimeria newalai* Dubey and Pande, 1963.
 Host : (i) *Herpestes mungo* (= *Herpestes edwardsi*), Indian Grey
 Mongoose, Mammalia : Carnivora.
207. *Eimeria nilgai* Bhatia, 1970.
 Host : *Bosilepus tragocamelus*, Nilgai, Mammalia : Artiodactyla.

208. *Eimeria ninakohlyakimovi* Yakimoff and Rastegaieff, 1930.
 Host : (i) *Ovis aries* (= *Ovis* sp.), Domestic sheep.
 (ii) *Capra hircus* (= *Capra* sp.) Domestic goat
 (iii) *Capra aegagrus*, Wild goat.
 (iv) *Capra siberica*, Siberian Wild goat.
 (v) *Capra ibex*, Alpine Ibex/Ladakh goat
 (vi) *Ovis canadensis*, Rocky Mountain Bighorn sheep
 } Mammalia :
 Artiodactyla.
209. *Eimeria notopteri* Chakravarty and Kar, 1944.
 (i) *Notopterus notopterus*, Feather Back.
 (ii) *Notopterus chitala*, Humped Feather Back.
 } Pisces :
 Clupeiformes
210. *Eimeria numenii* Mandal, 1965.
 Host : *Numenius arquata*, Curlew, Aves : Charadriiformes.
211. *Eimeria nycticebi* Patnaik and Acharjyo, 1970.
 Host : *Nycticebus coucang*, Slow loris, Mammalia : Primate.
212. *Eimeria oryctolagi* Ray and Banik, 1965.
 Host : *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit,
 Mammalia : Lagomorpha
213. *Eimeria ovina* Levina and Ivens, 1970.
 Host : *Ovis aries* (= *Ovis* sp.), Domestic sheep,
 Mammalia : Artiodactyla.
214. *Eimeria ovoidalis* Ray and Mandal, 1961.
 Host : *Bubalus bubalis*, Indian Buffalo (calf), Mammalia : Artiodactyla.
215. *Eimeria pandei* Patnaik and Ray, 1965.
 Host : (i) *Herpestes mungo* (= *Herpestes edwardsi*), Indian Grey Mongoose.
 (ii) *Herpestes auropunctatus*, Small Indian Mongoose.
 } Mammalia :
 Carnivora.
216. *Eimeria parahi* Pande, Bhatia, Chauhan and Garg, 1970.
 Host : *Axis porcinus*, Hog deer, Mammalia : Artiodactyla.
217. *Eimeria patnaiki* Ray, 1966.
 Host : *Pavo cristatus*, Common Peafowl, Aves : Galliformes.

218. *Eimeria parva* Katlan, Moesy and Vijda, 1929.

- Host : (i) *Ammotragus lervia* (*Ovis tragelaphus*),
Barbary Sheep. }
(ii) *Ovis aries* (*Ovis* sp.), Domestic sheep. }
(iii) *Ovis orientalis*, Mouflon. }
(iv) *Ovis ammon*, Argali. }
(v) *Ovis canadensis*, Rocky Mountain }
Bighorn sheep. } Mammalia :
(vi) *Capra siberica*, Siberian Wild goat. } Artiodactyla.
(vii) *Capra ibex* Alpine Ibex/Ladakh goat. }
(viii) *Capra hircus* (= *Cupra* sp.) Domestic }
goat. }

219. *Eimeria pavonina* Banik and Ray, 1961.

Host : *Pavo cristatus*, Common peafowl, Aves : Galliformes.

220. *Eimeria pavonis* Mondal, 1965.

Host : *Pavo cristatus*, Common peafowl, Aves : Galliformes.

221. *Eimeria pellita* Superer, 1952.

- Host : (i) *Bos indicus* (= *Bos* sp.), Indian cattle. }
(ii) *Bos taurus* Domestic cattle. } Mammalia :
Artiodactyla.

222. *Eimeria perforans* (Leuckart, 1879) Sluiter and Schwellengrebel, 1912.

- Host : (i) *Lepus ruficaudatus* (= *Lepus negricollis ruficaudatus*), Indian hare/Black-napped hare, Mammalia : Lagomorpha.
(ii) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit, Mammalia : Lagomorpha.

223. *Eimeria perminuta* Henry, 1931.

Host : *Sus scrofa domestica* (= *Sas scrofa* = *Sus* sp.), Domestic pig.
Mammalia : Artiodactyla.

224. *Eimeria perminuta mathuri* Mishra, 1967.

Host : *Sus scrofa* Linn. (*Sus* sp.), Domestic pig,
Mammalia : Artiodactyla.

225. *Eimeria petauristae* Ray and Singh, 1950.

Host : *Petaurista inornatus* (= *Petaurista petaurista*), Common gaint flying Squirrel, Mammalia : Rodentia.

226. *Eimeria picta* Bhatia, 1968.

- Host : (i) *Chrysolophus pictus*, Golden Pheasant.
(ii) *Lophura nycthemera nippona* (= *Lophura* sp.), Kalij Pheasant.

227. *Eimeria piscatori* Ray and Das Gupta, 1936.
Host : *Natrix* (= *Xeochrophes*) *piscator*, Checkered Keel Back,
Reptilia : Ophidia.
228. *Eimeria polita* Pellerdy, 1949.
Host : *Sus scrofa domestica* (= *Sus* sp.), Domestic pig,
Mammalia : Artiodactyla.
229. *Eimeria porci* Vetterling, 1965.
Host : *Sus scrofa domestica* (= *Sus scrofa* = *Sus* sp.), Domestic pig,
Mammalia : Artiodactyla.
230. *Eimeria praecox* Johnson, 1930.
Host : *Gallus domesticus* (= *Gallus* sp.) Domestic Fowl,
Aves : Galliformes.
231. *Eimeria punjabensis* Gill and Ray, 1961.
Host : *Lepus ruficaudatus* (= *Lepus nigricollis ruficaudatus*), Indian
hare/Black-napped hare, Mammalia : Lagomorpha.
232. *Eimeria rajasthani* Dubey and Pande, 1963.
Host : *Camellus dromedarius*, One humped Camel,
Mammalia : Artiodactyla.
233. *Eimeria ramgai* Pande, Bhatia, Chauhan and Garg, 1970.
Host : *Tragulus minima*, Mouse deer, Mammalia : Artiodactyla.
234. *Eimeria robertsoni* (Madsen, 1938), Carvalho, 1943.¹
Host : (i) *Lepus arcticus groenlandicus* Green-
land Hare.
(ii) *Lepus townsendi campanius*, White-
tailed Jack rabbit
(iii) *Lepus europeaus*, European Hare.
(iv) *Campanius ruficaudatus* (= *Lepus*
nigricollis ruficaudatus, Indian hare/Black-
napped Hare. } Mammalia :
Lagomorpha
235. *Eimeria roscoviensis pluvialina* Mandal, 1965.
Host : (i) *Pluvialis apricaria*, Golden Plover, Aves : Charadiiformes.
(ii) *Motacilla a. alba* Pied or White Wagtail,
Aves : Passeriformes.
236. *Eimeria ruficaudati* Gill and Ray, 1960.
Host : *Lepus ruficaudatus* (= *Lepus nigricollis ruficaudatus*), Indian
hare/Black-napped hare, Mammalia : Lagomorpha.
237. *Eimeria sardari* Bhatia, Chauhan, Arora and Agarwal, 1973.
Host : *Muntiacus muntjak*, Barking deer : Mammalia : Artiodactyla.

238. *Eimeria sardinae* (Thelohan, 1890).
 Host : (i) *Clupea harengus*, Herring, Pisces : Clupeiformes.
 (ii) *Sardina* (= *Clupea*) *pilchardus*, Sardine,
 Pisces : Clupeiformes.
 (iii) *Homo sapiens*, Man, Mammalia : Primate.
239. *Eimeria scabra* Henry, 1931.
 Host : *Sus scrofa domestica* (= *Sus scrofa* = *Sus* sp.), Domestic pig,
 Mammalia : Artiodactyla.
240. *Eimeria southwelli* Halawani, 1930.
 Host : (i) *Aetobatis narinari* (= *Aetobatis flagellum*, Eagle Ray,
 Pisces : Rajiformes.
 (ii) *Scoliodon sorrakowah*, Light Tip Shark,
 Pisces : Lamniformes.
241. *Eimeria* sp.
 Host : *Culex* sp., Mosquito, Insecta : Diptera.
242. *Eimeria* sp., Bhatia, 1968.
 Host : *Axis axis*, Spotted deer, Mammalia : Artiodactyla.
243. *Eimeria* sp., Cooper and Gulati, 1926.
 Host : *Bos taurus*, Domestic Cattle, Mammalia : Artiodactyla.
244. *Eimeria* sp., Bhatia and Pande, 1967.
 Host : *Prophyrio prophyrio*, Purple Moorhen Aves : Charadriiformes.
245. *Eimeria* sp., Bhatia and Pande, 1967.
 Host : *Fulica a. atra*, Coota, Aves : Gruiformes.
246. *Eimeria* sp. Setna and Bana, 1935.
 Host : *Trichiurus sarala*, Small headed ribbon fish, Pisces : Perciformes.
247. *Eimeria* sp. Setna and Bana, 1935.
 Host : *Epinephelus tauvina*, Greasy reef cod, Pisces : Perciformes.
248. *Eimeria* sp., Setna and Bana, 1935.
 Host : *Plotossus canius* Canine cat-fish/Ell, Pisces : Siluriformes.
249. *Eimeria* sp., Setna and Bana, 1935.
 Host : *Coilla dussemieri*, Taper-tail anchovy, Pisces : Cluperiformes.
250. *Eimeria* sp., Setna and Bana, 1935.
 Host : *Epinephelus diocanthus*, Six-barred reefcod, Pisces : Perciformes.
251. *Eimeria* sp., Setna and Bana, 1935.
 Host : *Engraulis mystax*, Must ached anchovy, Pisces : Clupeiformes.
252. *Eimeria* sp., Satna and Bana, 1935.
 Host : *Sillago sihima*, Silver Whiting, Pisces : Perciformes.
253. *Eimeria* sp., Setna and Bana, 1935,
 Host : *Batrachus grunniens*, Frog fish, Pisces : Batrachidiformes.
- *254. *Eimeria* sp., Setna, and Bana, 1935.
 Host : *Otolithus ruber*, Rosy few fish, Pisces : Perciformes.

- *255. *Eimeria* sp., Chauhan, Bhatia, Arora, Agarwal and Ahluwalia 1973.

Host : *Francolinus francolinus*, Black partridge, Aves : Galliformes.

- *256. *Eimeria* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1973.

Host : *Pycnonotus jocosus*, Red whiskered Bulbul, Aves : Passeriformes

- *257. *Eimeria* sp.

Host : *Seicercas xanthosctistos*, Grey headed flycatcher,
Aves : Passeriformes

- *258. *Eimeria* sp., Chauhan, Bhatia, Arora, Agarwal and Ahluwalia, 1977.

Host : *Lophura leucomelana*, Kaliz Pheasant, Aves : Galliformes.

- *259. *Eimeria* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia 1973.

Host : *Columba* sp. Nagab pigeon/White pigeon,
Aves : Columbiformes.

- *260. *Eimeria* sp. Chauhan, Bhatia, Arora, Agarwal and Ahluwalia 1973.

Host : *Muntiacus muntjak*, Barking deer, Mammalia : Artiodactyla.

261. *Eimeria sphenocercae* Ray, 1952.

Host : *Sphenocercus sphenocercus* (= *Treron* sp.), Kokla Green Pigeon.
Aves : Columbiformes.

262. *Eimeria spinosa* Henry, 1938.

Host : *Sus scrofa domestica* (= *Sus scrofa* = *Sus* sp.), Domestic pig,
Mammalia : Artiodactyla.

263. *Eimeria stiedai* (Lindermann, 1865) Kisskalt and Hartmann, 1907.

Host : (i) *Lepus americanus*, Snowshoe Rabbit.

(ii) *Lepus timidus* Alpine hare (= Varying hare).

(iii) *Oryctolagus cuniculis* (= *Oryctolagus* sp.), Domestic Rabbit

(iv) *Sylvilagus floridanus mallurus*, Eastern Cotton tail.

(v) *Sylvilagus floridanus mearnsii* Mearn's Cotton tail.

(vi) *Sylvilagus nuttalli* (= *floridanus*) *gran-geri*, Cotton tail.

Mammalia :
Lagomorpha

264. *Eimeria stolatae* Ray and Das Gupta, 1938.
Host : *Natrix stolata* (= *Amphiesma stolata*), Striped Keelback, Reptilia : Ophidia.
265. *Eimeria subspherica* Christensen, 1941.
Host : (i) *Bos indicus* (= *Bos* sp.), Indian cattle. } Mammalia :
(ii) *Bubalus bubalis*, Indian Buffalo. } Artiodactyla.
(iii) *Bos taurus*, Domestic cattle.
266. *Eimeria suncus* Ahluwalia et al. 1979.
Host : *Suncus murinus*, House Shrew, Mammalia : Insectivora.
267. *Eimeria sylvilagi* Carini, 1943.
(i) *Lepus ruficaudatus* (= *Lepus nigricollis ruficaudatus*), Black naped hare/Indian hare. }
(ii) *Oryctolagus cuniculus* (= *Oryctolagus* sp.), Domestic Rabbit. } Mammalia :
(iii) *Sylvilagus brasiliensis minensis*, Brazilian hare. } Lagomorpha.
(iv) *Sylvilagus floridanus mearnsi*, Mearn's Cotton tail. }
268. *Eimeria teetari* Bhatia, Pandey and Pande, 1966.
Host : (i) *Francolinus francolinus*, Black partridge.
(ii) *Caccobis chukor* (= *Alectoris graeca*), Chuker partridge.
(iii) *Francolinus pondicerianus*, Grey Partridge.
269. *Eimeria tenella* (Railliet and Lucet, 1891), Fantham, 1909.
Host : *Gallus domesticus* (= *Gallus* sp.), Domestic Fowl, Aves : Galliformes.
270. *Eimeria tirupatiensis* Sivanarayan and Venataratnam, 1969.
Host : *Capra hircus* (= *Capra* sp.), Domestic goat, Mammalia : Artiodactyla.
271. *Eimeria tragocameli* Bhatia, 1970.
Host : *Boselepus tragocamelus* Nilgai, Mammalia : Artiodactyla.
272. *Eimeria triangularis* Chakravarty and Kar, 1943.
Host : *Trionyx gangeticus*, Gangetic Turtle, Reptilia : Chelonia.
273. *Eimeria trionyxae*, Chakravarty and Kar, 1943.
Host : *Trionyx gangeticus*, Gangetic turtle, Reptilia : Chelonia.
274. *Eimeria tropicalis* Malhotra and Ray, 1961.
Host : *Columba livia intermedia*, Blue rock Pigeon, Aves : Columbiformes.

275. *Eimeria tuberculata* Krishnamurthy and Kshirsagar, 1980.
Host : *Rattus rattus*, Common Rat, Mammalia : Redentia.
276. *Eimeria vanelli* Mandal, 1965.
Host : *Vanellus malabaricus*, Yellow Wattled Lapwing,
Aves : Charadriiformes
277. *Eimeria vanmurghavi* Bhatia, 1970.
Host : (i) *Gallus gallus*, Red Jungle fowl } Aves : Galliformes.
(ii) *Gallus soneratti*, Grey Jungle fowl }
278. *Eimeria varani*, Bhatia and Chauhan, 1972.
Host : *Varanus monitor* (= *Varanus bengalensis*), Monitor lizard,
Reptilia : Lacertilia.
279. *Eimeria wasielewskyi* Rastegaieff, 1930.
Host : (i) *Axis axis* Spotted deer, Mammalia : Artiodactyla.
(ii) *Cervus e. elaphus*, Red Deer, Mammalia : Artiodactyla.
(iii) *Cervus nippon hortulorum*, Sika deer,
Mammalia : Artiodactyla.
280. *Eimeria wyomingensis* Huizinga and Winger, 1942.
Host : (i) *Bos indicus* (= *Bos* sp.), Indian cattle. } Mammalia :
(ii) *Bos taurus*, Domestic cattle. } Artiodactyla
(iii) *Bubalus bubalis*, Indian Buffalo. }
281. *Eimeria yakimovi* Rastegaieff, 1930.
Host : *Boselepus tragocamelus* : Nilgai, Mammalia : Artiodactyla.
282. *Eimeria zuernii* (Rivolta, 1878), Martin, 1909.
Host : (i) *Bos indicus* (= *Bos* sp.), Indian cattle } Mammalia :
(ii) *Bos taurus*, Ox, Domestic cattle } Artiodactyla
(iii) *Bubalus bubalis*, Indian Buffalo. }
283. *Eimeria zygenae* Mandal and Chakravarty, 1965.
Host : *Zygaena* (= *Spyrna*) *blochii*, Arrow header of Hammar headed
Pisces : Lamniformes.
284. *Wenyonella ananis* Pande, Bhatia and Srivastava, 1965.
Host : *Anas platyrhynchos domesticus* (= *Anas platyrhynchos platyrhyn-*
chus), Mallard, Aves : Anseriformes.
285. *Wenyonella bahli* Misra, 1944.
Host : *Coturnix coturnix*, Common Grey Quail, Aves : Galliformes.
286. *Wenyonella columbae* Haldar and Ray Choudhury, 1974.
Host : *Calumba livia intermedia*, Blue rock Pigeon,
Aves : Columbiformes.

287. *Wenyonella gagari* Sarkar and Ray, 1968.
Host : *Anas boschus* (= *Anas* sp.), Domestic duck, Aves : Anseriformes.
288. *Wenyonella gallinae* Ray, 1945.
Host : *Gallus domesticus* (*Gallus* sp.), Domestic Fowl, Aves : Galliformes.
289. *Wenyonella hoarai* Ray and Das Gupta, 1937.
Host : *Sciurus* sp. Squirrel, Mammalia : Rodentia.
290. *Wenyonella mackinnoni* Misra, 1947.
Host : *Motacilla alba*, Pied White Wagtail, Aves : Passeriformes.
291. *Wenyonella pellerdyi*, Bhatia and Pande, 1966.
Host : *Anas guerguedula*, Blue-winged Teal/Gargany Teal, Aves : Anseriformes.
292. *Octosporella mabuiae* Ray and Raghavachari, 1942.
Host : *Mabuya* sp., Skink, Reptilia : Lacertilia.
293. *Pythonella bengalensis* Ray and Das Gupta, 1937.
Host : *Python* sp., Indian Python, Reptilia : Ophidia.

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XV. GLOSSARY

ANISOGAMY : Conjugation between dissimilar gametes.

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

BINARYFISSION : A mode of reproduction in which the division of the nucleus into two is followed by the division of the cell.

COCCIDIA : Telosporidia in which the mature trophozoite is intracellular and small, the zygote is non-motile, and the sporozoites are developed within a spore.

COCCIDIOMORPHA : Term used by Doflein to include coccidia and Haemosporidia.

COELOZOIC : Parasites that live in the lumen of the alimentary canal or other cavities in the body of the host.

CONJUGATION : Union of two organisms leading to reproduction by germs or spores.

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

CYTOZOIC : Parasites that are lodged inside a cell.

EIMERIDEA : Coccidia in which the gametocytes are similar in size and develop independently.

ENCYSTMENT : The phenomenon of becoming motionless, excreting a membranous cyst.

EPISPORE : The outer covering of a spore.

GAMETE : Specialized cells tend to meet and fuse in conjugation.

GAMETOCYST : The cyst formed round two associated sporonts or gametocytes.

GAMETOCYTE : The mother-cell which gives rise to a number of gametes.

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

GAMONT : An individual tend to form gametes ; also known as sporont.

HISTOZOIC : Parasites that occur in the spaces between groups of cells.

HOLOZOIC : Animals which are entirely dependent for food on other organisms, which they capture, devour and digest,

ISOGAMETES : Gametes which are similar in shape and size.

ISOGAMY : Conjugation between similar gametes.

KARYOSOME : A chromatic mass surrounded by plastin within the nucleus.

MACROGAMETE : The larger or inactive gamete in anisogamous conjugation.

MABROGAMETOCYTE : The mother-cell of the macrogametes.

MEROZOITES : A product of asexual reproduction or schizogony.

MICROGAMETOCYTES : The mother-cell of microgametes.

MITOCHONDRIA : Minute cytoplasmic inclusions, occurring in the form of spherical granules or rod-shaped or criscentic bodies inside the cell.

MITOTIC : Indirect division of the nucleus, which is accompanied by the formation of spindle of threads.

MONOSPOROUS : Developing into a single spore.

MULTINUCLEATE : Possessing many nuclei.

MULTIPLE FISSION : A mode of reproduction in which the division of the nucleus is not immediately followed by the division of the cell, but, after repeated nuclear division, the cell divides into as many parts as there are nucleus.

NUCLEOUS : A minute, more solid particle developed singly or in varying number within the nucleus of an animal or vegetable cell.

NUCLEUS : More densely granular body within the substance of an animal or vegetable cell.

OCTOSPOROBLASTIC : Producing eight sporoblasts.

OCTOSPOROUS : Producing eight spores.

OCTOZOIC SPORE : A spore containing eight sporozoites.

OOCYST : A cyst containing the conjugated gametes.

PARASITE : An organism living in or upon the body of another organism and dependant for its existence on that organism or a limited group of organisms.

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

SCHIZONT : The stage which is about to divide into a number of parts called merozoites,

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

SPOROBLAST : A product of the initial reproduction of the zygote, including both capsule and contents ; a cell which develops directly into a spore.

SPORO CYST : The covering or coverings of the spore. Sometimes used in the same sense as a spore.

SPORO GONY : The development of spores from the sporont.

SPORONT : An adult sporozoan which is destined to form gametes or to give rise to sporoblasts.

SPOROPLASM : The protoplasmic mass inside the spore.

SPOROZOITE : Each of the small falciform bodies which are released when the spore-wall is absorbed.

SYNGAMY ; Sexual union or conjugation involving a complete fusion of two gametes.

TROPHOZOITE : The young feeding and growing parasite.

VACUOLATE : Having a number of clear spaces or vacuoles.

VERMICULAR : Resembling a worm in shape.

ZYGOTE : The cell resulting from the complete fusion of two gametes.

XVI. SUBJECT INDEX

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ERRATA

<i>Page</i>	<i>Line</i>	<i>Printed as</i>	<i>Read as</i>
3	15th, 17th & 19th line from top	Dasgupta	Das Gupta
40	11th Line from top	A.C.S.	Sarkar
41	4th line from top	esch	each
48	9th line from top, 11th line from top & 5th line from below	meaozoites residud Puff (Ital)	merozoites residual Puff (Roman)
56	12th line from top & 13th line from top	author's collections Sinha, Chottoraj	collections of the describer Sinha, Sinha, Chottaraj
80	6th line from top	Fig. 52B, mature	Fig. 52A mature
81	8th line from top	Fig.	Fig.
100	9th line from top	Dubey and Pande (1963)	Dubey and Pande (1963c)
104	2nd line from top	long (1982)	Long (1982).
105	4th line from top	Bubl,	Bull.
112	14th line from top & 16th line from top	Aiyar (1937) (1963)	Aiyar (1937a, b) (1963a)
132	with in figure	1 2	A B
142	4th line from top	Schizonrs	Schizonts
147	10th line from below & 13th line from below	qupti	gupti
148	3rd line from below	microphle	micropyle
149	6th line from top	i	is
163	20th line from top	1945c & 1959a, b	1945b & 1954a, c
165	last line	Sphetieal	spherical
167	3rd line from below	Chakrrrvarty	Chakravarty
173	24th line from top	intensline	intestine
185	17th line from top	Eimoria	Eimeria
196	3rd line from top & 3rd line from below	gramule gamate	granule gamete
202	18th line from below	Prodesh	Pradesh
205	19th line from top	Culcutta	Calcutta
208	9th line from top	rafractile	refractile
213	1st line	Simulteniously	Simalteniously

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215	12th line from top	Pettillo	Pattillo
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218	6th line from top & 5th line from below	reslduum ovidal	residuum ovoidal
224	9th line from below	layer in	layer is
226	17th line from below	Patnaik (1965)	Patnaik (1965c)
229	5th line from below	Recl	Rec
230	12th line from top	Ray (1952, 61)	Ray (1952b, 61)
231	18th line from top	1967b	1967a.
	6th line from below & 9th line from below	1966, 69 1954	1966d, 69 1954b.
232	5th line from top	Bordjocoki	Bordjochki
257	18th line from top to 22nd line	The occurrence ...from India.	} Delete
281	4th line from below	168	217
283	7th line from top	169	218
342	14th line from below	<i>Eimeria anatis</i>	<i>Wenyonella anatis</i>
349	5th line from below	1927	1937
358	1st line from top	<i>Grrulax</i>	<i>Garrulax</i>
	3rd & 29th line from top	<i>garrulnsae</i> <i>Purus</i>	<i>garrulusae</i> <i>Parus</i>
359	13th line from top	<i>tristratus</i>	<i>tristriatus</i>



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