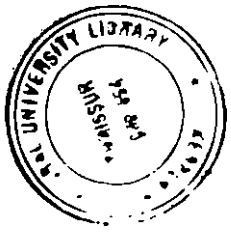
PREVALENCE, PATHOLOGY AND TREATMENT OF COCCIDIOSIS IN RABBITS



By

SHAMEEM. H.

THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science in Veterinary Parasitology

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

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MANNUTHY, THRISSUR - 680651
KERALA, INDIA

2002

DECLARATION

I hereby declare that this thesis entitled **"PREVALENCE, PATHOLOGY AND TREATMENT OF COCCIDIOSIS IN RABBITS"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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Mannuthy
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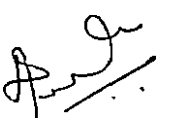
CERTIFICATE

Certified that this thesis entitled **"PREVALENCE, PATHOLOGY AND TREATMENT OF COCCIDIOSIS IN RABBITS"** is a record of research work done independently by **H. Shameem** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.



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ACKNOWLEDGEMENTS

To the greatest degree, I am indebted to Dr. K. Devada, Assistant Professor, Department of Veterinary Parasitology and Chairperson of the Advisory Committee for her affectionate guidance, constant supervision, constructive criticism and personal care extended throughout the preparation of this piece of research.

I am cordially obliged to Dr. H. Subramanian, Associate Professor and Head i/c, Department of Veterinary Parasitology for his constant encouragement and valuable suggestions which greatly assisted me in the timely completion of this work.

I extend my sincere thanks to Dr. Mammen J. Abraham, Associate Professor, Centre of Excellence in Pathology and Dr. K. Anilkumar, Assistant Professor, Centre for Advanced Studies in Animal Breeding and Genetics, for their kind co-operation and earnest help as members of the Advisory Committee during the course of my work.

There are no words to pay my respect and gratitude to Dr. Lucy Sabu, Assistant Professor (Sel. Grade), Department of Veterinary Parasitology for her words of inspiration, kindness and professional guidance during the entire period of research.

I sincerely acknowledge Dr. P.P. Balakrishnan, Dean i/c, College of Veterinary and Animal Sciences, for the facilities provided for research work.

I sincerely acknowledge Dr. V. Jayaprakasan, Associate Professor and Head i/c and Dr. G. Krishnan Nair, Associate Professor, Department of Veterinary Microbiology, for their help and co-operation in taking the photomicrographs.

I am thankful to Dr. K.V. Valsala, Professor and Head i/c, Centre of Excellence in Pathology for permitting me to utilize the facilities in the

department for the collection of postmortem samples and for histopathological studies.

I gratefully acknowledge the wholehearted help rendered by Mrs. K.S. Sujatha, Assistant Professor (Sel. Grade) and Head i/c, Department of Statistics for statistical analysis.

The help and co-operation extended by the non-teaching staff of Department of Veterinary Parasitology and the Rabbit Research Station, Mannuthy are also gratefully acknowledged.

I sincerely acknowledge the help rendered by Dr. R. Sangeetha, Dr. T.S. Rejitha and Dr. M.N. Priya, M.V.Sc scholars, Department of Veterinary Parasitology, during the course of my work.

The moral support and encouragement given by my friends Dr. T.V. Bisi, Dr. J.P. Smitha, Dr. A.K. Deepa, Dr. Bindu Raj and Dr. Chinthu are memorable.

I would like to record special thanks to Dr. N. Yuvaraj and Dr. I.S. Sajitha for their cordial friendship and personal help extended to me during my research work.

Nothing will be sufficient to show my deep sense of gratitude to Dr. P. Bindu and Dr. V. Babitha for their mental support, encouragement and priceless help rendered to me during this study. I sincerely acknowledge their warm friendship which enabled a strenuous task remain a pleasure throughout.

I sincerely acknowledge the facilities and financial grants provided by the Kerala Agricultural University.

I would like to place a record of my sincere gratitude to Dr. Basheer Ahamed (Orthopaedic Surgeon) my dear father-in-law who had been the inspiration behind me to take up this study. Whatever little I have achieved today is because of him and I owe a lot to him. I am also thankful to the co-operation and help extended by my mother-in-law and sister-in-law.

With immense pleasure I would like to acknowledge with gratitude the mental support, love, care and heartfelt blessings from my everdear Vappa and Umma.

My heartfelt gratitude to my dear deedi, Shareena for her constant encouragement and prayers from across the miles.

Words fail to express my gratitude and love to my dearest younger sister Munnu for her queries, care and support. She was always with me throughout thick and thin.

This task would not have been completed successfully but for the understanding, love, mental support and constant encouragement by my beloved husband Dr. Salih Sadiq. I express my heartfelt gratitude to him for being my pillar of strength and for bearing with me all the inconveniences.

No words can express the language of heart. Within the limits of lexicon I express my love, care and gratitude to my dear son Fardeen (Sachu) for his smiles, love, tenderness and cheer which added to my strength to complete this mission successfully.

Above all I bow before the Almighty Allah for the blessings showered upon me in all walks of my life.

H. SHAMEEM

Dedicated to

The Almighty

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Introduction

1. INTRODUCTION

The European rabbit *Oryctolagus cuniculus* is the only species of the order Lagomorpha which has been introduced into every country of the world. Breeds of modern domestic rabbits have been developed since the 18th century. There are now several hundred varieties throughout the world varying in size, colour, type of haircoat and other characteristics. Rabbits are produced for meat, wool, research and for rearing as pets. Best known for being prolific, rabbits are also efficient converters of plant protein to high value animal protein. Rabbits can turn 20 per cent of the proteins they eat into edible meat while it is only 8 to 12 per cent for beef cattle. Rabbit meat production is therefore an attractive proposition next to broiler chicken especially when the aim is to produce quality animal protein.

The rabbit population in Kerala is estimated to be 82,157 as per the Livestock Census (1996). This throws light on the awareness and perception gained by the rabbit farmers of our state on the ease and economics of rabbit farming.

Nevertheless, these small mammals are also susceptible to many infectious diseases. Among the various diseases, coccidiosis is a major protozoan disease of rabbits caused by members of the genus *Eimeria*. It is essentially a disease of young rabbits, very common in breeding and rearing establishments where sanitation is poor. In traditionally reared domestic rabbits

the disease may provoke depression, diarrhoea and high mortality whereas in commercially reared rabbits, coccidiosis occurs mostly as a subclinical disease causing growth retardation and alteration of feed conversion. In India, rabbit coccidiosis was first reported by Cooper (1927). Thus coccidial infections are found to be a major constraint responsible for the slow growth of the industry and therefore its control assumes paramount importance for a successful and profitable rabbit farming enterprise.

Considering the significance of the aforementioned facts the present study was undertaken with the following objectives:

a. to study the prevalence and to identify species of coccidial organisms infecting rabbits

b. to assess the pathological changes in rabbit coccidial infections and

c. to evaluate the efficacy of sulphadimidine, furazolidone and metronidazole in natural infections of rabbit coccidiosis.

Review of Literature

2. REVIEW OF LITERATURE

2.1 Prevalence

Earlier studies on the prevalence of *Eimeria* spp. in rabbits was done by Mykytowycz (1962) who reported the incidence of six species of *Eimeria* in an experimental population of the Australian wild rabbit. They were *E. perforans, E. media, E. stiedai, E. irresidua, E. magna* and *E. piriformis*. He also noticed a higher rate of infection during rainy season than in dry season and in young rabbits below three months rather than in adults. No sex variation was observed on the rate of infection.

Niak (1967) reported coccidiosis in laboratory rabbits in Teheran and detected species like *E. magna, E. perforans, E. media, E. irresidua, E. nagpurensis, E. stiedai, E. piriformis* and *E. neoleporis*.

Catchpole and Norton (1979) examined 596 faecal samples from three commercial rabbitries in South East England, out of which 96 per cent contained oocysts. The species were identified as *E. magna, E. perforans, E. coecicola, E. irresidua,E. flavescens, E. intestinalis* and *E. piriformis. Eimeria magna, E. media* and *E. perforans* were the most frequently occurring species.

Peeters *et al.* (1981) made a survey of coccidiosis in rabbits in commercial and domestic rabbitries in Belgium and recognized nine different species of *Eimeria* from 1052 faecal samples. *Eimeria magna*, , *E. media* and *E. perforans* were very common in both the rabbitries. *Eimeria stiedai* was not

recorded in commercial rabbitries. Significantly higher oocyst counts were detected in domestic rabbits than in medicated commercial rabbits housed in wire cages.

Satyanarayana *et al.* (1982) reported an outbreak of both hepatic and intestinal coccidiosis in 22 adult and 55 young rabbits in a farm in Andhra Pradesh, India.

Sanyal and Srivastava (1986) conducted studies on subclinical coccidiosis in domestic rabbits in the semiarid parts of Rajasthan. Out of the 92 samples examined, 48 were positive for coccidiosis indicating a rate of 52.17 per cent. Infection was more in the rabbits of 12 to 24 weeks followed by those of 6 to 12 weeks. Breedwise prevalence was higher in New Zealand white rabbits followed by White Giant. Eight different species were identified and they were *E. media, E. perforans, E. magna, E. irresidua, E. elongata, E. nagpurensis, E. piriformis* and *E. intestinalis,* in the decreasing order of prevalence.

Rai and Singh (1987) conducted epidemiological studies on postweaning rabbit mortality in Himachal Pradesh, India and found that coccidiosis contributed to 9.12 per cent of the total mortality. Higher mortality occurred during rainy seasons (June-September) : : that too in rabbits of 6 to 12 weeks of age.

Jain (1988) recorded the prevalence and compared the morphology of eight sporulated oocysts of *Eimeria* viz., *E. media, E. perforans, E. piriformis,*

E. magna, E. exigua, E. irresidua and *E. intestinalis* of domestic rabbits in Madhya Pradesh, India.

The study of Meitei *et al.* (1988) on the incidence of *Eimeria* infections in domestic rabbits in and around Ranchi, Bihar revealed that 54.35 per cent of rabbits were infected. The different species of coccidia identified were *E. magna, E. irresidua, E. perforans, E. coecicola, E. media, , E. intestinalis* and *E. stiedai* in the order of frequency. Besides, the infection was observed to be higher during the rainy season.

Zarzara *et al.* (1989) reported a low infection of livers with *E. stiedai* (0.09 per cent) and a high infection of intestines especially with *E. magna* and *E. perforans* (19.26 per cent) in the farm rabbits of Romania.

Mundin and Barbon (1990) examined 375 faecal samples from four rabbit farms in Uberlandia city in Brazil and identified *E. magna, E. media, E. irresidua, E. coecicola, E. perforans* and *E. flavescens* as the causative agents.

Okewole (1990) reported an epizootic of coccidiosis in domestic rabbits in the Plateau and Bauchi States, Nigeria. Faecal tests carried on 187 animals revealed heavy coccidial infection with counts of 6,000 to 600,000 oocysts per gram of faeces in 70 per cent of the samples. The most frequently occurring coccidia were *E. magna, E. perforans, E. media, E. piriformis* and *E. coecicola* followed by *E. irresidua, E. nagpurensis, E. intestinalis* and *E. stiedai* with lesser incidence.

Darwish and Golemansky (1991) reported ten *Eimeria spp.* from 75 domestic rabbits representing four regions of Syria with an overall prevalence of 77.3 per cent. The ten species found in the order of decreasing prevalence were *E. perforans, E. coecicola, E. magna, E. exigua, E. irresidua, E. matsubayashi, E. intestinalis, E. periformis, E. media and E. stiedai.*

A survey carried out by Wang and Tsai (1991) in 1152 rabbits in Taiwan, revealed coccidial oocysts in 95 to 100 per cent of young weaned rabbits of two months age. Adult female rabbits were detected as carriers.

Balasubramanian *et al.* (1992) reported the incidence of intestinal coccidiosis (70 per cent morbidity and 10 per cent mortality) in young Chinchilla crossbred rabbits at a farm in Dharmapuri, Madras, India.

D'Souza *et al.* (1992) recorded the intestinal species viz., *E. magna, E. media, E. irresidua, E. elongata, E. nagpurensis, E. perforans, E. piriformis, E. coecicola, E. intestinalis* and the hepatic species *E. stiedai* as responsible for rabbit coccidiosis in Karnataka.

The species of *Eimeria* identified by Pillai and Subramanian (1993) in the rabbits of Kerala were *E. magna, E. perforans, E. media* and *E. intestinalis. Eimeria magna* was found in 89 per cent of the samples while *E. intestinalis* had the lowest incidence (12 per cent).

Al-Khafaji and Rhaymah (1995) examined 1500 rabbits from the College of Veterinary Medicine and other five sites in Mosul, Iraq and observed

the rate of infection as 28 per cent. The species isolated were *E. stiedai, E. perforans, E. media, E. intestinalis* and *E. irresidua.*

Jithendran (1995) conducted a survey of the rabbit farms in and around Palampur, Himachal Pradesh and found that 76 (37.6 per cent) out of 202 rabbits had died of clinical coccidiosis. The species involved were *E. stiedai, E. magna, E. intestinalis, E. media, E. irresidua, E. piriformis, E. elongata, E. perforans* and *E. flavescens.*

Tambur *et al.* (1995) identified *E. perforans* (44 per cent), *E. flavescens* (30 per cent), *E. magna* (24 per cent), *E. irresidua* (16 per cent) and *E. stiedai* (9 per cent) in the faecal samples of 240 farmed rabbits in the Pancevo area, Serbia.

Bhat *et al.* (1996) made a detailed study on rabbit coccidiosis highlighting the species of *Eimeria* concerned, lifecycle, pathology, disease prevalence and control. They concluded that the prevalence of coccidiosis was 21 to 60 per cent in the European countries and 13 to 64 per cent in India.

Jha and Thakuri (1996) conducted autopsy studies on 201 rabbits presented at the Pakhribas Agricultural Centre and observed that the main causes of death also included intestinal coccidiosis (42.8 per cent) and hepatic coccidiosis (8.4 per cent). The species of *Eimeria* identified were *E. piriformis* (50 per cent), *E. irresidua* (15 per cent), *E. perforans* (14 per cent), *E. flavescens* (14 per cent) and *E. intestinalis* (8 per cent).

Jithendran and Bhat (1996) encountered eight species of coccidia in 180 of 314 rabbits that suffered from subclinical infections in four commercial Angora rabbitries from Himachal Pradesh. The species were *E. magna, E. perforans, E. media, E. irresidua, E. stiedai, E. intestinalis, E. piriformis* and *E. coecicola.*

Nfi and Ndoping (1996), who determined the causes of mortality in rabbits reared at the institute of Zootechnical and Veterinary Research Station (IRZV) Mankon, Cameroon believed the incidence of coccidiosis to be one of the causes of mortality.

The incidence of coccidiosis studied by Rajkhowa (1996) in a rabbit farm in Meghalaya, India showed both intestinal as well as hepatic infections. Higher rate of infection occurred in rabbits below three months during May to August and the oocyst count ranged from 40,000 to 1,20,000 per gram of faeces. The high rise of infection during May to August was attributed to the favourable humidity and temperature levels for the sporulation of oocysts.

Gurpartap and Khahra (1997) recorded 32.28 per cent of 508 faecal samples of rabbits infected with coccidia in Punjab. The infection reached the peak during the monsoons. *Eimeria magna, E. perforans, E. irresidua, E. media, E. stiedai, E. intestinalis* and *E. coecicola* were the species recorded in the decreasing order of frequency.

In a survey conducted by Vila Vicosa and Caeiro (1997) in Portugal, the *Eimeria* spp. found in rabbits were identified as *E. intestinalis, E. irresidua, E. magna, E. perforans, E. media, E. piriformis* and *E. stiedai.*

The prevalence of *Eimeria* spp. among domesticated rabbits in Maiduguri, Nigeria was investigated by Biu and Nwosu (1998). Faecal sample examination of 305 slaughtered rabbits showed a prevalence of 31.9 per cent of infection. Nine species of *Eimeria* were recorded and they were *E. perforans, E. media, E. stiedai, E. neoleporis, E. intestinalis, E. piriformis, E. magna, E. exigua* and *E. elongata.*

The preliminary report on coccidiosis in wild rabbits in Western Australia by Hobbs and Twigg (1998) indicated the presence of ten species of *Eimeria* viz., *E. exigua, E. perforans, E. intestinalis, E. piriformis, E. media, E. flavescens, E. magna, E. stiedai, E. irresidua* and *E. coecicola* in the order of decreasing prevalence.

Subsequent studies made by Jithendran *et al.* (1998) in four commercial rabbit farms in Kangra Valley, Himachal Pradesh revealed that 82 per cent of the infected animals harboured two to four eimerian species. *Eimeria magna, E. perforans* and *E. media* were the predominant species, while *E. irresidua, E. stiedai, E. intestinalis, E. piriformis* and *E. coecicola* were found in lesser frequency. Among the 202 rabbits that died during the course of the study, 76 had clinical coccidiosis. It was found that the overall mortality rate was greater in weaners than in growers and adults.

Raji and Oladele (1998) conducted a retrospective study over ten years on the prevalence of the bacterial flora and diseases of rabbits in Zaria, Northern Nigeria and opined that coccidiosis was one of the most common and

important diseases of rabbits in that area with a prevalence rate of 18.74 per cent.

Suchitrasena *et al.* (1998) studied the incidence and epizootiology of coccidiosis in rabbits in and around Hyderabad. Out of 535 faecal samples, 231 were found positive for coccidia showing an overall incidence of 43.17 per cent. A higher incidence of coccidiosis was observed in rabbits below three months followed by those of three to six months of age. Lower incidence was found in females (41.43 per cent) when compared to male rabbits (45.26 per cent). The infection was more in local breeds than in crossbreeds and purebreeds.

Toula and Ramadan (1998) examined faecal samples of 100 domestic rabbits in Jeddah, Saudi Arabia and identified five species of *Eimeria* viz., *E. perforans, E. magna, E. stiedai, E. exigua* and *E. piriformis.* The overall prevalence rate was 90 per cent.

In a survey by Balicka-Ramisz (1999), nine species of coccidia were identified with *E. perforans* (93.3 per cent) being the most predominant one from 3375 NewZealand white rabbits on a rabbit farm in Poland.

Hobbs *et al.* (1999) did not observe any difference in the severity of infection of eight species of *Eimeria* in male and female rabbits. But seasonal differences were detected in the oocyst counts of *E. flavescens* and *E. stiedai.* The overwhelming determinant of heavy oocyst count was found to be the ... of the host age with six species being much more abundant in rabbits below four months.

Musongong and Fakae (1999) detected the prevalence of *E. stiedai* infection as 37.4 per cent out of the 131 livers examined in local domestic rabbits in Eastern Nigeria.

Al-Sadi and Al-Khafaji (2000), who investigated on the naturally occurring diseases of rabbits in Mosul, Iraq, noted the prevalence of both hepatic and intestinal coccidiosis caused by *E. stiedai* and *E. magna, E. media, E. intestinalis* and *E. irresidua* respectively.

A preliminary report on *E. matsubayashi* in rabbits in Yugoslavia has been given by Tambur *et al.* (2000). The species identified from 520 faecal samples included *E. flavescens, E. magna, E. neoleporis* and *E. media.*

2.2 Description of *Eimeria* spp. in rabbits

2.2.1 Eimeria coecicola

This was first identified by Carvalho in 1942.

Pellerdy (1965) described the oocysts as subcylindrical in shape narrowing slightly towards the micropyle. The oocyst wall was smooth, yellow in colour and the size of oocysts were 32.8 to 44.3 μ by 15.7 to 22.8 μ. Sporulation occurred in 50 to 75 h.

According to Flynn (1973), oocysts were ovoid, smooth and yellow, measured 25 to 40 μ by 15 to 21 μ with a micropyle and a residuum. There was no polar granule. The sporocysts were 17.1 μ by 8 to 9 μ in size, ovoid in shape with a stieda body. Oocyst sporulation time was noticed to be 72 h.

2.2.2 *Eimeria exigua*

Yakimoff was the first to report on the species *E. exigua* in 1934. According to Yakimoff, the oocysts were round or ovoid in shape and measured 10 to 18 μ by 9 to 16 μ. The wall was smooth and no micropyle was visible. It lacked an oocystic residuum.

2.2.3 *Eimeria flavescens*

This species was first described by Marotel and Guilhon in 1941. According to Catchpole and Norton (1979) these oocysts were ovoidal in shape with a wide micropylar end and lacked an oocyst residuum. The oocysts measured an average of 32.1 μ by 21.4 μ and the sporocysts measured an average of 14.6 μ by 8.4 μ.

2.2.4 *Eimeria intestinalis*

The oocyst of this species was first identified by Cheissin in 1948.

Pellerdy (1965) described the oocyst as pear shaped or oblique, which measured 23 to 30 μ in length and 15 to 20 μ width. Oocyst wall was smooth and yellowish. Micropyle was present at the tapering anterior end. Oocystic residual body was also present. Sporulation time was noted as 24 or 48 h.

According to Flynn (1973) the oocysts were piriform, smooth, yellow and 21 to 36 μ by 15 to 21 μ with a micropyle and a residuum but no polar granule. Sporocysts were elongated and ovoid. Sporulation time was noticed to be 24 to 48 h.

2.2.5 Eimeria irresidua

This species was identified by Kessel and Jankiewicz in 1931.

According to Pellerdy (1965), oocysts were ovoid in shape and were found to be the largest rabbit coccidia with an average size of 38.3 μ by 25.6 μ. The oocyst wall was smooth. Sporulation was complete in 48 to 60 h.

Flynn (1973) described the oocysts as ovoid and smooth, 38 by 26 μ in size with a prominent micropyle but no polar granule or residuum. Sporocysts were ovoid and contained a stieda body and a residuum. Oocyst sporulation time was noticed to be 48 to 60 h.

2.2.6 Eimeria magna

The oocysts of this species were first recognized by Perard in 1925.

Pellerdy (1965) described the oocyst as ovoid-ellipsoidal with truncated anterior end. A broad micropyle was present with a collar like protrusion formed by the outer layer of the wall. The oocysts measured 31 to 40 μ by 22 to 26 μ. Sporulation was complete in 62 to 72 h.

According to Flynn (1973) the oocysts were ovoid or ellipsoidal, smooth, orange-yellow and measured 27 to 41 μ by 17 to 29 μ. Micropyle was large, surrounded by shoulders. Sporocysts were ovoid with a stieda body and sporocystic residuum. Sporulation time was found to be 48 to 72 h.

2.2.7 Eimeria matsubayashi

First identified by Tsunoda in 1952. According to Pellerdy (1965) the oocysts were broad ovoid in shape measuring 24.8 μ by 18.2 μ. The wall was smooth and transparent. Sporulation completed in 32 to 40 h.

Flynn (1973) described the oocysts as broadly ovoid, measuring 22 to 29 μ by 16 to 22 μ with a micropyle and a residuum. Sporocysts were ovoid and contained a residuum.

2.2.8 Eimeria media

Eimeria media was first described by Kessel in 1929.

Pellerdy (1965) described the oocyst as ovoid with a somewhat truncated anterior end and a micropyle. They were 27 to 36 μ by 15 to 22 μ in size. The wall was smooth, light pink in colour, uniformly thick narrowing towards the micropyle. Sporocystic residual bodies were also elongated in shape. Sporulation was complete within 52 h.

According to Flynn (1973) the oocysts were ovoid, smooth and 19 to 33 μ by 13 to 21 μ with a micropyle and residuum. There was no polar granule. Sporocysts were elongate and ovoid with a stieda body and a residuum. Oocyst sporulation time was observed to be 48 h.

2.2.9 Eimeria nagpurensis

According to Flynn (1973) the oocysts were barrel shaped, colourless or yellow and measured 20 to 27 μ by 10 to 15 μ. The oocyst wall was thin with no micropyle or residuum.

Peeters *et al.* (1981) described *E. exigua, E. nagpurensis* and *E. perforans* as a single species. Morphological differences were insufficient to differentiate them.

2.2.10 Eimeria neoleporis/E. elongata

Flynn (1973) described the oocysts as ellipsoidal and measured 35 to 40 μ by 17 to 20 μ. The oocyst wall was thin and a broad micropyle was present. Polar granule and residuum were absent.

2.2.11 Eimeria perforans

Leuckert in 1879 described this species as *Coccidium perforans* but a correct description enabling differentiation was given by Kessel and Jankiewicz in 1941.

Pellerdy (1965) described the oocysts as ellipsoidal rather than ovoid in shape. They measured 15 to 29 μ by 11 to 17 μ. The rounded pole on both sides were fairly equal. Sporulation was complete in 56 h.

According to Flynn (1973), the oocysts were ovoid, smooth and measured 24 to 30 μ by 14 to 20 μ. There was no micropyle or polar granule.

Sporocysts were ovoid and contained a stieda body and a residuum. Sporulation time was 48 h.

2.2.12 Eimeria piriformis

The species *E. piriformis* was identified by Kotlan and Pospesch in 1934. Pellerdy (1965) described the oocysts as pear shaped and they measured 26 to 32 μ by 17 to 21 μ. The oocyst wall was light yellowish brown, smooth with double contours. A prominent micropyle was visible at the tapering end. Sporulation occurred in 24 to 48 h.

According to Flynn (1973), the oocysts were ovoid, smooth, yellow brown and 26 to 32 μ by 17 to 21 μ, with a micropyle but no polar granule or residuum. Oocyst sporulation time was 48 h.

2.2.13 Eimeria stiedai

This species was first described by Lindemann in 1865 and later by Kisskalt and Hartmann in 1907.

Pellerdy (1965) described the oocysts as narrow oval in shape with indistinct micropyle at the anterior end. Oocysts measured 30 to 40 μ by 16 to 25 μ. Sporulation was complete in 48 to 72 h.

According to Flynn (1973), the oocysts were ovoid or ellipsoidal and measured 28 to 40 μ by 16 to 25 μ. A flat micropylar end was noted with a smooth salmon coloured wall. There was no polar granule or residuum. Sporocysts were ovoid with a stieda body and a residuum.

2.3 Pathology

2.3.1 Clinical signs

Ostler (1961) reviewed the diseases of broiler rabbits and found that there were only slight symptoms in hepatic coccidiosis during the prepatent period after which the appetite decreased with loss of condition, pot belly and death in five weeks after infection. It was seen that the intestinal coccidia infected rabbits died with no premonitory symptoms except diarrhoea which was profuse and watery initially that turned mucoid later.

Hoffman *et al.* (1973) noticed that the presence of intestinal *Escherichia coli* infection aggravated the coccidial infection in young rabbits while Coles (1986) described the reasons for anaemia in coccidiosis.

Sanyal and Srivastava (1986) carried out an investigation to assess the magnitude of subclinical coccidiosis in rabbits. They observed that in commercially reared rabbits, coccidiosis occurred in a subclinical form with growth retardation and altered feed conversion whereas in domestic rabbitries a clinical disease characterised by anorexia and mortality was seen.

Cheema *et al.* (1990) reported an outbreak of hepatic coccidiosis from an experimental rabbit colony in Islamabad. The main symptoms included anorexia, diarrhoea, reluctance to move and death in three to four days.

Ong and Nazira (1990) reported on mortality of rabbits following diarrhoea, listlessness and slight distension of the abdomen in hepatic coccidiosis.

According to Sanyal and Sharma (1990), experimental infection of 10^5 oocysts of *E. stiedai* proved lethal to the rabbits. No clinical symptoms were detected but all the infected rabbits succumbed to the infection exhibiting only lethargy and unthriftness just before death.

Pillai and Subramanian (1993) reported emaciation and varying degrees of diarrhoea mixed with mucus in cases of intestinal coccidiosis in rabbits.

Clinical findings noted by Raj Khowa (1996) in rabbits below three months of age with intestinal coccidiosis, included anorexia with rough hair coat, weakness, retarded growth, bloating, diarrhoea and dysentery while in hepatic coccidiosis the liver was enlarged and palpable. Mixed infection with hepatic and intestinal species was also found to result in retarded growth and rough hair coat.

Sena *et al.* (1997) noted a reduction in the counts of PCV, Hb and erythrocytes and an increase in the total leucocyte count in rabbit coccidiosis. Decreased serum glucose and total serum proteins and albumin levels were also recorded.

Experimental infection of rabbits with $2x10^5$ to $4x10^5$ sporulated oocysts of intestinal coccidia resulted in a subclinical form of coccidiosis with symptoms like polydypsia, bristling hair and weight loss (Tambur *et al.*, 1998).

Clinicopathological studies conducted by Jithendran and Kurade (2001) on induced *E. magna* infection in adult New Zealand White rabbits produced a refractory infection without affecting the general health of the host, following

the administration of 10^5 sporulated oocysts. The characteristic symptoms of the infection during the patent period were loose faeces with oocysts and a slight loss of weight.

2.3.2 Gross and histopathology

Weisbroth *et al.* (1974) opined that the death of parasitized epithelial cells resulted in ulceration which were manifested grossly as multiple white areas in the intestinal wall.

Prescott (1978) reviewed the intestinal disorders and diarrhoea in rabbit and found that in intestinal coccidiosis, the pathological changes included dilatation of the duodenum and paleness of the jejunum and ileum together with white foci in the mucosa. Coccidial stages were present in the jejunum, ileum and caecum and nest of the organisms frequently involved the whole villi. Thickening of the caecal wall with greyish white necrotic areas were the postmortem lesions in rabbit coccidiosis as described by Soulsby (1982).

A detailed study was carried out by Krishna and Vaid (1987) on the necropsy of coccidia infected rabbits. According to them, soiling of the hind quarters around the anal region with blood mixed faeces was a common appearance. Subcutaneous blood vessels revealed moderate engorgement and the lungs, congestion and patchy areas of emphysema. Heart showed a rounded appearance with gelatinous fat. Liver usually had moderate congestion with the presence of greyish white pin head sized areas. Stomach and intestines were congested with diffused areas of haemorrhages in ileum and caecum along with thick slimy material mixed with blood. Smears prepared from the intestinal mucosa and from the blood mixed slimy material revealed presence of large number of coccidial oocysts in varying stages of development.

Histopathologically, the sections of intestines revealed characteristic lesions of intestinal coccidiosis along with presence of large number of macro and microgamonts and oocysts in the epithelial cells of the mucosa.

Cheema *et al.* (1990) recorded an enlarged liver with irregular whitish nodules in hepatic coccidiosis on necropsy. The bileducts were dilated with extensive proliferation of the biliary epithelium. Schizonts and oocysts of *E. stiedai* were observed in the epithelial cells and the bile ducts.

Haemorrhagic gastroenteritis, mucoid enteritis, whitish nodules in the liver, hepatomegaly, enlarged gall bladder and bloat were observed by Okewole (1990) in coccidia infected rabbits below four months of age.

Sanyal (1991) who studied the hepatic pathology in *E. stiedai* infection in domestic rabbits found a tenfold increase in the weight of livers in infected group along with yellowish white nodules scattered over the surface of liver. Microscopically these lesions consisted of proliferating biliary epithelia, developmental stages of coccidia with periportal fibrosis and degenerative changes of hepatocytes.

Wang and Tsai (1991) observed numerous scattered white nodules about 0.1 to 0.5 cm in diameter on the liver surface and dark greenish mucoid exudate in the intestinal lumen in rabbits with hepatic coccidiosis. Histopathological lesions comprised of hyperplasia of the bileduct epithelium with different developmental stages of coccidia. Granulomatous tissues were seen encircling

the bile duct with infiltration of inflammatory cells. Oocysts could also be seen in the lumen of bile duct.

Pillai and Subramanian (1993) observed that the intestines of dead rabbits were oedematous, inflammed and hyperaemic with greyish white foci on the mucosa. Histopathological examination revealed thickening of the intestine due to moderate hypertrophy of the villi and the presence of various endogenous stages in the epithelial cells.

Extension of catarrhal enteritis from the small intestine to the large intestine with greyish white discolouration of caecum and necrotic areas in the superficial mucosa were some of the autopsy findings pointed out by Rajkhowa (1996) in intestinal coccidiosis. In hepatic coccidiosis liver was enlarged and bile duct dilated with formation of whitish nodules on the surface of the liver.

Necropsy studies in rabbits experimentally infected with intestinal coccidia by Tambur *et al.* (1997) revealed catarrhal haemorrhagic enteritis. They also noticed that the intestinal mucosa was reddish, oedematous and covered with mucus. Microscopically, developmental stages of the coccidia in the intestinal epithelium along the intestinal villi were seen. Blood vessels were congested and erythrocytes were observed in discrete extravasations.

Necropsy examination of infected rabbits with *E. magna* by Jithendran and Kurade (2001) revealed mild to moderate congestion of the intestinal mucosa extending from the duodenum to the caecum. Microscopic lesions were proliferative changes in the epithelial lining of intestine and presence of

intraepithelial coccidial oocysts. The tips of villi also showed necrotic changes and the lamina propria was infiltrated with mononuclear cells.

2.4 Treatment

2.4.1 Sulphadimidine

Davies *et al.* (1961) recommended the use of 0.2 per cent solution of sulphadimidine continuously in the drinking water for 24 days for controlling hepatic coccidiosis. Sulphaquinoxaline in food or water at 0.1 per cent for 14 days was also acclaimed to be effective against intestinal coccidiosis.

Satyanarayana *et al.* (1982) administered sulmet (sulphadimethyl pyrimidine 12.5 per cent solution) at 18 ml per litre of water for the first two days followed by 3 ml per litre to rabbits infected with hepatic coccidiosis and found it to be effective.

The activity of sulphaquinoxaline, robenidine, methylbenzoquate, clopidol and a mixture of methylbenzoquate and clopidol (Lerbek) was studied by Joyner *et al.* (1983) in rabbits infected with hepatic coccidiosis. Only sulphaquinoxaline (250 ppm) and Lerbek gave satisfactory control of this infection. It was found that sulphaquinoxaline totally controlled the oocyst production and no further oocysts were produced even after the drug was withdrawn.

Bautista (1986) experimentally infected rabbits with *E. stiedai* and studied the activity of a mixture of sulphadimethoxine and pyrimethamine as

prophylactic and therapeutic medication. All the parameters studied showed that the chemotherapeutic medication provided efficient control of the infection. According to Jacob (1987) oocysts of sulpha treated animals failed to sporulate.

Krishna and Vaid (1987) found that the treatment with Neftin and sulphamethazine in water reduced the morbidity and mortality amongst intestinal coccidia infected rabbits.

Meitei *et al.* (1989) treated intestinal coccidiosis in rabbits with sulphadimidine (500 mg per kg body weight) daily for eight days and found a significant reduction in the oocyst count and increase in body weight. Levels of haemoglobin and packed cell volume were found to improve after the treatment.

Cheema *et al.* (1990) administered sulphadimidine in feed at a concentration of 0.2 per cent for three days to rabbits infected with hepatic coccidiosis. The oocysts disappeared from the faeces on the third day post treatment and were not recorded thereafter.

Okewole (1990) recommended the use of sulphaquinoxaline at the rate of 13.2 mg per kg body weight in water to be effective to control the outbreak of coccidiosis.

D'Souza *et al.* (1992) reported that sulphadimidine at the rate of 500 mg per kg body weight orally for eight days was effective against rabbit coccidiosis as prophylaxis.

The same scientists (1993) carried out therapeutic trials and opined that a combination of sulphadiazine (1 g) and trimethoprim (0.5 to 1.0 g) per litre of water for five days was also found to be effective against rabbit coccidiosis.

Pillai and Subramanian (1993) used sodium sulphaquinoxaline at a concentration of 0.05 per cent for a period of five days for the successful control of coccidial infection in rabbits.

Rajkhowa (1996) reported the usefulness of sodium sulpha-dimethyl pyrimidine (12.5 per cent w/v) at dose of one millilitre per kg body weight on the first day followed by 0.5 ml per kg body weight for next three days in controlling rabbit coccidiosis. Preventive medication at a dose rate of 60 ml per four litres of water was adopted and no clinical outbreak was reported.

Sena *et al.* (1997) studied the efficacy of various coccidiostats and reported sulphaquinoxaline sodium (125 mg per kg body weight for two periods of three days with a two day interval) as 90 per cent effective against coccidiosis in rabbits.

Laha *et al.* (1999) discussed on the comparative efficacy of sulphadimidine and a combination of amprolium and sulphaquinoxaline in controlling the coccidial infection of rabbits in the hilly regions of India. A sharp decline in the faecal oocyst count was noted in sulphadimidine treated animals. Sulphadimidine was also successful in controlling the infection in rabbits not responding to the treatment with amprolium and sulphaquinoxaline combination.

2.4.2 Furazolidone

Bedrnik and Martinez (1976) studied the effect of various anticoccidials in naturally and experimentally infected rabbits and found furazolidone as ineffective against rabbit coccidiosis.

Balasubramanian *et al.* (1992) successfully treated rabbits with intestinal coccidiosis with furaltadone (10 mg per kg body weight) in drinking water for five days.

Treatment trials undertaken by D'Souza *et al.* (1993) showed that nitrofurazone (25 per cent w/w) and furazolidone (3.6 per cent w/w) compound (Bifuran) one tab in one litre of water brought about a significant reduction in oocyst counts and an apparent improvement in the condition of treated animals despite the report of Adams (1995) on the poor absorption of the drug in animals.

Sena *et al.* (1997) found that rabbits given furaltadone hydrochloride (100 mg per kg body weight daily for seven days) were completely cured of coccidiosis.

2.4.3 Metronidazole

Reshetnyak *et al.* (1970) reported on the highly satisfactory therapeutic control of coccidiosis in rabbits with metronidazole at dose rate of 40 mg per kg body weight. They were able to reduce the clinical signs in both intestinal and hepatic coccidiosis in rabbits.

Trials with 350 and 450 ppm of metronidazole in the feed of coccidia infected rabbits brought about a reduction in the oocyst counts as well as mortality among rabbits (Zhang and Xue, 1990).

Materials and Methods

3. MATERIALS AND METHODS

3.1 Prevalence

Data on the prevalence of coccidiosis in rabbits were collected by random screening of faecal samples of rabbits of the Rabbit Research Station, Mannuthy and those of different rabbit farms in and around Thrissur District and from rabbits brought for postmortem at the Centre of Excellence in Pathology, College of Veterinary and Animal Sciences, Mannuthy during the period from October 2001 to September 2002. Studies related to the effect of age, sex, breed, season and management on the prevalence of coccidiosis were also carried out.

3.2 Diagnosis of infection

3.2.1 Clinical signs

The clinical signs manifested by rabbits suspected for coccidiosis was observed in detail.

3.2.2 Microscopical examination of faecal samples

Faecal samples collected from the rabbits were processed for microscopical examination by standard laboratory techniques viz., sedimentation and floatation.

3.3 Identification of species

The oocyst sporulation time and the morphological characters of both unsporulated and sporulated oocysts (Pellerdy, 1965) were taken as criteria for the identification of species of *Eimeria*.

3.3.1 Determination of sporulation time

Cultures of faecal samples positive for coccidian oocysts were prepared to determine the sporulation time. The oocysts were collected and suspended in two per cent potassium dichromate solution in petridishes and allowed to sporulate at room temperature. Sporulation was aided by aeration at regular intervals using glass pipettes. Drying was avoided by constantly adding potassium dichromate solution. The samples were examined at six hourly intervals daily to determine the sporulation time (Catchpole and Norton,1979).

3.3.2 Morphology and micrometry

The morphological details of the unsporulated and sporulated oocysts were studied under high power and oil immersion objectives. The unsporulated oocysts were examined for the size, shape, colour, texture of oocyst wall and presence or absence of a micropyle. The sporulated oocysts were observed for the sporocyst and sporozoite shapes, presence or absence of steida body, oocystic residuum, sporocystic residuum and polar body (Pellerdy, 1965). Micrometry was done to measure the size of oocysts and a minimum of 30 to 50 oocysts of each type was studied and the average was determined (Catchpole and Norton,1979).

3.4 Pathology

3.4.1 Gross and histopathology

Organs collected from rabbits brought for postmortem were examined to study the gross lesions. Tissues from the liver and contents from the bile ducts and intestines were collected for detection of coccidial oocysts. Portions of liver and intestine showing lesions suspected for coccidiosis were preserved in ten per cent formalin. Tissues were processed and sections of five to six micron size were prepared for histopathological studies after staining with haematoxylin and eosin.

3.5 Analysis of blood parameters

Blood was collected from ten clinically infected animals in sterile vials with EDTA as anticoagulant for the estimation of packed cell volume, haemoglobin, erythrocyte count and total leucocyte count. The haematological values of ten healthy animals were also taken as control.

3.5.1 Packed cell volume (PCV)

Packed cell volume was determined by Wintrobe method using Wintrobe haematocrit tube (Wintrobe, 1974).

3.5.2 Haemoglobin (Hb)

Haemoglobin was estimated by Sahli's acid haematin method (Benjamin,1978).

3.5.3 Erythrocyte count

Red blood cell count was assessed using a haemocytometer and diluting fluid (Benjamin, 1978).

3.5.4 Total leucocyte count

The total leucocyte count was determined as per Benjamin (1978).

3.6 Treatment with anticoccidials

In the present study thirty affected rabbits were identified and divided into three groups of ten animals each. Treatment trials with sulphadimidine, furazolidone and metronidazole were undertaken in these groups respectively.

3.6.1 Sulphadimidine sodium

The first group of animals was treated with sulphadimidine sodium boluses (Pabadine, Sarabhai) @ 200 mg per kg body weight. The drug was administered orally for three consecutive days.

3.6.2 Furazolidone

The second group was administered furazolidone oral suspension (Furoxone, SmithKline Beecham) @ 10 mg per kg body weight orally for five days.

3.6.3 Metronidazole

The third group was given metronidazole oral suspension (Flagyl, Rhone-Poulene) @ 40 mg per kg body weight orally for three days.

3.7 Determination of drug efficacy

The number of oocyst per gram of faeces was detected as per the method described by Bowman (1995). The mean oocyst count of each group determined just before treatment and on day seven post treatment were statistically analysed (Snedecor and Cochran, 1994). The efficacy of the drugs was assessed based on the reduction in the number of oocysts per gram of the faeces on the seventh day after treatment.

Results

4. RESULTS

4.1 Prevalence

A total of 550 faecal samples of rabbits collected from the Rabbit Research Station, Mannuthy and six local rabbitries in and around Thrissur were examined during the period from October 2001 to September 2002. One hundred and two animals were found to harbour coccidial infection indicating a prevalence of 18.54 per cent. Monthwise prevalence of coccidiosis showed maximum infection in August 2002 (81.81 per cent) while a lower prevalence rate was observed during January 2002 (4.8 per cent). The monthwise prevalence is presented in Table 1 and depicted in Fig. 1.

The prevalence of coccidiosis was observed to be higher in young rabbits below three months (76.47 per cent) and it declined significantly with the advancement of age. (Table 2 and Fig. 2).

Coccidiosis was widely prevalent in females (63.72 per cent) than in male rabbits (36.27 per cent) that were examined in the present study (Table 2).

Breedwise prevalence of coccidiosis in rabbits is depicted in Table 3 and Fig.3. From the number of animals examined in each breed the prevalence rates indicated a high infection in New Zealand White (10.9 per cent) followed by Grey Giant (3.63 per cent), Soviet Chinchilla (2.9 per cent) and finally the local/crossbreeds (1.09 per cent).

Seasonwise, the prevalence of coccidial infections in rabbits was found as 46.07 per cent, 12.27 per cent and 10.66 per cent during coldwet South West Monsoon, dry and warm wet North East monsoon respectively (Table 4 and Fig 4).

Prevalence of coccidial infections was more common in traditionally reared domestic rabbitries where the surroundings were damp and humid. Rabbits reared in commercial rabbitries in wire cages and dry environment were apparently healthy.

4.2 Diagnosis of Infection

4.2.1. Clinical signs

In majority of the animals coccidiosis was observed in a subclinical form with growth retardation and reduced feed intake. In such cases the oocyst count per gram of faeces ranged from 5,000 to 30,000 only. Affected rabbits with a low oocyst count did not show any apparent signs. However, the clinically infected animals were characterised by diarrhoea, soiled fur, anorexia and loss of condition,excreting oocysts in a range of 35,000 to 70,000 per gram of faeces.

4.2.2 Microscopical examination of faecal samples

Oocysts of different species of *Eimeria* were detected by microscopical examination of the faecal samples. Sedimentation method alone was employed for the concentration of oocysts as the results were obtained readily.

4.3 Identification of species

Speciation and identification of the various coccidia was done on the basis of sporulation time and oocyst morphology.

4.3.1 Sporulation time

The mean sporulation time for different species of *Eimeria* was found to be two to three days.

4.3.2 Morphology and micrometry

Different species could be identified even before sporulation based on the characteristic shape, size and presence or absence of micropyle of the unsporulated oocyst. But the sporulated oocysts revealed better internal details like presence or absence of oocystic residuum and sporocystic residuum. Six species of intestinal coccidia were recognised. They were *E. media, E. magna, E. perforans, E. coecicola, E. flavescens* and *E. piriformis*. Mixed infections were common. It was found that 96 per cent of the animals carried two to three different species at a time. *Eimeria media* (80 per cent), *E. magna* (86 per cent) and *E. perforans* (86 per cent) occurred most frequently. *E. coecicola* (50 per cent) and *E. flavescens* (15 per cent) were less common and *E. piriformis* (8 per cent) was relatively rare. Some coccidial oocysts were distorted in shape and failed to sporulate. Although tissues from suspected cases of hepatic coccidiosis were collected and examined, no oocysts could be recovered in the present study. The following were the different species of *Eimeria* identified from rabbits. Their distinct morphological characters are furnished in Table 5.

4.3.2.1 *Eimeria coecicola* (Plate 1; Fig.s 1 and 1)

Oocysts were elongate cylindrical in shape narrowing slightly towards the micropyle. Oocyst wall was smooth and had an oocystic residuum. Sporocysts were ovoid in shape. Oocyst mean dimensions were 32 μ by 15 μ. Sporulation time was 36 to 48 h.

4.3.2.2 *Eimeria flavescens* (Plate 1; Fig. 2)

The oocysts were broadly ovoidal in shape with the micropyle at the broad end. Oocystic residuum was absent. Sporocysts were elongate ovoid in shape. Average size of oocysts were 30 μ x 18 μ. Sporulation time was 48 to 72 h.

4.3.2.3 *Eimeria magna* (Plate 1;Fig. 3)

Oocysts were comparatively larger and ovoid-ellipsoidal, smooth and yellowish brown in colour darker than the other oocysts. A prominent large micropyle 6 to 8 μ long was present and surrounded by shoulders or lip like elevations characteristic of *E. magna*. Sporocysts were ovoid, oocystic and sporocystic residuum were present. Average dimensions observed were 35 μ by 20 μ for the oocyst, 2.5 μ thickness for the oocyst wall and 15 μ x 9 μ for the sporocyst. Sporulation time was 48 to 72 h.

4.3.2.4 *Eimeria media* (Plate 1;Fig. 4)

Oocysts were ovoid, smooth with a micropyle and oocystic residuum. There was no polar granule. Sporocysts were elongate ovoid and had a stieda

body and residuum. Mean oocyst size was 27μ by 14 μ, oocyst wall was 2 μ thick and sporocyst size was 10 μ x 6 μ. Sporulation time was 48 h.

4.3.2.5 *Eimeria perforans* (Plate 1;Fig.5)

Oocysts were smaller in size measuring an average size of 23 μ length and 15 μ width. They were colourless, ovoid, smooth with an oocyst residuum. Micropyle and polar granule were absent. Sporocysts were ovoid and contained a sporocystic residuum. Oocyst wall was 2 μ thick and sporocyst size was 10 μ x 6 μ. Sporulation time was 24 to 48 h.

***4.3.2.6 Eimeria piriformis* (Plate 1;Fig.6)**

The oocysts were distinctly pear shaped measuring 25 μ by 17 μ. Oocyst wall was smooth with a prominent micropyle at the tapering end. Oocystic residuum and polar granule were absent. Sporocystic residuum was present. Sporulation time was 48 h.

4.4 Pathology

4.4.1 Gross pathology

The following details were observed on autopsy of rabbits that died of coccidiosis brought to the Centre of Excellence in Pathology, College of Veterinary and Animal Sciences, Mannuthy. Rabbits were emaciated and had varying degrees of diarrhoea. On antemortem examination there was soiling of the hind quarters around the anal region with diarrhoeic faeces (Plate 1; Fig.7). The intestine was thickened, oedematous and the contents mixed with

mucus. Circumscribed greyish white foci were visible on the mucosa. Scrapings from the intestinal lumen revealed oocysts. Variable hyperaemia was also noted. Liver and bile duct did not show any pathognomonic lesion. Scrapings from the bile duct did not reveal any oocyst.

4.4.2 *Histopathology*

Selected regions of intestine were processed for histopathological study. The intestinal sections revealed characteristic lesions of intestinal coccidiosis. Schizonts of various sizes and in various stages of development, gametogonic stages and oocysts could be detected in the intestinal epithelium. The tips of villi showed necrotic changes and desquamation of epithelial cells resulting in villous atrophy and collapse of the glandular mucosa. Inflammatory exudates with necrotic debris could be seen in the lumen (Plate 2; Fig.1). The epithelial lining of the intestine showed proliferative changes and presence of intraepithelial coccidial oocysts (Plate 2; Fig.2). Loss of intestinal epithelium resulted in ulcers. There was moderate infiltration of the lamina propria with mononuclear cells. Scattered areas of congestion and haemorrhage were also noted. The schizonts were oval and filled with merozoites. The undifferentiated gamonts were round to oval with uniform eosinophilic staining and a dot like nucleus (Plate 2; Fig.3). Immature oocysts with plastic granules coalescing to form the oocyst wall were also evident in the epithelial cells (Plate 2; Fig.4).

4.5 Analysis of blood parameters

Haematological parameters were determined in ten naturally infected cases and also in a control group of ten apparently healthy animals. The naturally infected cases comprised of seven subclinical and three clinical infections. Haematological values recorded a significant variation between the clinically infected and apparently healthy animals (Table 6).

4.5.1 Packed cell volume (PCV)

A significant reduction ($P<0.05$) was noticed in the values of packed cell volume of the clinically infected group in comparison with those of the healthy group. The mean values were 29.4 ± 0.96, 39.63 ± 2.57 and 40.95 ± 2.22 in the clinical, subclinical and apparently healthy groups respectively. Variation between the subclinical and healthy groups was not significant.

4.5.2 Haemoglobin (Hb)

Haemoglobin levels were low in the clinically infected group and significantly different ($P<0.05$) when compared to the healthy and subclinically infected groups; the mean values being $6.7 \pm .4$, 7.7 ± 0.49 and 8.6 ± 1.26 respectively.

4.5.3 Erythrocyte Count

A significant reduction ($P<0.5$) was observed in erythrocyte count of clinically infected group when compared to healthy and subclinically infected groups. The mean values were 3.39 ± 0.37, 4.81 ± 0.34 and 5.72 ± 0.46 in the clinically infected, subclinically infected and the healthy groups respectively.

The variation in the erythrocyte counts was nonsignificant in subclinically infected group.

4.5.4 Total leucocyte count (TLC)

Respective mean values of TLC were 9.3 ± 0.46, 8.347± 0.99 and 8.4 ± 0.37 for clinically infected, subclinically infected and healthy groups. The variation between the groups was found to be of no significance.

4.6 Treatment with anticoccidials

Results of the treatment trials with three anticoccidial drugs against coccidiosis are presented in Table 7.

4.6.1 Sulphadimidine sodium

Sulphadimidine sodium was administered orally to rabbits with apparent clinical signs of coccidiosis, at a dose rate of 200 mg per kg body weight for three consecutive days. Out of the ten animals treated with this drug, only three were clinically infected. In all the cases, the oocysts disappeared almost completely after seven days. Clinical signs were reduced and animals regained their health. The drug showed an efficacy of 99.55 per cent in the subclinical cases and 99.8 per cent in the clinical cases.

4.6.2 Furazolidone

Furazolidone was used at a dose rate of 10 mg per kg body weight orally for five days. The drug was tried on two clinically infected and eight subclinically infected animals. The efficacy was evaluated as 88.17 per cent in

the clinical group and 82.8 per cent in the subclinical group. Even though there was a reduction in the oocyst counts, the drug failed to eliminate the infection completely.

4.6.3 Metronidazole

The infected rabbits were treated with metronidazole at a dose rate of 40 mg per kg body weight orally for three days. The treatment group consisted of four clinical cases and six subclinical cases. The efficacy of drug was found to be 65.58 per cent in the subclinical cases and 74.26 per cent in clinical cases. The recovery rate was not satisfactory.

4.7 Determination and comparison of drug efficacy

The mean clearance efficacies of sulphadimidine sodium, furazolidone and metronidazole were found to be 99.68 per cent, 85.48 per cent and 69.92 per cent respectively in the therapy of rabbit coccidiosis.

Comparison of the three drugs with ANOCOVA showed significant difference between sulphadimidine sodium and the other two drugs ($P < 0.05$) (Table 8). There was no significant difference between furazolidone and metronidazole treated groups. Among the three drugs, sulphadimidine sodium was found to be the most effective drug against rabbit coccidiosis in the present study.

Tables

Table 1. Monthwise prevalence of coccidiosis

Month	Number examined	Number positive	Per cent positive
October 2001	30	3	10
November 2001	25	3	12
December 2001	30	4	13.33
January 2002	205	10	4.8
February 2002	58	13	22.41
March 2002	30	5	16.66
April 2002	30	10	33.33
May 2002	30	5	16.66
June 2002	50	15	30
July 2002	30	14	46.66
August 2002	22	18	81.81
September 2002	20	2	10
Total	550	102	18.54

Table 2. Sexwise and agewise prevalence of coccidiosis

Age	No. of males positive	Per cent positive	No. of females positive	Per cent positive	Total number	Per cent
Below 3 months	32	41.02	46	58.97	78	76.47
3-6 months	5	25	15	75.00	20	19.6
6 months and above	0	0	4	100	4	3.92
Total	37	36.27	65	63.72	102	

Table 3. Breedwise prevalence of coccidiosis

Breeds	Number examined	Number Positive	Per cent
New Zealand White	250	60	10.9
Grey Giant	130	20	3.63
Soviet Chinchilla	120	16	2.90
Local/Crossbreds	50	6	1.09
Total	550	102	18.54

Table 4. Seasonwise prevalence of coccidiosis

Season	Month	No. of samples examined	Number positive	Percent
Cold Wet South West Monsoon (heavy rainfall)	June – August	102	47	46.07
Warm Wet North East Monsoon (low rainfall)	September – November	75	8	10.66
Dry	December – May	383	47	12.27

Table 5. Morphology, micrometry and sporulation time of *Eimeria* spp. in rabbits

Species	Shape of oocyst	Mean size of oocyst (µm)	Micropyle	Sporocyst mean size (µm)	Oocystic residuum	Oocyst wall thickness (µm)	Sporulation time (h)	Oocysts per cent distribution
E. coecicola	Elongate cylindrical	32 by 15	Present	--	Present	--	36 to 48	50
E. flavescens	Broadly ovoid	30 by 18	Present	--	Absent	--	48 to 72	15
E. magna	Ovoid ellipsoidal	35 by 20	Present micropyle with lipping	15 by 9	Present	2.5	48 to 72	86
E. media	Ovoid	27 by 14	Present	10 by 6	Present	2	48	80
E. perforans	Ovoid	23 by 15	Absent	10 by 6	Present	2	24 to 48	86
E. piriformis	Pear shaped	25 by 17	Present	--	Absent	--	48	8

Table 6. Haematology of healthy and infected rabbits

Category	Healthy	Infected		't' values	
		Subclinical	Clinical	Healthy	Infected
No. of rabbits examined	10	7	3	10	10
Parameters	Mean ± SE	Mean ± SE	Mean ± SE		
Packed cell volume (%)	40.95 ± 2.22	39.63 ± 2.57	29.4 ± 0.96*	4.72	5.97*
Haemoglobin (g/dl)	8.6 ± 1.26	7.7 ± 0.49	6.7 ± 0.4*	2.66	3.10*
Erythrocyte count ($x10^6/mm^3$)	5.72 ± 0.46	4.81 ± 0.34	3.39 ± 0.37*	2.38	6.5*
Total leucocyte count ($x10^3/mm^3$)	8.4 ± 0.37	8.347 ± 0.99	9.3 ± 0.46	0.77	1.51

* $P<0.05$ (significant)

Table 7. Efficacy of anticoccidials against coccidiosis in rabbits

Drug	Dose	Intensity	No. of animals treated	0 day mean oocyst count ± SE	7th day mean oocyst count ± SE	Clearance efficacy (%)	Mean clearance efficacy (%)
Sulphadimidine sodium	200 mg/kg orally for 3 days	Mild	7	17485.71± 5078.7	78.6 ± 37.6	99.55	99.68
		Severe	3	62333.3± 4255.7	116 ± 44.1	99.81	
Furazolidone	10 mg/kg orally for 5 days	Mild	8	25587.5 ± 2865.5	4400 ± 779.9	82.80	85.48
		Severe	2	59200 ± 2800	7000 ± 500	88.17	
Metronidazole	40 mg/kg orally for 3 days	Mild	6	9733± 1577	3350 ± 718	65.58	69.92
		Severe	4	44000 ±3874	11325 ± 1082.7	74.26	

Table 8. Comparison of drugs using 'ANOCOVA'

Drug & Dose	No. of animals treated	Mean values of OPG in log *	Mean ± S.E of Mean
Sulphadimidine sodium @ 200 mg/kg orally for 3 days	10	1.300^{a}	1.3 ± 0.1177
Furazolidone @ 10 mg/kg orally for 5 days	10	3.431^{b}	3.431 ± 0.1177
Metronidazole @ 40 mg/kg orally for 3 days	10	3.862^{bc}	3.862 ± 0.1177

$P<0.05$

* Means having a common letter are not significantly different.

Figures

Fig 1. Monthwise prevalence of Coccidiosis

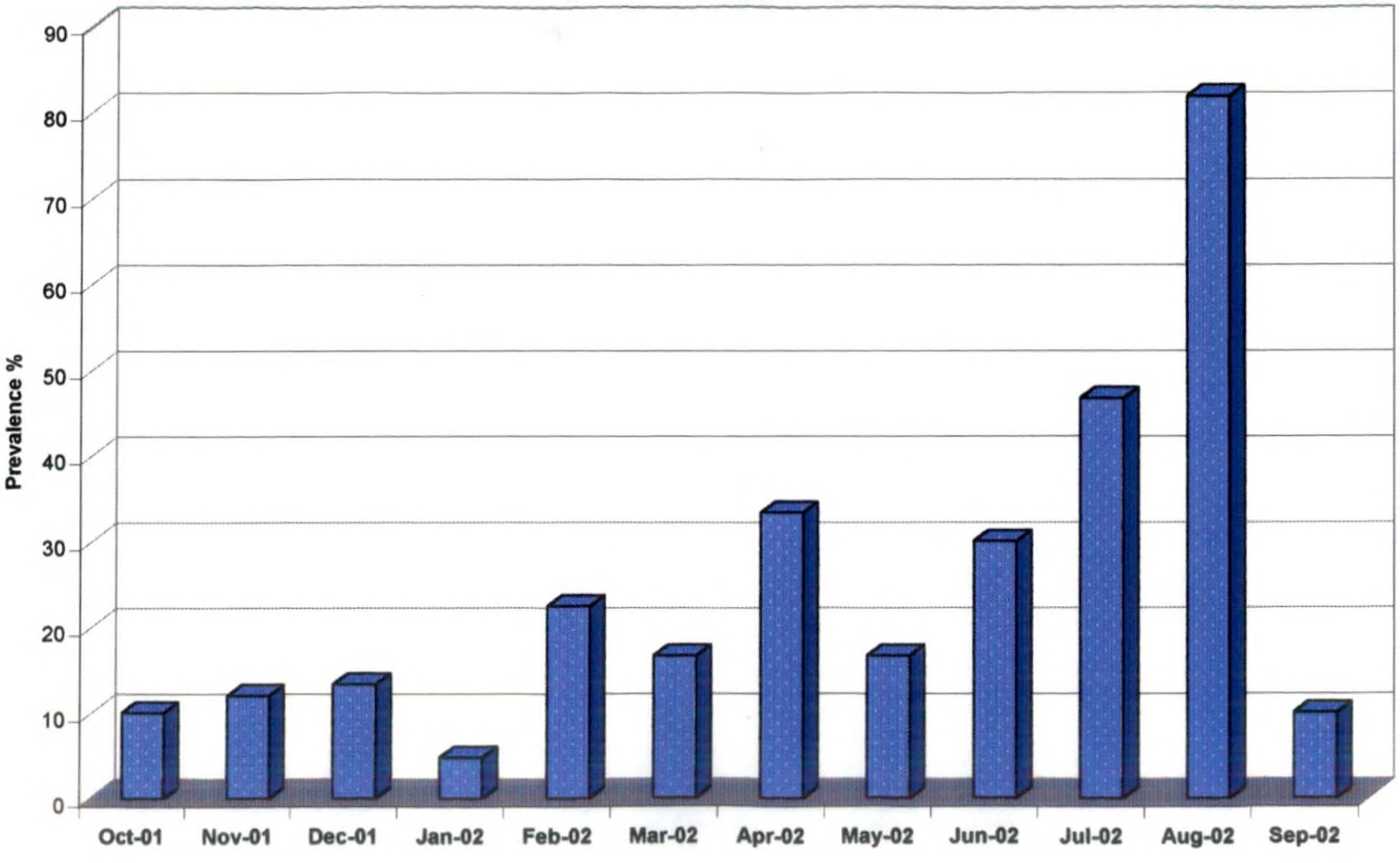


Fig 2. Agewise prevalence of Coccidiosis

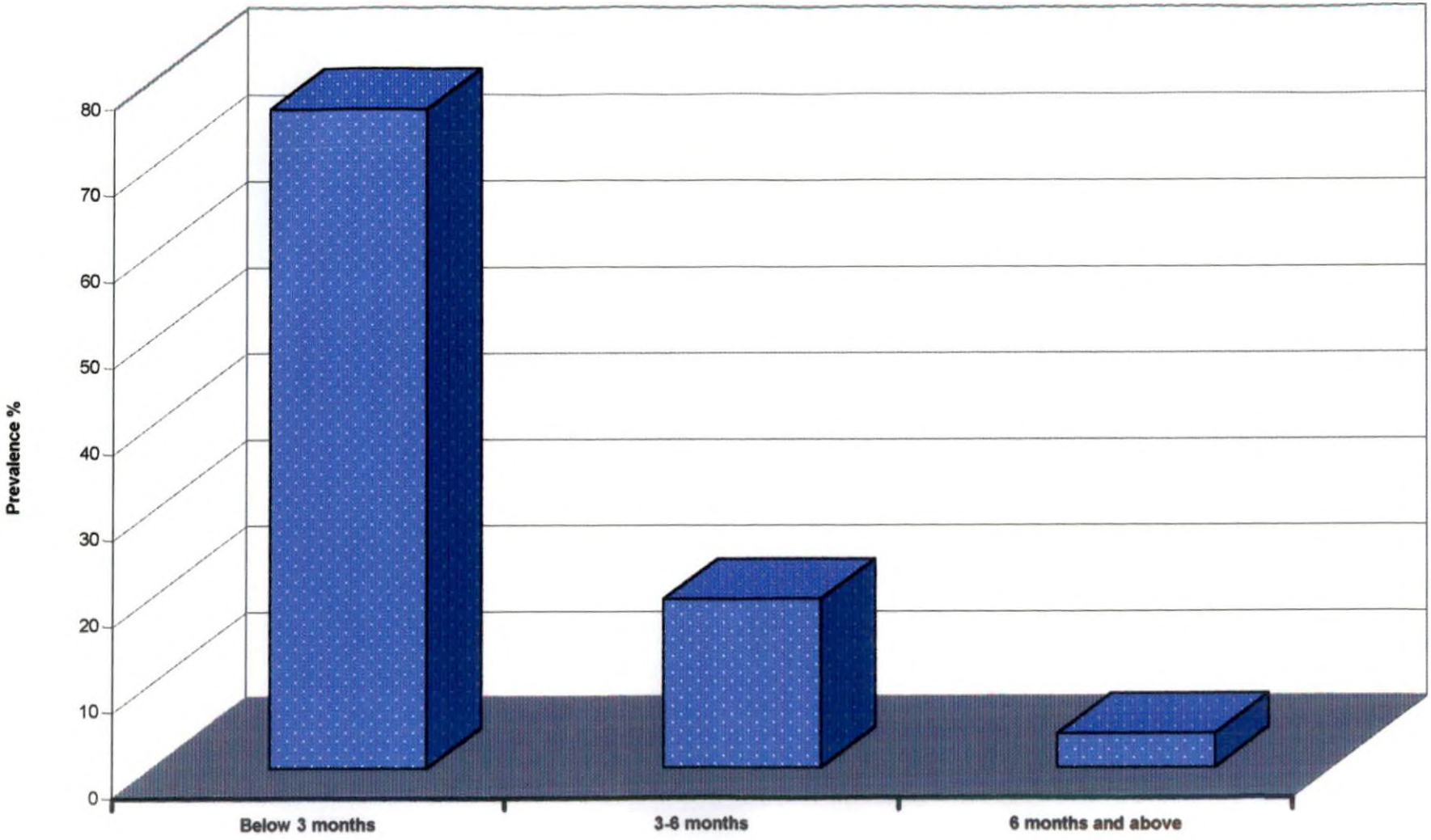


Fig 3. Breedwise prevalence of Coccidiosis

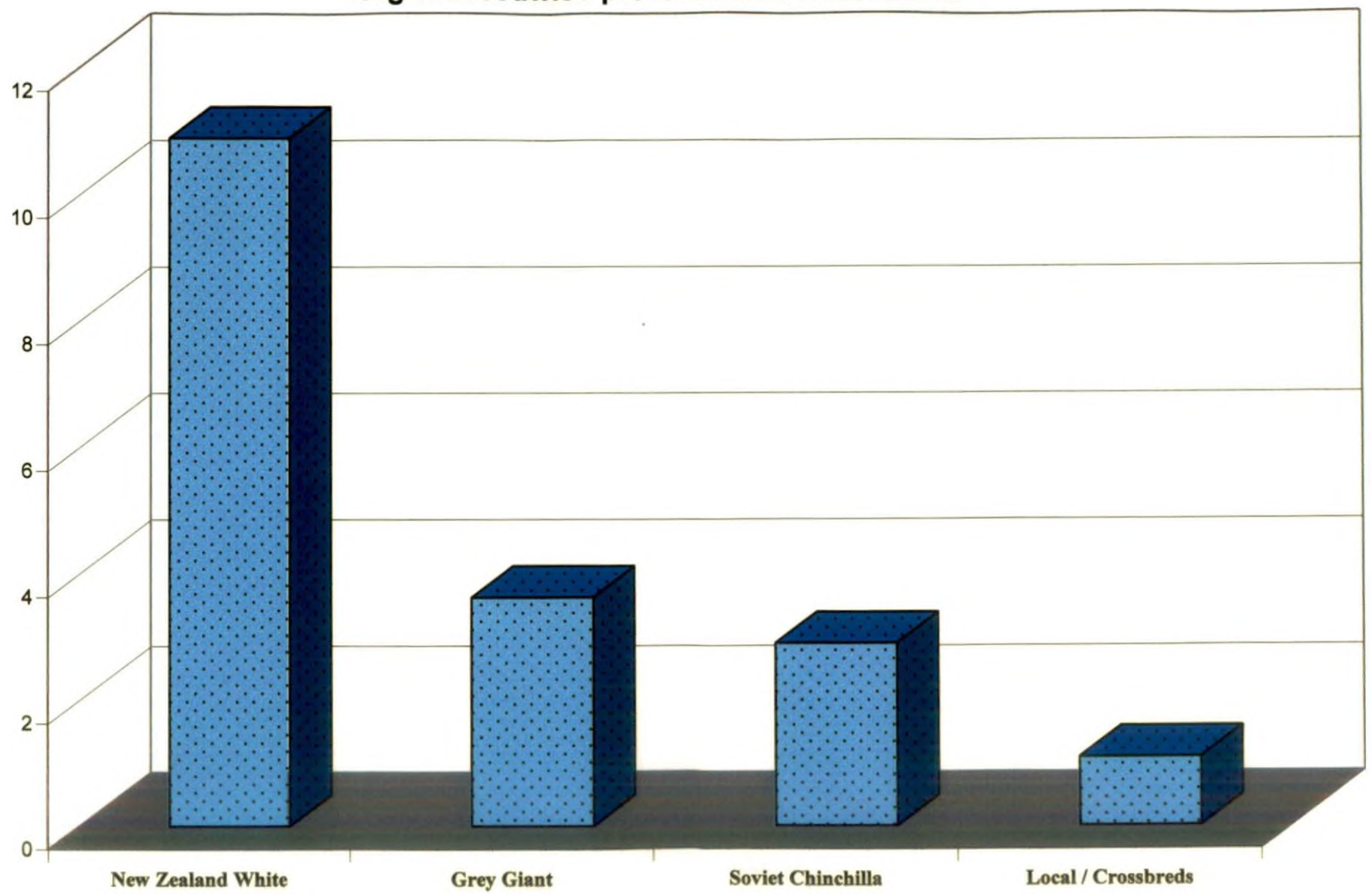
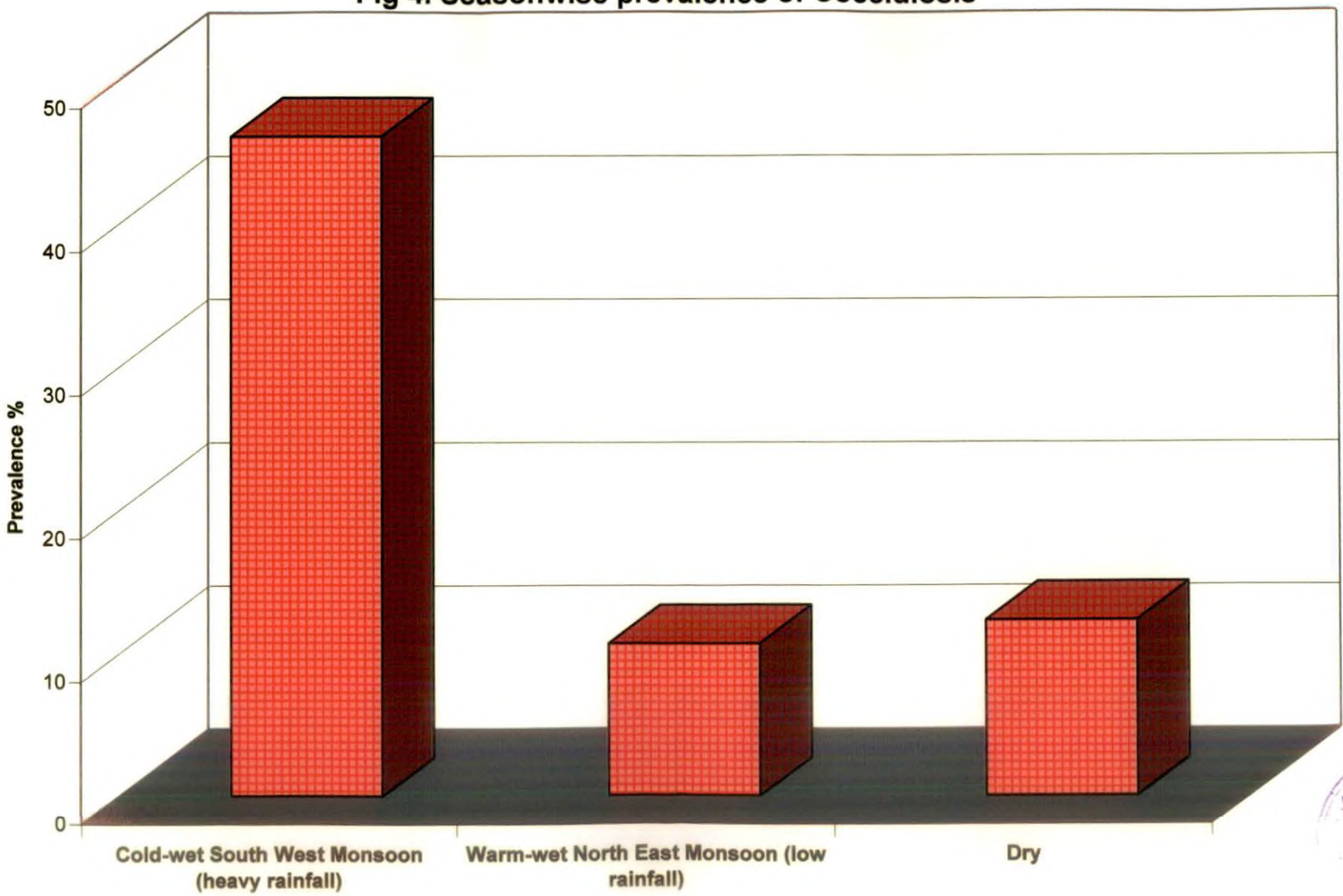


Fig 4. Seasonwise prevalence of Coccidiosis



Plates

Plate 1

Fig.1. Sporulated oocyst of *Eimeria coecicola* ×400

Fig.1.1 Unsporulated oocyst of *Eimeria coecicola* ×400

Fig.2 Sporulated oocyst of *Eimeria flavescens* ×400

Fig.3 Sporulated oocyst of *Eimeria magna* ×400

Fig.4 Sporulated oocyst of *Eimeria media* ×400

Fig.5 Sporulated oocyst of *Eimeria perforans* ×400

Fig.6 Sporulated oocyst of *Eimeria piriformis* ×400

Fig.7 Gross appearance of rabbit died of coccidiosis

Fig. 1

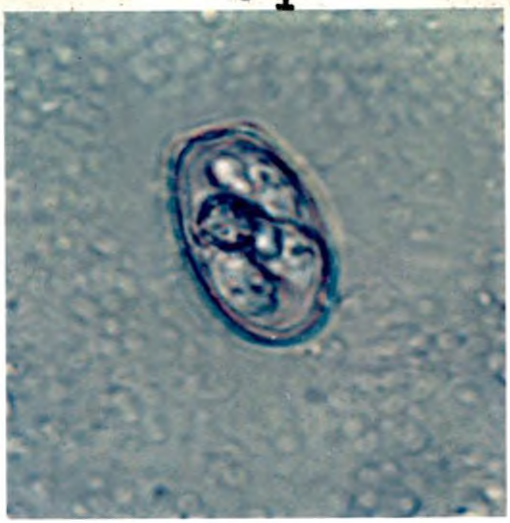


Fig.2

Fig. 1.1

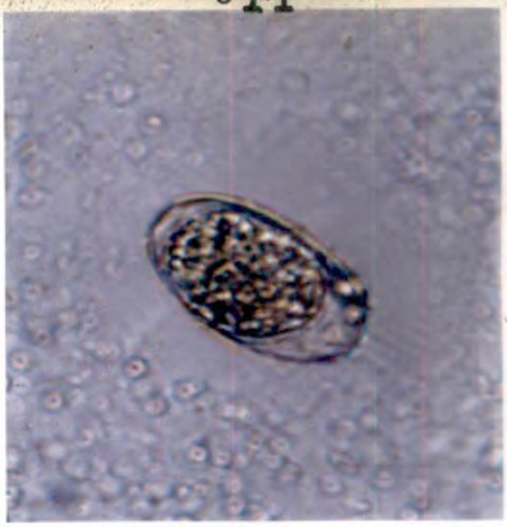


Fig.3

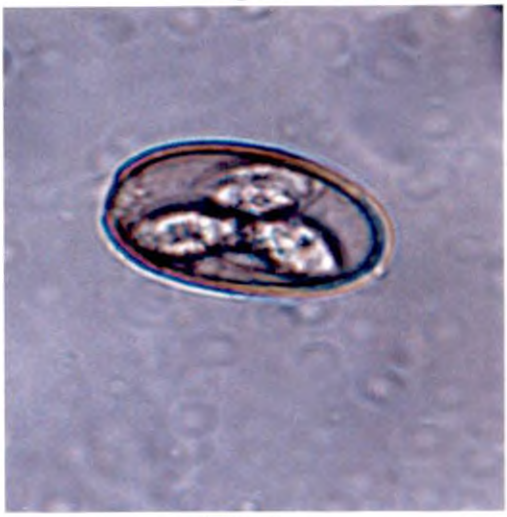


Fig.4

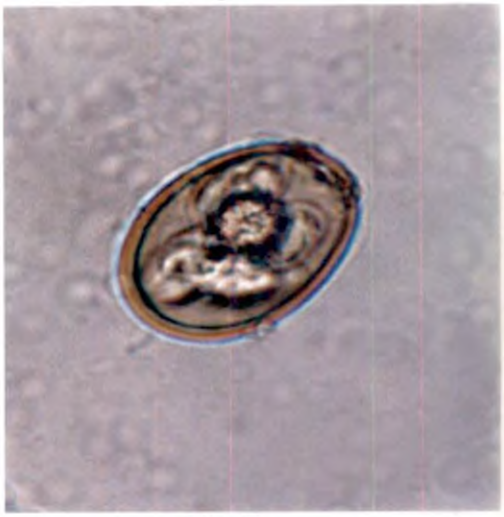


Fig.5

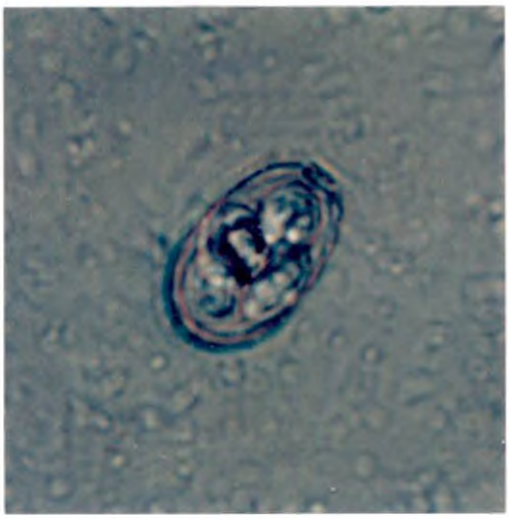


Fig.6

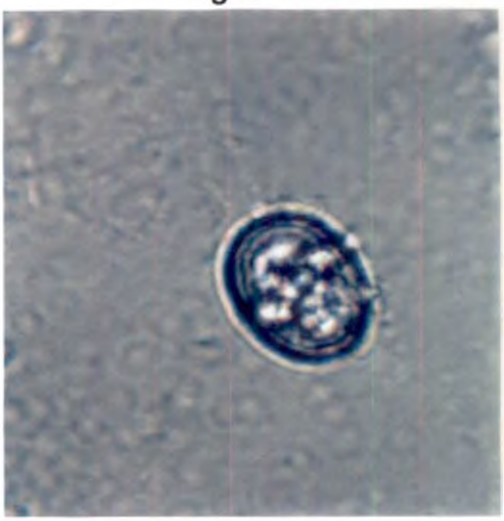


Fig.7

Plate 2

Fig.1 Section of intestine showing schizonts, gametogonic stages and desquamated epithelial cells H&Ex100

Fig.2 Section of intestine showing intraepithelial coccidial oocysts. H&E x400

Fig.3 Section of intestine showing schizonts and undifferentiated gamonts with mononuclear infiltration and haemorrhage. H&E x 400

Fig.4 Section of intestine showing immature oocyst with plastic granules. H&E x 1000

Fig. 1

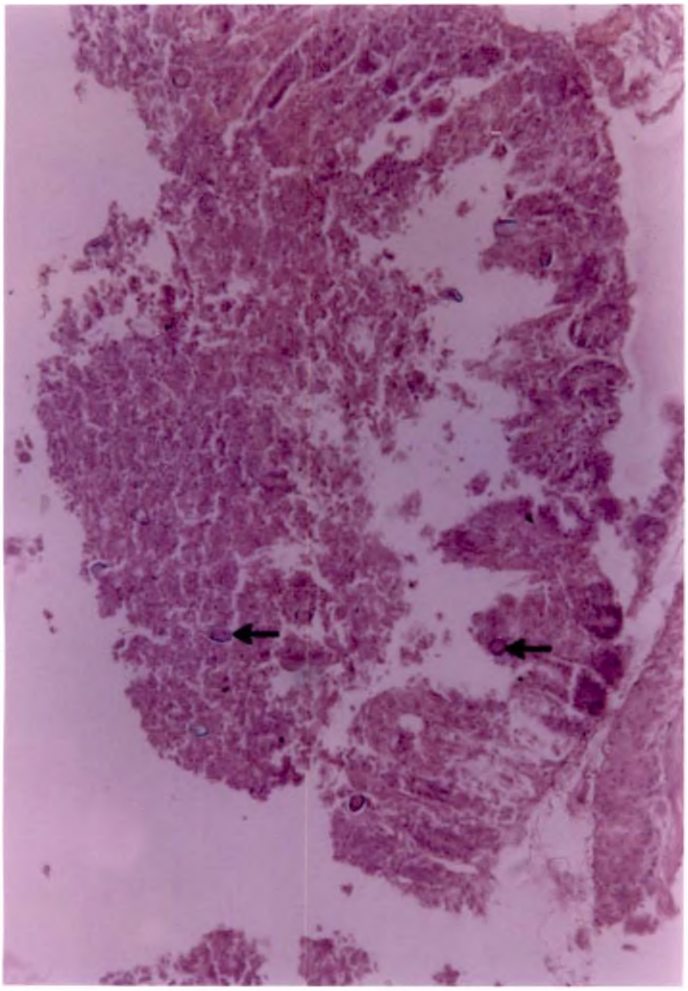


Fig. 2

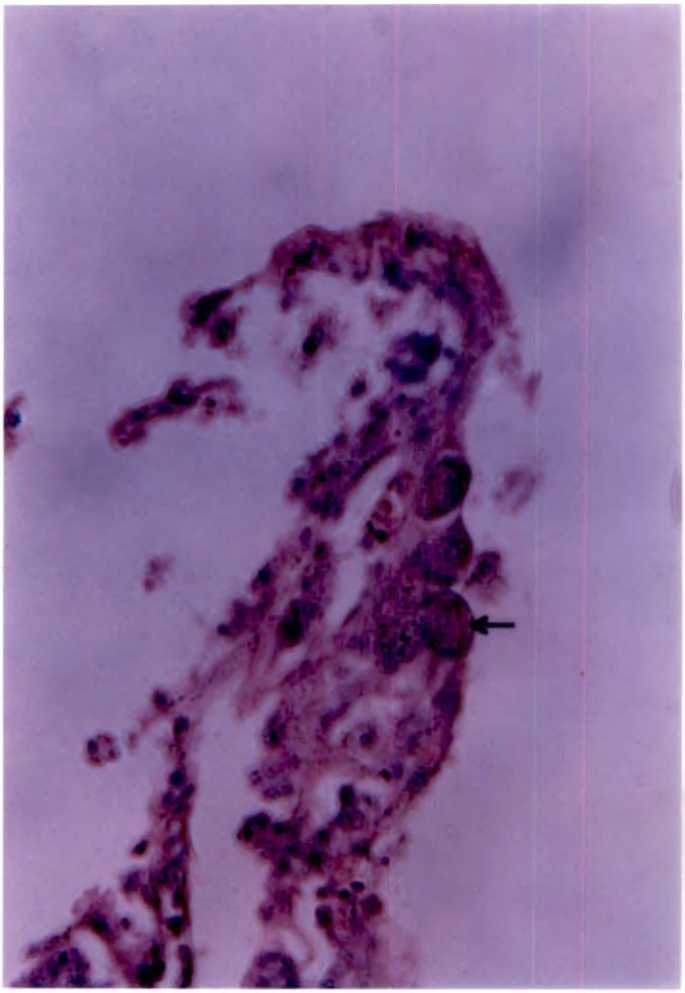


Fig. 3

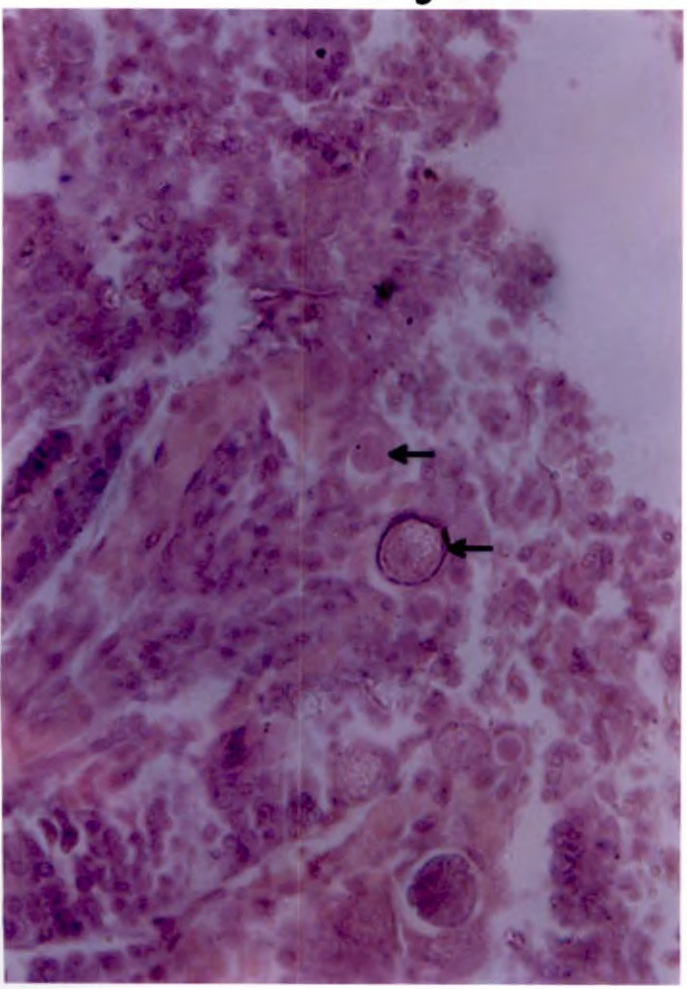
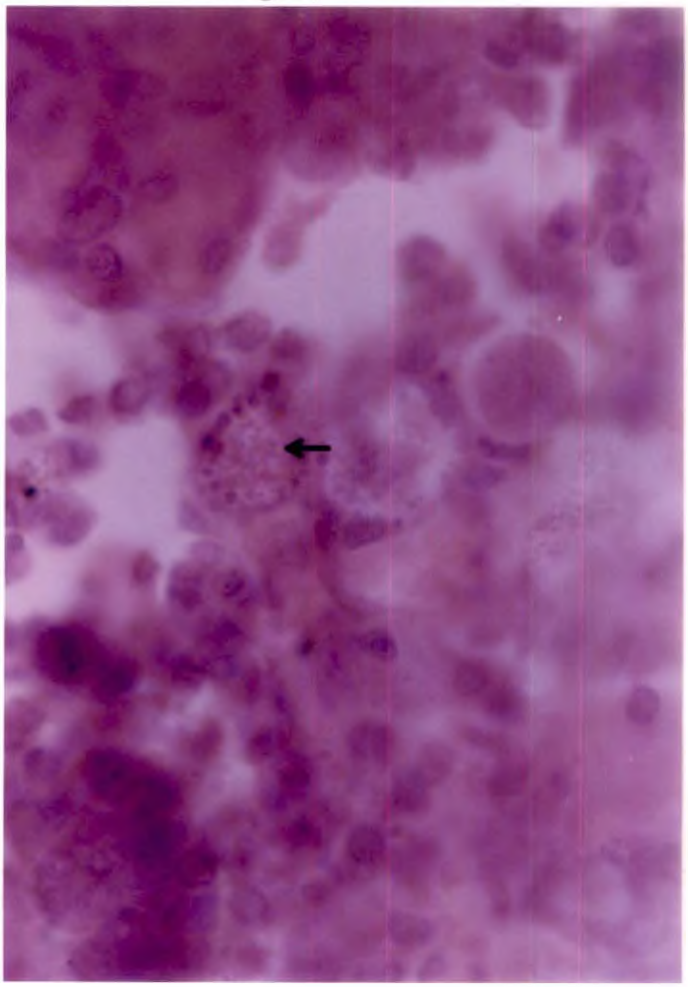


Fig. 4



Discussion

5. DISCUSSION

5.1 Prevalence

Prevalence of coccidiosis in rabbits was found to be 18.54 per cent in the present study showing 102 animals positive for coccidia out of 550 faecal samples screened at the Rabbit Research Station, Mannuthy and six local rabbitries in and around Thrissur round the year. The prevalence of infection was observed to be the highest in August 2002 (81.81 per cent). This high incidence of infection during July to August might be due to the favourable humidity and temperature levels for sporulation of the oocysts during this period and it corraborates with the results of Rajkhowa (1996) who also reported on the rise of infection in areas of high humidity and rainfall.

The prevalence of coccidiosis was found to be high in young rabbits below three months of age. This is in accordance with the studies of Mykytowycz (1962), Rajkhowa (1996) and Suchitrasena *et al.* (1998). High incidence in young rabbits might be due to a lower resistance and also due to the fact that the adult female rabbits usually act as carriers in the farm and transmit the infection to the young ones. Adult rabbits also showed an increased resistance to coccidia - an acquired immunity or a complex of other factors related to the increasing age, described generally as age resistance (Mykytowycz, 1962).

In the present study more number of female rabbits harboured the infection (63.72 per cent) than the males (36.27 per cent). This may be due to

the lesser number of male animals that were available for screening. According to Mykytowycz (1962) who obtained similar results, coccidiosis could be more pronounced during the breeding season when pregnancy causes extra stress on the females. He also claimed that the does produced more oocysts than the bucks. However, the effect of pregnancy on the level of infection in females could not be ascertained in the present study. These findings were contradictory to the observations of Suchitrasena *et al.* (1998) who observed only a slight difference in the infection levels between male (45.26 per cent) and female rabbits (41.43 per cent).

Breedwise prevalence studies revealed highest infection in New Zealand White (10.9 per cent) followed by Grey Giant (3.63 per cent) which concurred with the observations made by Sanyal and Srivastava (1986). The present result may be attributed to the screening of more number of the commonly seen breeds of rabbits in our area, like New Zealand White and Grey Giant.

The cold wet South West Monsoon season recorded higher occurrence (46.07 per cent) of coccidiosis in rabbits denoting the significance of rainfall and dampness for the sporulation of oocysts. This was in accordance with the observations of Meitei *et al.* (1988), Rajkhowa (1996) and Gurpartap and Khahra (1997).

Peeters *et al.* (1981) observed higher incidence of coccidiosis in domestic rabbitries than in commercial rabbitries. Similar results were also noticed in the present study. Rabbits maintained in commercial farms where coccidiostats were regularly given were noticed to be free from the disease whereas nonmedicated domestic rabbits, housed in humid and damp atmosphere developed coccidial infection instantly.

5.2 Diagnosis of infection

In the present study, diagnosis was carried out based on the clinical signs and microscopical examination of faecal samples of suspected animals. In mild cases where the animals were only subclinically affected, the oocyst count ranged from 5,000 to 30,000 per gram of faeces. Affected rabbits did not show any apparent signs except growth retardation and reduced feed intake. This was similar to the reports of Sanyal and Srivastava (1986). In severe cases where the animals were clinically infected, the oocyst count ranged from 35,000 to 70,000 per gram of faeces. Clinically infected animals showed diarrhoea, soiled fur, anorexia and loss of condition. Similar signs were observed by Jithendran and Kurade (2001).

5.3 Identification of species

The species of coccidia infecting rabbits screened in the present study were identified on the basis of sporulation time and oocyst morphology. The average sporulation time was found to be two to three days. This was agreeable with the observation of Sanyal and Srivastava (1986). Some oocysts were

distorted in shape and failed to sporulate. This was seen in rabbits which were administered coccidostats as prophylactic medication. Similar finding was noticed by Jacob (1987) in goats treated with sulpha (SULMET).

The morphological features of oocysts of various *Eimeria* spp. identified in the present study were more or less similar to those described by several earlier workers.

Elongate cylindrical shape and other morphological characters of *E. coecicola* obtained in the present study concurred with the descriptions made by Flyyn (1973) and Catchpole and Norton (1979).

The morphological characteristics of *E. flavescens* observed in the present study were in agreement with the reports of Catchpole and Norton (1979).

The oocysts of *E. magna* showed similar morphology as observed by Pellerdy (1965) and Catchpole and Norton (1979).

The morphological characteristics of *E. media* observed in the present study were similar to the reports of Catchpole and Norton (1979) and Soulsby (1982).

The oocysts of *E. perforans* were the smallest ones identified in the present study. The morphology of the oocysts was agreeable with the details compiled by Catchpole and Norton (1979) and Peeters *et al.* (1981).

Typical pear-shaped oocysts of *E. piriformis* obtained in the present study were similar to those noted and reported by Pellerdy (1965) and Catchpole and Norton (1979).

5.4 Pathology

5.4.1 Gross pathology

In the present study, the coccidia infected rabbits were emaciated and diarrhoeic with soiling of the hind quarters. Intestinal mucosa revealed greyish white foci and the intestine was thickened and oedematous. These were comparable to the findings of Krishna and Vaid (1987). Similar observations were made by Pillai and Subramanian (1993) who also noticed oedematous, inflammed intestine with greyish white foci on the mucosa of affected rabbits. These greyish white foci on the intestinal mucosa was due to the accumulation of the schizogonic stages of the organisms (Pellerdy, 1965; Weisbroth *et al.*, 1974 and Soulsby, 1982).

5.4.2 Histopathology

In the present study, the intestinal sections revealed various endogenous stages of coccidia in the epithelial cells microscopically. Active inflammatory reaction with infiltration of mononuclear cells was observed. Scattered areas of congestion and haemorrhage was noted. These findings were more or less similar to those of Krishna and Vaid (1987), Pillai and Subramanian (1993) and Jithendran and Kurade (2001).

5.5 Analysis of blood parameters

The present study indicated significant alterations in the haematological values of clinically infected animals. Packed cell volume (PCV), haemoglobin (Hb), and erythrocyte count were found to decrease significantly in clinical infections whereas the total leucocyte count showed a slight increase which were in accordance with the findings of Sena *et al.* (1997).

Significant reduction in PCV, Hb and total erythrocyte count is considered to be characteristic in anemias (Coles, 1986). Reduction of values in the present study can be correlated with the petechial lesions in the intestine as a result of coccidial infection. The slight increase in the total leucocyte count may be regarded as a response to the tissue destruction and inflammation of the intestine by the host body.

5.6 Treatment with anticoccidials

5.6.1 Sulphadimidine sodium

Treatment of coccidiosis with sulphadimidine sodium was carried out at the rate of 200 mg per kg body weight orally for three consecutive days in ten infected rabbits. Significant reduction in the oocyst count was observed and the animals regained their health after the treatment. The mean clearance efficacy was observed to be 99.68 per cent. This finding was in agreement with those of Meitei *et al.* (1989), Cheema *et al.* (1990), D'Souza *et al.* (1992) and Laha *et al.* (1999).

5.6.2 Furazolidone

Furazolidone at the rate of 10 mg per kg body weight orally for five days did not completely eliminate the infection. There was no appreciable reduction in the count of oocysts although the severity of diarrhoea was found to decrease. The mean clearance efficacy was noted as 85.48 per cent. Similar findings were also observed by Bedrnik and Martinez (1976). But D'Souza *et al.* (1993) reported that a combination of nitrofurazone and furazolidone was found to bring a significant reduction in the oocyst counts of rabbits suffering from coccidiosis. As this product was not being marketed and hence unavailable at the time of research, it could not be included for trials in the present study.

5.6.3 Metronidazole

Metronidazole was administered at a dose rate of 40 mg per kg body weight orally for three days in ten naturally infected rabbits. Although Reshetnyak *et al.* (1970) and Zhang and Xue (1990) found that metronidazole was able to reduce the clinical signs and oocyst count in coccidia infected rabbits, this drug did not bring about a satisfactory result in the present study. Some of the clinical signs persisted even after treatment. Oocyst count also did not reduce markedly. The mean clearance efficacy of the drug was only 69.92 per cent.

5.7 Determination and comparison of drug efficacy

Treatment trials with sulphadimidine sodium, furazolidone and metronidazole proved sulphadimidine sodium as the most effective drug against rabbit coccidiosis. Sulphadimidine sodium brought about a marked reduction in clinical signs and oocyst count after treatment.

Sulphadimidine is one of the earliest and effective drugs against coccidiosis and still used abundantly. It acts on the second generation schizonts as competitive antagonists of PABA and interferes with folate utilization that is required for the developing coccidial stages. A practical difficulty encountered in the present study was the presentation of sulphadimidine as boluses which caused difficulty in administration.

Furazolidone was found to be less effective against rabbit coccidiosis in the present study. This may be due to the poor absorption of the drug from the digestive tract (Adams, 1995). Better results could be invariably obtained on increasing the dosage of the drugs.

Metronidazole did not bring about satisfactory result in the present study. The drug was included in the present work as it is primarily active against anaerobic protozoal tissue parasites like *Entamoeba* and *Giardia* sp. Essentially, an increase in the dose rate and a change in the treatment schedule is presumed to improve the results.

Treatment against coccidiosis in rabbits becomes difficult, as this disease is not noticeable in the initial stages. Hence, frequent coprological examination of rabbits of different age groups during all seasons and prompt therapeutic and prophylactic medication with maintenance of hygiene are necessary to keep the farms free of coccidia.

Summary

6. SUMMARY

A detailed study on the prevalence, pathology and treatment of coccidial infections in rabbits belonging to different age groups, breeds and sex was carried out. The effect of season and management on the incidence of the disease was also studied. Faecal samples for the detection of infection were collected from suspected cases of rabbits at the Rabbit Research Station, Mannuthy and local rabbitries in and around Thrissur during the period from October 2001 to September 2002. The salient findings of the study were as follows.

1. Out of 550 faecal samples screened, 102 animals were positive for coccidial oocysts showing an overall prevalence rate of 18.54 per cent. The occurrence of coccidiosis was found to be maximum during the month of August (81.81 per cent). Higher infection was noticed in young rabbits below three months (76.47 per cent) which might be due to the lower resistance of young ones. Female animals (63.72 per cent) were found to be more affected than the males (36.27 per cent). This may be attributed to the lesser number of male animals screened during the study. Breedwise, the disease occurred more in New Zealand White (10.9 per cent) followed by Grey Giant (3.63 per cent). Coccidiosis was seen more in the months of heavy rainfall during cold wet South West Monsoon (46.07 per cent) indicating favourable humidity and temperature levels for the sporulation of oocysts.

2. In the present study, diagnosis was carried out based on the clinical signs and microscopical examination of faecal samples by concentration method, viz., sedimentation. Subclinically affected animals showed growth retardation and reduced feed intake whereas clinically infected ones showed diarrhoea, soiled fur, anorexia and loss of condition.

3. Six species of *Eimeria* infecting rabbits were identified in the present study based on sporulation time and oocyst morphology. Mixed infections were common with 96 per cent of the animals carrying two to three different species. They were *Eimeria media* (80 per cent), *E. magna* (86 per cent) *E. perforans* (86 per cent), *E. coecicola* (50 per cent), *E. flavescens* (15 per cent) and *E. piriformis* (8 per cent). *Eimeria magna* and *E. perforans* occurred most frequently followed by *E. media.*

4. Pathological studies were conducted on the rabbits brought for postmortem at the Centre of Excellence in Pathology, College of Veterinary and Animal Sciences, Mannuthy. Antemortem examination showed that the rabbits had suffered from heavy diarrhoea that was denoted by the soiling of fur with diarrhoeic faeces. Macroscopically intestine was found thickened and oedematous with mucoid contents. Circumscribed greyish white foci were visible on the mucosa which were due to the accumulation of the schizogonic stages of coccidia.

5. Histopathological studies of the intestine revealed characteristic lesions of intestinal coccidiosis. Schizonts, gametogonic stages and oocysts could be detected in the intestinal epithelium. Active inflammatory

reaction with infiltration of mononuclear cells was observed. Scattered areas of congestion and haemorrhage was noted. The tips of villi showed necrotic changes and desquamation of epithelial cells resulted in villous atrophy. Oocysts or other developmental stages could not be recovered from the liver by either coprological or histopathological examination.

6. Haematological studies was carried out in a group of ten affected animals and a control group of ten apparently healthy animals. Significant reduction ($P<0.05$) was noticed in the mean values of packed cell volume (29.4 ± 0.96), haemoglobin (6.7 ± 0.4) and erythrocyte count (3.39 ± 0.37) of the affected animals when compared to the healthy ones. Reduction in the haematological values can be correlated with the petechial lesions in the intestine as a result of coccidial infections. A slight increase in the total leucocyte count (9.3 ± 0.46) in the affected animals can be attributed as response to the tissue destruction and inflammatory condition in the intestine.

7. Treatment trials against rabbit coccidiosis was carried out with three anticoccidial drugs namely sulphadimidine sodium (200 mg per kg body weight for three days), furazolidone (10 mg per kg body weight five days) and metronidazole (40 mg per kg body weight for three days). Each drug was administered orally to ten animals. The mean clearance efficacy of the three drugs were 99.68 per cent, 85.48 per cent and 69.92 per cent respectively. Sulphadimidine was found to be the most effective anticoccidial which can be used in rabbit

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