

HELMINTH PARASITES OF INDIAN ELEPHANTS

By

KHOMDRAM SOMORENDRO SINGH

THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Parasitology
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mananthy, Trichur

1988

170569

636.0869

KHO/HE



To My Loving Parents

DECLARATION


I hereby declare that this thesis entitled "HELMINTH PARASITES OF INDIAN ELEPHANTS" is a bonafide record of research work done by me during the course of research and that the 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.


KHONDRAM SOHORENDRO SINGH

Mannuthy,
28.9.86

CERTIFICATE

Certified that this thesis entitled "HELMINTH PARASITES OF INDIAN ELEPHANTS" is a record of research work done independently by Shri. Khondiram Somarendro Singh under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.



28/9/88

Dr. R. CHANDRASEKHARAN,
(Chairman, Advisory Board)
Professor,
Department of Parasitology,
College of Veterinary and Animal Sciences,
Mannuthy, Trichur,

Mannuthy,
28/9/88

ACKNOWLEDGEMENTS

With deep sense of gratitude, I wish to express my sincere thanks to:

Dr. K. Chandrasekharan, Professor, Department of Parasitology, and Chairman of the Advisory Committee, for his inspiring guidance, helpful suggestion and sustained encouragement throughout the course of study and preparation of thesis.

Dr. K. Rajamohanam, Professor and Head; Dr. V. Sathianesan, Professor, Department of Parasitology and Dr. Jacob V. Cheeran, Senior Scientist, Department of Pharmacology for their helps and valuable suggestions of the manuscript as members of the Advisory Committee.

Dr. R. Kalyana Sundaram, Director, Centre of Excellence for Research in Animal Diseases, for the help rendered during the study and for taking microphotographs.

Dr. K. Radhakrishnan, Dean i/c, for affording facilities for the conduct of the study.

Dr. T.V. Subramaniam, Veterinary Officer, Guruvayoor Devaswom and his staff for the unforgettable and generous help made during my experiment.

Dr. K. Madhavan Pillai and Dr. C. George Verghese, Professors, Department of Parasitology, for their helps during the study.

Dr. (Mrs) Lucy Jacob and Dr.(Mrs) K. Devada, Junior Assistant Professors, Department of Parasitology; Dr. T. Thiagarajan, Ph.D. Scholar, for their personal interest and valuable help especially during the preparation of thesis.

The Director, Veterinary and Animal Husbandry Services, Government of Manipur for granting deputation to undergo this course and The Director, Manpower Development, NEC, Shillong, for providing financial assistance in the form of fellowship during the course of study.

I also appreciate my wife Smt. Keshori Devi, for encouraging me in undertaking and completing the study, silently and cheerfully, tolerating all troubles.

KHOMDRAM SOMORENDRO SINGH

TABLE OF CONTENTS

		<u>Page No.</u>
INTRODUCTION	..	1
MATERIALS AND METHODS	..	3
INCIDENCE OF HELMINTHS:		
REVIEW OF LITERATURE	..	7
RESULTS	..	14
DISCUSSION	..	64
TREATMENT:		
REVIEW OF LITERATURE	..	71
RESULTS	..	73
DISCUSSION	..	75
SUMMARY	..	76
REFERENCES	..	78
ABSTRACT		

LIST OF TABLES

	<u>Page No.</u>
Table 1. Month-war prevalence of helminthic infection in captive elephants	16
Table 2. Comparative measurements of <u>Murshidia murshidia</u> recorded by Lane (1914), Witenberg (1925), Westhuyesen (1938) and in the present study in Indian elephant	50
Table 3. Comparative measurement of <u>Murshidia falcifera</u> recorded by Lane (1914), Witenberg (1925), Westhuyesen (1938) and in the present study in Indian elephant	51
Table 4. Comparative measurement of <u>Quilonia renniei</u> recorded by Lane (1914), Westhuyesen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant	52
Table 5. Comparative measurement of <u>Chonionium epistomum</u> recorded by Lane (1914), Ware (1924) and in the present study in Indian elephant	53
Table 6. Comparative measurement of <u>Decrusia additictia</u> recorded by Lane (1914), Westhuyesen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant	54
Table 7. Comparative measurement of <u>Amira pileata</u> recorded by Lane (1914), Khalil (1922), Westhuyesen (1938) and in the present study in Indian elephant	55
Table 8. Comparative measurements of <u>Equinubria sipunculiformis</u> recorded by Lane (1914), Westhuyesen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant	56
Table 9. Comparative measurements of <u>Parabronema indicum</u> recorded by Baylis (1921), Westhuyesen (1938) and in the present study in Indian elephant	57
Table 10. Comparative measurements of <u>Parabronema smithi</u> recorded by Baylis (1921), Westhuyesen (1938) and in the present study in Indian elephant	58

	<u>Page No.</u>
Table 11. Comparative measurements of <u>Grammocephalus hybridatus</u> recorded by Westhuyzen (1938) and in the present study in Indian elephant	59
Table 12. Comparative measurements of <u>Grammocephalus varedatus</u> recorded by Westhuyzen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant	60
Table 13. Comparative measurements of <u>Pseudodiscus collinsi</u> recorded by Bhalerao (1933), Westhuyzen (1938), Mukherjee and Chauhan (1965) and in the present study in Indian elephant	61
Table 14. Comparative measurements of <u>Pseudodiscus hawkosi</u> recorded by Stiles and Goldbergers (1910), Fukui (1929), Westhuyzen (1938), Malik et al. (1959) and in the present study in Indian elephant	62
Table 15. Comparative measurements of <u>Gastrodiscus secundus</u> recorded by Bhalerao (1933), Mukherjee and Chauhan (1965) and in the present study in Indian elephant	63
Table 16. Efficacy of Albendazole against strongylosis in elephants	74

LIST OF PLATES

Plate I
(Microphotographs)

- Fig. 1. Strongyle egg
 Fig. 2. Cestode egg
 Fig. 3. Amphistome egg
 Fig. 4. Nivitolobilharzia egg

Plate II
(Camera lucida drawings)

- Fig. 1. Strongyle egg
 Fig. 2. Cestode egg
 Fig. 3. Amphistome egg
 Fig. 4. Nivitolobilharzia egg

Plate III
(Microphotographs)

- Fig. 1. Murshidia murshidia - head end
 Fig. 2. Murshidia murshidia - male tail
 Fig. 3. Murshidia murshidia - female tail

Plate IV
(Camera lucida drawings)

- Fig. 1. Murshidia murshidia - anterior end, dorsal view
 Fig. 2. Murshidia murshidia - anterior end, lateral view
 Fig. 3. Murshidia murshidia - male bursa, lateral view
 Fig. 4. Murshidia murshidia - male bursa, dorsal ray
 Fig. 5. Murshidia murshidia - male spicules
 Fig. 6. Murshidia murshidia - female tail with genital ducts

Plate V
(Microphotographs)

- Fig. 1. Murshidia falcifera - head end
 Fig. 2. Murshidia falcifera - male tail
 Fig. 3. Murshidia falcifera - female tail

Plate VI
(Camera lucida drawings)

- Fig.1. Murshidia falcifera - anterior end, lateral view
 Fig.2. Murshidia falcifera - anterior end, dorsal view
 Fig.3. Murshidia falcifera - male bursa, lateral view
 Fig.4. Murshidia falcifera - male bursa, dorsal ray
 Fig.5. Murshidia falcifera - male spicules
 Fig.6. Murshidia falcifera - female tail

Plate VII
(Microphotographs)

- Fig.1. Quilonia rennici - head end
 Fig.2. Quilonia rennici - male tail
 Fig.3. Quilonia rennici - female tail

Plate VIII
(Camera lucida drawings)

- Fig.1. Quilonia rennici - anterior end, dorsal view
 Fig.2. Quilonia rennici - anterior end, lateral view
 Fig.3. Quilonia rennici - male bursa, dorsal ray
 Fig.4. Quilonia rennici - male bursa, lateral view
 Fig.5. Quilonia rennici - spicules
 Fig.6. Quilonia rennici - female tail

Plate IX
(Microphotographs)

- Fig.1. Cheniencium epistomum - head end
 Fig.2. Cheniencium epistomum - male tail
 Fig.3. Cheniencium epistomum - female tail

Plate X
(Camera lucida drawings)

- Fig.1. Cheniencium epistomum - anterior end, dorsal view
 Fig.2. Cheniencium epistomum - anterior end, dorso-lateral view
 Fig.3. Cheniencium epistomum - male bursa, lateral view
 Fig.4. Cheniencium epistomum - male bursa, dorsal ray

Fig.5. Chenianidium epistomum - male epicules

Fig.6. Chenianidium epistomum - female tail

Plate XI
(Microphotographs)

Fig.1. Deorusia additictia - head end

Fig.2. Deorusia additictia - male tail

Fig.3. Deorusia additictia - female tail

Plate XII
(Camera lucida drawings)

Fig.1. Deorusia additictia - head, dorsal view

Fig.2. Deorusia additictia - anterior end, lateral view

Fig.3. Deorusia additictia - male bursa, lateral view

Fig.4. Deorusia additictia - male bursa, dorsal ray

Fig.5. Deorusia additictia - male epicules

Fig.6. Deorusia additictia - female end

Plate XIII
(Microphotographs)

Fig.1. Amira pileata - head end

Fig.2. Amira pileata - male tail

Fig.3. Amira pileata - female tail

Plate XIV
(Camera lucida drawings)

Fig.1. Amira pileata - anterior end, dorsal view

Fig.2. Amira pileata - male bursa, dorsal ray

Fig.3. Amira pileata - male bursa, lateral view

Fig.4. Amira pileata - male epicules with accessory piece

Fig.5. Amira pileata - female end

Plate XV
(Microphotographs)

Fig.1. Equinubria sirunculiformis - head end

Fig.2. Equinubria sirunculiformis - male tail

Fig.3. Equinubria sirunculiformis - female tail

Plate XVI
(Camera lucida drawings)

- Fig.1. Equinubria sipunculiformis - anterior end, lateral view
 Fig.2. Equinubria sipunculiformis - male bursa, lateral view
 Fig.3. Equinubria sipunculiformis - male bursa, dorsal ray
 Fig.4. Equinubria sipunculiformis - male spicules
 Fig.5. Equinubria sipunculiformis - female tail

Plate XVII
(Microphotographs)

- Fig.1. Parabronema indicum - head end
 Fig.2. Parabronema indicum - male tail
 Fig.3. Parabronema indicum - female tail

Plate XVIII
(Camera lucida drawings)

- Fig.1. Parabronema indicum - anterior end, dorsal view
 Fig.2. Parabronema indicum - anterior end, lateral view
 Fig.3. Parabronema indicum - male caudal end, ventral view
 Fig.4. Parabronema indicum - male caudal end, lateral view
 Fig.5. Parabronema indicum - female vulvar region
 Fig.6. Parabronema indicum - female tail

Plate XIX
(Microphotographs)

- Fig.1. Parabronema smithi - head end
 Fig.2. Parabronema smithi - male tail
 Fig.3. Parabronema smithi - female tail

Plate XX
(Camera lucida drawings)

- Fig.1. Parabronema smithi - anterior end, dorsal view
 Fig.2. Parabronema smithi - male caudal end, ventral view
 Fig.3. Parabronema smithi - male caudal end, lateral view
 Fig.4. Parabronema smithi - vulvar region of female
 Fig.5. Parabronema smithi - female tail

Plate XXI
(Microphotographs)

- Fig.1. Gramnocephalus hybridatus - head end
 Fig.2. Gramnocephalus hybridatus - male tail
 Fig.3. Gramnocephalus hybridatus - female tail

Plate XXII
(Camera lucida drawings)

- Fig.1. Gramnocephalus hybridatus - anterior end, lateral view
 Fig.2. Gramnocephalus hybridatus - lateral lobe of bursa, inside view
 Fig.3. Gramnocephalus hybridatus - lateral lobe of bursa, external view
 Fig.4. Gramnocephalus hybridatus - male dorsal ray
 Fig.5. Gramnocephalus hybridatus - male spicules
 Fig.6. Gramnocephalus hybridatus - female tail

Plate XXIII
(Microphotographs)

- Fig.1. Gramnocephalus varedatus - anterior end
 Fig.2. Gramnocephalus varedatus - female tail

Plate XXIV
(Camera lucida drawings)

- Fig.1. Gramnocephalus varedatus - head, lateral view
 Fig.2. Gramnocephalus varedatus - anterior end, lateral view
 Fig.3. Gramnocephalus varedatus - female tail
 Fig.4. Gramnocephalus varedatus - vulvar region of female

Plate XXV
(Microphotographs)

- Fig.1. Pseudodiscus collinsi
 Fig.2. Pseudodiscus hawkeni
 Fig.3. Gastrodiscus secundus

Plate XXVI
(Camera lucida drawings)

Fig. 1. Pseudodiscus collinei

Plate XXVII
(Camera lucida drawings)

Fig. 1. Pseudodiscus hawaiiensis

Plate XXVIII
(Camera lucida drawings)

Fig. 1. Gastrodiscus secundus

KEY TO LETTERING

a.p	-	accessory piece
a.l.r	-	accessory lateral ray
al	-	also
a.pa	-	anal papillae
a	-	anus
b.t	-	buccal tube
b.c	-	buccal capsule
c.p	-	cervical papillae
c	-	condens
cu.p	-	cuticular prominences
d.g	-	dorsal gutter
d.r	-	dorsal rays
d.o.d	-	dorso-oesophageal duct
e.d.r	-	externo-dorsal ray
g.p	-	genital pore
h.em	-	hexacanth embryo
in	-	intestine
in.d	-	intestinal diverticulum
l.r	-	lateral ray
l	-	leaflets
l.e	-	left spicule
l.ri	-	longitudinal ridges
mi	-	miracidium
m	-	mouth
n.r	-	nerve ring

ce	-	cesophagus
c.d	-	cesophagus diverticulum
c.f	-	cesophagus funnel
cp	-	operculum
c.s	-	oral sucker
c	-	ovary
ovi	-	ovifactor
p	-	papillae
p.b.p	-	pre-bursal papillae
r.s	-	right spicule
seg.en	-	segmented embryo
se	-	semilunes
s.g	-	shell gland
s	-	spicule
sp	-	spine
t	-	tail
te	-	teeth
tes	-	testes
t.e.d.r	-	trifurcated externo-dorsal ray
ut	-	uterus
v	-	vagina
v.d	-	vas-deferens
v.r	-	ventral ray
v.s	-	ventral sucker
vit.	-	vitelline glands
vu	-	valva

Introduction

INTRODUCTION

The Indian elephant (Elephas maximus) one of the largest and elegant of the terrestrial mammals on earth belongs to the order Proboscidea. In India, their widespread habitats are in different States, viz., Assam, Nagaland, Bihar, Orissa, West Bengal, Karnataka, Tamil Nadu and Kerala. As per the recent enumeration there are about 2900 wild elephants and 500 captive elephants in Kerala. The captive elephants are being maintained by the Forest Department, Temples and private individuals. They have been closely associated with the social and cultural life of Indians for centuries and are being used for religious and social functions, timber hauling, capturing and training of other elephants.

As per the Indian mythology, elephant is considered as the image of the God Ganesh, who removes the obstacles and ill fates. In Kerala, in any religious festivals, it is considered incomplete, if an elephant with ornate decorations is not included.

An outgrowth of the upper incisor in the male Indian elephant, called 'tusk' is a highly precious commodity and from which many beautiful and enchanting items are made. Elephant tricks are very spectacular in circuses.

Different species of parasites especially helminths are found to be harboured by both captive and wild elephants. Helminthic infection due to trematodes or nematodes or cestodes

cause debility, weakness, anaemia in all types of elephants and even delayed growth and mortality in young elephants.

It is only evident that control of infection of helminths will definitely have a direct influence on the health and growth of elephant and thereby augment the economy of the country. In recent years a large number of broad spectrum anthelmintics effective against different species of helminths of animals and birds have been introduced. But studies on the efficacy and safe dosage of these drugs in Indian elephants are comparatively little.

In order to formulate effective control measures against parasites, a sound knowledge of their incidence, intensity of infection and seasonal variation is an essential pre-requisite.

Hence with the objective to reduce the morbidity and mortality caused by helminthic infection in the endangered species, elephants, a study has been taken up as follows:

1. Systematic study on the prevalence of helminthiasis and specific identification of helminths in Indian elephants.
2. Clinical trial in naturally infected elephants with recently introduced anthelmintics to evaluate and compute the safe dosage of the drugs.

Materials and Methods

MATERIALS AND METHODS

Prevalence of helminths

The prevalence of helminthic infection in captive Indian elephants maintained by temples, private individuals and Forest Departments in different parts of Kerala was studied. The study was made by screening the dung samples of naturally infected elephants of different age groups and sex and also by examining the viscera and other internal organs during the time of post-mortem of elephants.

The details such as approximate age, season and locality from where the collections were made, were also noted. During the post-mortem all the different organs were examined separately for the presence of any helminth parasites. The contents as well as scrapings of the mucosa of gastro-intestinal tract were also examined for the presence of helminths.

Examination of dung sample

The eggs of trematodes, cestodes and nematodes present in the dung samples were identified by centrifugal sedimentation technique and microscopical examination. Egg per gram (EPG) was estimated in positive cases of helminthiasis to determine the extent of infection by using Stoll's dilution method (Soulsby, 1976).

Faecal culture

Individual dung samples about 10-15 g from infected and medicated elephants were collected in small petri-dish^{es} and

were moistened with well water. Each petri-dish was then kept in a bigger petri-dish containing filtered well water, and was covered with another large petri-dish. The culture was aerated by lifting ^{the} petri-dish on the top twice a day and was incubated at room temperature. The respective cultures were examined under a dissection microscope for the detection of larvae.

Collection of worms

Worms were collected from the dung bolus passed by medicated elephants and also from the gastro-intestinal tract and liver of dead elephants by means of mounted needles and fine brushes. Small worms were recovered by mixing dung material with water and by examining the sediment under a dissection microscope.

Examination of adult nematode worms

Adult nematode worms collected, were washed in normal saline to remove adherent mucus and dirt. Studies on easily identifiable features were made after preparing temporary aqueous mounts in normal saline. The details of the worms were studied either by making semipermanent mounts after clearing with lactophenol or carbolic acid or creosote or by making permanent mounts with canadabalsam after passing through ascending grades of alcohol.

Examination of amphistomes

Similar to nematodes, amphistomes were also collected during post-mortem and also from the dung of dewormed elephants.

Immediately after collection they were transferred into Normal saline solution. Then they were flattened by pressing between two glass slides and fixed in 10 per cent formalin for 36 hours. The specimens were then washed in running tap water for 12 hours. For staining they were kept overnight in working solution of acetic alum carmine.

The specimens were destained in 1 per cent acid alcohol and washed in several changes of distilled water to remove even traces of the reagent. Then dehydrated in ascending grades of alcohol (70%, 80%, 90% and 100%) allowing 30 minutes in each grade. Finally they were cleared in two changes of xylol, 15 minutes in each. Then specimens were kept in a mixture of equal parts of xylol and canadabalsam for a minimum of one day and then mounted in canadabalsam. The mounted specimens were used for a detailed study of the morphological features, measurements and camera lucida drawings.

Preservation

Adult worms and eggs were preserved in 10 per cent formalin.

Diagram

Diagrams were drawn with the aid of camera lucida.

Photomicrograph

Photomicrographs were taken from preserved as well as fresh materials.

Measurements

Measurements of adult worms were made with the aid of

an ocular micrometer and also from camera lucida drawings. All the measurements were in millimetre.

Evaluation of efficacy of anthelmintics

Twentyfour elephants belonging to private individuals and Devaswom organizations which were naturally infected with strongyles, were selected after estimating the egg count. The anthelmintic efficacy of Albendazole (Albomar 15% powder, Glindia Ltd.) was estimated at a dose rates of 25mg and 3 mg/kg body weight. The drug was administered orally after mixing with jaggery. EPG of all the elephants were determined as per Stoll's dilution technique on the day of medication, prior to the administration of drug and on the first, second and third day following medication. The worms voided in the dung after medication were collected and identified. The efficacy of the drug was calculated by comparing the reduction in the number of eggs after medication with the pre-medication EPG.

Prevalence and Description

PREVALENCE OF HELMINTHS

REVIEW OF LITERATURE

Studies on the prevalence of helminth parasites in Indian elephants are comparatively few as compared to that of African elephants.

Steel (1878) reported some mortality of young elephants of Sanger's circus with heavy infection due to Dachmius sangeri now known as Bathmostomum sangeri (Cobbold, 1879). Lane (1914) identified and described Equinubria sipunculiformis, Asifa vasifa, Decrusia decrusi, Murshidia murshidia, M. falcifera, Quilonia quilona, Q. travancra and Amira pileata from eight Indian elephants. Lane (1915) collected Murshidia murshidia from the stomach contents of a female elephant during its post-mortem. The same author (1921) also found out nematode parasites, Quilonia quilona from the stomach, Grammocephalus varedatus from the bile duct and Bathmostomum sangeri from the caecum of Indian elephants. Baylis (1921) created a new genus - Parabronema to accommodate two new species of nematodes he collected from elephants, and he named them Parabronema indicum and P. smithi respectively.

Frank (1924) could collect 40 adult worms of Murshidia indica and four immature Choniangium sp. from the stomach and caecum of Indian elephants. In 1925, Witenberg had the opportunity to study Murshidia falcifera, M. murshidia, M. lanei and M. neveulemairei n.sp. from the large intestine of an Indian elephant which died in Warsaw circus. Maggit (1926) recovered a cestode Anoplocephala manubriata from a dead captive elephant

(Elephas maximus) in Burma. Bhalerao (1933) described five trematode parasites, viz., Fasciola jacksoni, Pfenderius papillatus, Pseudofascius collinsi, P. hawkesii and Gastrofascius secundus from elephants maintained in Assam and Burma. Naemark (1937) reviewed the trematodes under the family Paramphistomidae found in elephants and other animals in India. Westhuyzen (1938) reported Murehidia murehidia, M. indica, M. falcifera, Quilonia rennei, Q. travancore, Decrusia additictia, Cheniastium opistomum, Anira pileata, Equinubria apunculiformis, Bunoostomum foliatum, Bathmoostomum genceri, Pseudofascius collinsi and P. hawkesii from the intestine; Parabronema indicum and P. gnichi from the stomach; Grammocephalus hybridatus, G. varolettus and Fasciola jacksoni from the bile duct and Syngamus indicus from the pharynx, of four circus elephants and described their distinctive morphological features.

Vogel and Mining (1940) reported the occurrence of bilharzia parasite for the first time in Indian elephants and they described in detail the morphological features of its egg. Mudaliar and Ramanujachari (1945) described a new species of Schistosome, Schistosoma nairi from Indian elephant. Bhalerao (1947) transferred Schistosoma nairi from the genus Schistosoma to the genus Ornithobilharzia and renamed it as Ornithobilharzia nairi on account of the presence of one set of vitellaria in females and large number of testes in males. Nickel (1949) found out two types of large trematodes from the intestine of Indian elephant and identified one of them as Hawkesius sp.

Southerland et al. (1950) recorded and described a nematode, Bathmostomum sangeri from a 14 year old Asian elephant. Rammohan and Hiregauder (1953) reported six cases of bilharziasis by observing eggs in the dung sample of elephants. Ramanujachari and Alwar (1954a) reported a species of microfilaria which they recovered from cutaneous haemorrhagic nodules of Indian elephants, for the first time, and opined as the microfilaria of Parafilaria multipapillosa. Later the same authors (1954b) recovered unsheathed microfilaria and a female filarid worm from a cutaneous bleeding nodule of an elephant. Based on the presence of paired vitelline glands in females, and large number of testes in males, Dutta and Srivastava (1955) reallocated the parasite Ornithobilharzia nairi to the genus Bivitellobilharzia.

Kries (1956) reported Murshidia falcifera and Quilonia sedecimradiata n.sp. from an Indian elephant. Sarwar and Shaikh (1956) recovered Grammocephalus varedatus from large intestine, Bathmostomum sangeri from small intestine and a single male worm of Parabronema africanum from the surface of the liver of a baby elephant. In the same year 1956, Vogelsang and Mayaudon collected helminths, viz., Fasciola hepatica, F. jacksoni and Grammocephalus varedatus from the liver, Parabronema indicum, Bunostomum foliatum, Equinubria sipunculiformis, Murshidia murshidia and Pfenderius papillatus from alimentary canal of elephants. Chabaud (1957) made a detailed and extensive critical review of the genera Quilonia and Murshidia. Kalapesi and Purohit (1957) found sections of eggs of Schistosoma species

from the liver and mesenteric lymphnodes and sections of non-tuberculate adult worms from the mesenteric vein during the histological examination of the lesions. They also collected Parabronema indicum from one intestinal nodule.

Alvar and Lalitha (1958) reported a case of 'haemorrhagic filariasis' and recovered unsheathed microfilaria in the blood that oozed out from the skin nodule. Alvar et al. (1959) encountered a few female filarid worms from cutaneous haemorrhagic nodules of elephants. They found them distinctly different from other known filarids of elephants and hence they created a new genus Indofilaria for the species which they named Indofilaria pattabiramani. Malik et al. (1959) also collected and described some species of amphistomes from a circus elephant, the species collected being Pfenderius papillatus, P. heterocaeca and Pseudodiscus hawkesii. Peter and Srivastava (1960) described the morphological features of the adult stage, redia, cercaria and metacercaria of Pseudodiscus collinsi, an amphistome of elephant.

Fernando and Fernando (1961a) reported Murshidia murshidia, M. falcifera, Equinubria sipunculiformis, Quilonia renniei, Decrusia additictia and Fasciola jacksoni from Indian elephants (Elephas maximus) in Ceylon. The same authors (1961b) collected eight nematode species, viz., Murshidia murshidia, M. falcifera, Quilonia renniei, Q. sedicimradiata, Equinubria sipunculiformis, Decrusia additictia, Bathmostomum sangeri, Grammocephalus varedatus, one amphistome, Pfenderius papillatus and one cestode

Anoplocephala manubriata from a three year old captive young male Indian elephant. Dutta and Srivastava (1961) described the epidermal plates of the miracidia of Bivitellobilharzia nairi. McGaughey (1962) listed different internal helminth parasites, Bathmostomum sanceri, Grammocephalus varadatus, Equinubria sipunculiformis, Quilonia renniei, Murshidia indica, Chonioncium sp., Decrusia sp., Pseudodiscus collinsi, P. hawkesii, Pfenderius papillatus and Fasciola jacksoni from elephants. Mukherjee and Chauhan (1965) studied Pfenderius papillatus, P. heteroeca, P. biramanicus, Pseudodiscus collinsi, P. hawkesii and Gastrodiscus secundus from the intestine of Indian elephants. Sundaram (1966) described the generic features of the helminths, viz., Murshidia sp., Quilonia sp., Chonioncium sp., Equinubria sp., Decrusia sp., Bathmostomum sp., Grammocephalus sp., Parabronema sp., Indofilaria sp., Fasciola jacksoni, Pfenderius papillatus, Ornithobilharzia nairi and Anoplocephala manubriata.

Bhattacharjee (1967) recorded a case of stephenofilariasis in Indian elephant and the recovered filarid worm was named as Stephenofilaria srivastava. Seneviratna et al. (1967) reported an unsheathed microfilaria similar to that of Dipetalonema sp. from 22 domesticated elephants (Elephas maximus) in Ceylon. In 1968, Seneviratna and Jaya Singhe collected Parabronema smithi, Grammocephalus hybridatus along with the larval stage of Cobboldia elephantis from a baby elephant. Gneve (1969) encountered Bathmostomum sanceri, Murshidia

neveulemairci, Quilonia renniei, Parabronema smithi and a new species of Strongyloides elephantis from Indian elephants. Rajamohanam (1970) reported a case of acute enteritis caused by Murshidia sp. from a captive elephant. Datta et al. (1972) collected Chonionquium epistomum and Cobboldia elephantis from the dung of an elephant following medication. Chandrasekharan et al. (1972) recovered a filarid worm from the dung bolus of a calf elephant, following anthelmintic medication and described the worm as a new species, Indofilaria elephantis. Sundaram et al. (1972) redescribed Bivitellobilharzia nairi collected from a dead elephant. Romboli et al. (1976) reported Grammocephalus hybridatus from the bile ducts of an elephant which died in a zoo. Caple et al. (1978) collected Fasciola jacksoni from the bile duct of an Asian working elephant during its post-mortem.

A case of cestodiasis caused by Anoplocephala manubriata in an Indian elephant was reported by Chandrasekharan et al. (1979). Huang (1981) found out three trematode parasites viz., Fasciola jacksoni from the liver and bile duct, Gastrodiscus secundus from colon and caecum and Pseudodiscus collinsi from colon, caecum and stomach of elephants. Chatterjee et al. (1982) redescribed Stephenofilaria sp. obtained from skin scrapings of four domesticated elephants. In 1984, Gupta and Kalia recovered Murshidia sp. from the stomach of Indian elephants. Chatterjee (1984) for the first time, described adult stage and microfilaria of a filarid worm indistinguishable from

Stephenofilaria assamensis from cutaneous nodules of four elephants. Gupta and Trivedi (1984) reported Quilonia sinhai n.sp. from the small intestine of an elephant. Bauyor and Stoye (1985) listed out different species of helminths along with other types of parasites from Asian and African elephants. Gupta and Jaishwal (1985) reported Quilonia guptai n.sp. from the intestine of an Indian elephant. Zahedi et al. (1986) reported a case of microfilarial infection in the ear vein of a young elephant in Malaysia. Roy and Majumdar (1988) collected Murshidia murshidia worms from the dung samples of an Indian elephant following medication.

RESULTS

Prevalence

The prevalence of helminth parasites in captive Indian elephants (Elephas maximus indicus) was estimated in Kerala State, over a period of 12 months from March 1987 to February 1988.

A total of 203 elephants were examined which comprised of 42 forest and 161 non-forest animals; out of this, 117 elephants were found to be infected with either single or mixed infection of nematodes, trematodes and cestodes. The percentage of infection of helminths among the total animals examined was 57.6.

Among these 117 elephants, 89 elephants showed monospecific infection of strongyles, three elephants showed *Bivitellobilharzia* infection, three elephants cestode infection, two elephants amphistome infection and 20 elephants mixed infection with respective percentages of infection 76.1, 2.6, 2.6, 1.7 and 17.0.

The direct effect of the season and age on the prevalence and extent of infection were also considered in this study.

Season

There are two seasons in Kerala: the summer or dry season is from December to May and the rainy season is from June to November months. During summer, the average temperature rises upto 36°C in certain districts of the State. The average annual



Fig 1



Fig 2



Fig 3



Fig 4

rainfall from the South-west and North-east monsoons have been recorded as 150 to 170 cm. Out of the 117 cases helminthiasis, incidence was less in summer (52.44%) and more in rainy season (70%) (Table 1).

Elephants from the age of seven to 40 years were examined for the helminthic infection. Almost all the elephants of different age groups were found to suffer from different helminth infections.

Study of eggs

Four types of eggs, viz., strongyle, amphistome, cestode and Bivitellobilharzia were encountered in the dung of the naturally infected elephants, collected during the study.

Strongyle egg (Plate I, Fig.1, Plate II, Fig.1)

The strongyle eggs were oval, thin shelled with segmented embryo and measured from 0.064 mm to 0.089 mm with an average of 0.070 mm in length and from 0.038 mm to 0.061 mm with an average of 0.049 mm in width.

Cestode egg (Plate I, Fig.2, Plate II, Fig. 2)

The cestode egg was slightly rounded and hexagonal in shape, thick walled with hexacanth embryo and measured 0.065 mm in length and 0.062 mm in breadth.

Amphistome egg (Plate I, Fig.3; Plate II, Fig.3)

The amphistome eggs were oval with an operculum and length measured from 0.143 mm to 0.163 mm with an average of 0.156 mm

Table 1. Month-wise prevalence of helminthic infection in captive elephants

Month	Number of elephants screened	Number of elephants infected
1987 March	76	28
April	1	1
May	38	22
June	-	-
July	6	6
August	19	9
September	15	10
October	1	1
November	19	16
December	7	5
1988 January	11	9
February	10	10
Total	203	117

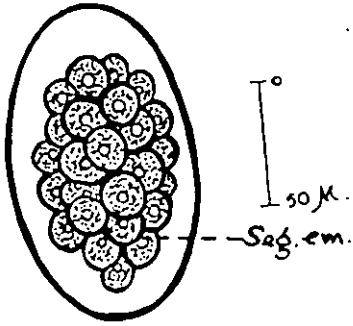


Fig. 1

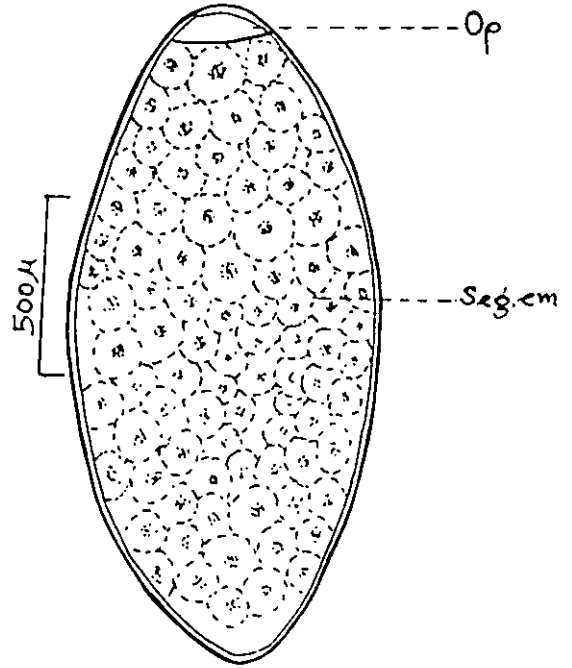


Fig. 3

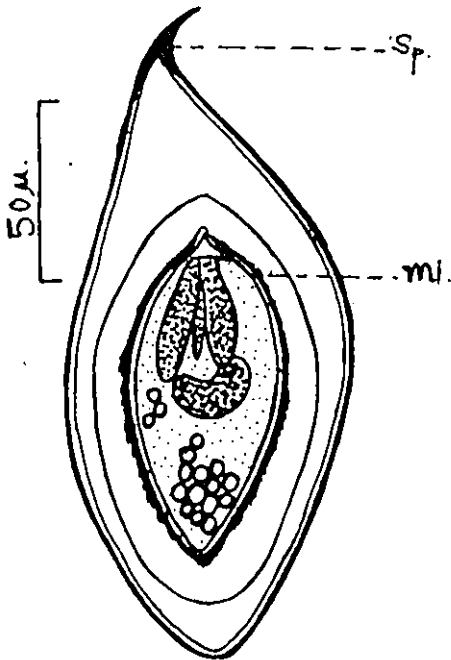


Fig. 4

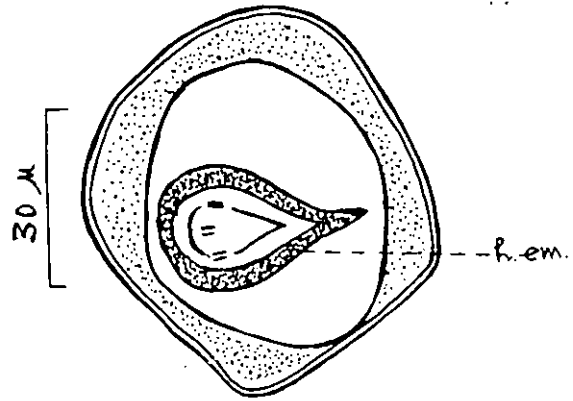


Fig. 2

and from 0.071 mm to 0.094 mm with an average of 0.082 mm in width.

Bivitellobilharzia egg (Plate I, Fig.4; Plate II, Fig.4)

Bivitellobilharzia eggs were oval, one side flattened with a terminal spine and with active miracidium inside. The ova measured from 0.138 mm to 0.179 mm by from 0.066 mm to 0.097 mm and length of spine ranged from 0.005 mm to 0.012 mm.

Study of adult worms

Fourteen species of adult helminth parasites were encountered during the present investigation viz.,

1. Murshidia murshidia
2. Murshidia falcifera
3. Quilonia rennei
4. Chonioncium epistomum
5. Decrusia additictia
6. Amira pileata
7. Equinubria sipunculiformis
8. Parabronema indicum
9. Parabronema smithi
10. Grammocephalus hybridatus
11. Grammocephalus varedatus
12. Pseudodiscus collinsi
13. Pseudodiscus hawkesii
14. Gastrodiscus secundus

Description of adult worm

1. Murshidia murshidia (Lane, 1914)General morphological features

(Plate III, Figs.1, 2 and 3; Plate IV, Figs.1 and 2)

The worms were fairly slender and tapering towards the head end. Mouth was directed straight forward. Mouth collar was more prominent laterally giving the appearance of two lateral lips, each of which bore a sessile, lateral and two prominent head papillae. The buccal capsule was roughly cylindrical and oval in cross section but the thickness of the wall varied at different parts. Since the buccal capsule was thicker caudad and thinner cephalad on its dorsal and ventral than on its lateral aspects, its cavity was as its cephalad end wider dorso-ventral than latero-lateral. The external leaf crown which originated about one-third of the way down the depth of buccal capsule was composed of numerous fine elements, originating along a curved line which ran closer to the anterior margin of buccal capsule dorsally and ventrally than laterally. The dorsal as well as ventral leaf crowns were shorter than the lateral thus giving to the mouth the shape of a dorso-ventral slit. The internal leaf crown which forms the anterior margin of the buccal capsule was short. The oesophagus was short, stout, widening caudad of the nerve collar. Its caudad end was guarded by three intestinal valves. The boundaries of the cells of chyle intestine were more marked. The cephalic cervical glands were large, and well developed. The lateral cervical papillae were long, slender and project somewhat cephalad. The leaf crown elements were 60 in number.



Fig. 1



Fig. 2

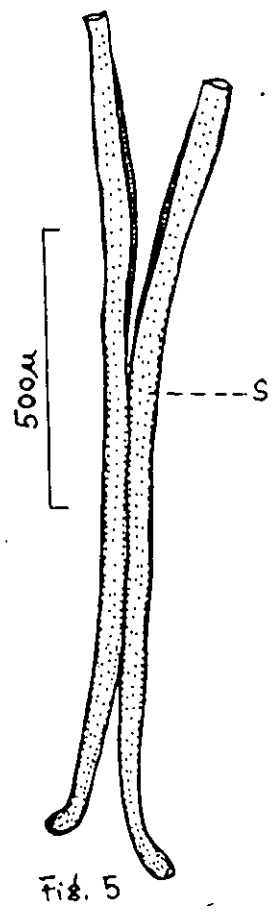
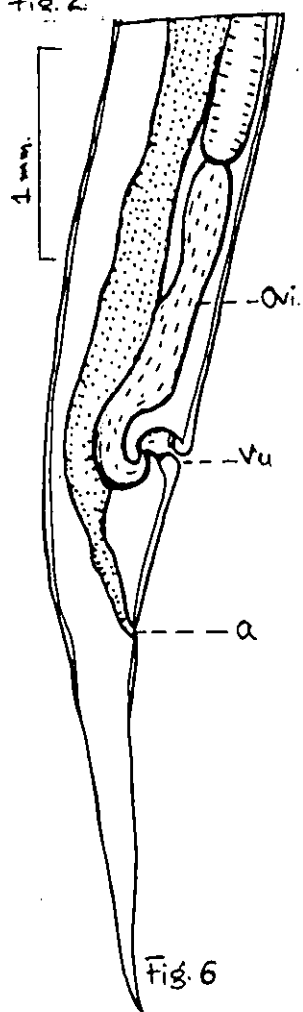
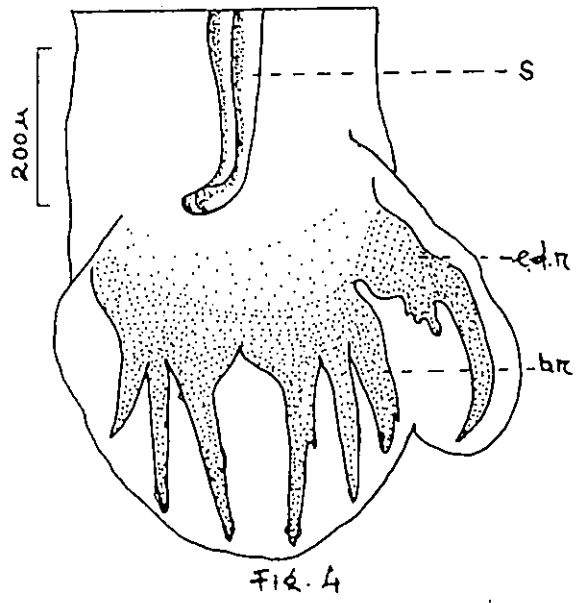
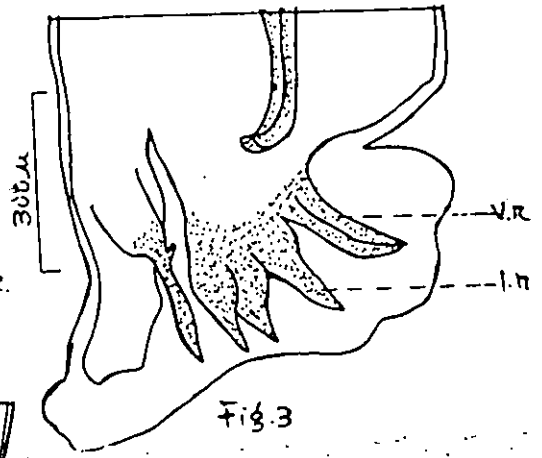
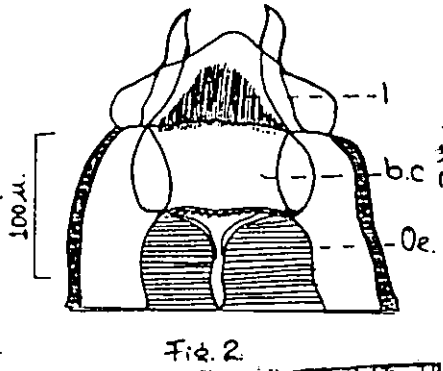
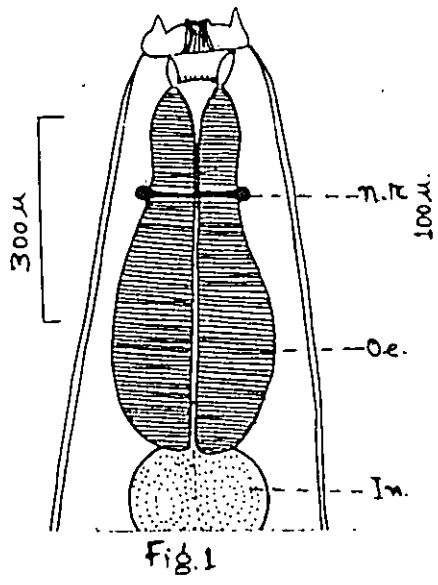


Fig. 3

Male: The male worms measured 19 mm to 24 mm in length. The width increased from the head towards the equator where it measured 0.7 mm to 0.9 mm. The diameters at the region oesophageal bulb and just anterior of the bursa were 0.30 mm to 0.34 mm and 0.62 mm to 0.74 mm respectively. The diameter of head was 0.17 mm to 0.24 mm and the buccal capsule measured 0.07 mm by 0.10 to 0.13 mm. The length of oesophagus ranged from 0.51 mm to 0.57 mm and width ranged from 0.20 mm to 0.25 mm. The nerve ring was at 0.24 mm to 0.32 mm, the excretory pore at 0.99 mm to 1.05 mm and the cervical papillae at 1.0 mm to 1.11 mm from the cephalic end.

The bursa was characteristic with swollen bases of the lateral rays and general ruggedness of the externo-dorsal and dorsal rays (Plate IV, Fig.3). The three divisions of the dorsal ray were situated equidistant from one another (Plate IV, Fig.4). The ventral and lateral rays arose from a common trunk. Spicules were equal in length, the shaft was straight for its whole length. The extremities were bent almost directing dorsad. The extreme end was "beak" shaped and an irregular "S" shaped accessory piece was present (Plate IV, Fig.5). The spicules measured 1.31 mm to 1.51 mm in length.

Female: The female worm measured 22 mm to 28 mm in length and width ranged from 0.73 mm to 1.0 mm. The diameter of head was 0.18 mm to 0.24 mm and the buccal capsule measured 0.07 mm by 0.10 mm to 0.13 mm. The diameters at the region of oesophageal bulb and cephalad to vulva were 0.30 mm to 0.36 mm and



0.50 mm to 0.53 mm respectively. The oesophagus measured 0.55 mm to 0.62 mm in length and the width measured 0.23 mm to 0.27 mm. The nerve ring was at 0.25 mm to 0.32 mm, the excretory pore 1.0 mm to 1.02 mm and cervical papillae 1.02 mm to 1.07 mm from the cephalic end respectively.

The females had a long tail and the vulva was just shortly cephalad of the anus (Plate IV, Fig.6). The vulva was marked by fairly long, low cuticular prominence caudad to it. The vagina ran cephalad and divided into two uteri which had the same direction, each one provided with ovifectors which ran parallel with one another and ended abruptly in two cephalad running ovaries.

The tail length ranged from 1.62 mm to 2.12 mm. The vulva was at 0.70 mm to 0.84 mm from the anus and the length of vagina was 1.30 mm to 1.75 mm. The lateral caudal papillae was 1.50 mm to 1.55 mm from the tail tip and the uteri was 5.2 mm to 5.7 mm long. The eggs were 0.070 to 0.072 mm by 0.042 mm to 0.045 mm in size.

The comparative measurements of H. murshidia given by Lane. (1914), Witenberg. (1925), Westhuyzen. (1938) and in the present study are furnished in table 2.

2. Murshidia falcifera (Cobbold, 1882)

General morphological features

(Plate V, Figs.1, 2 and 3; Plate VI, Figs. 1 and 2)

Murshidia falcifera showed morphological characters similar

Plate V

- Fig. 1. Murshidia falcifera - head end (x 100)
Fig. 2. Murshidia falcifera - male tail (x 50)
Fig. 3. Murshidia falcifera - female tail (x 20)

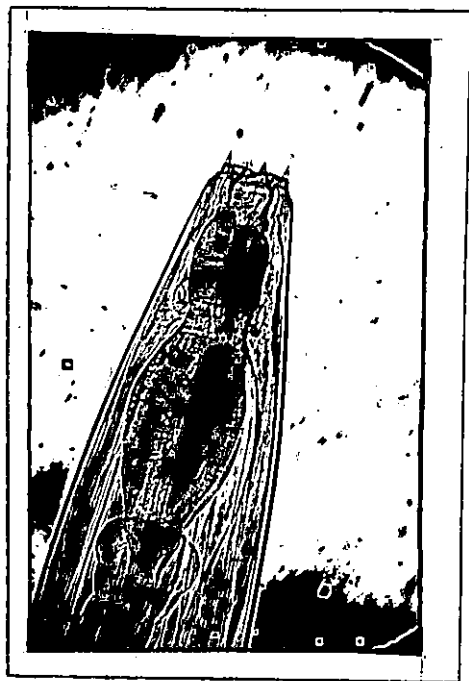


Fig. 1

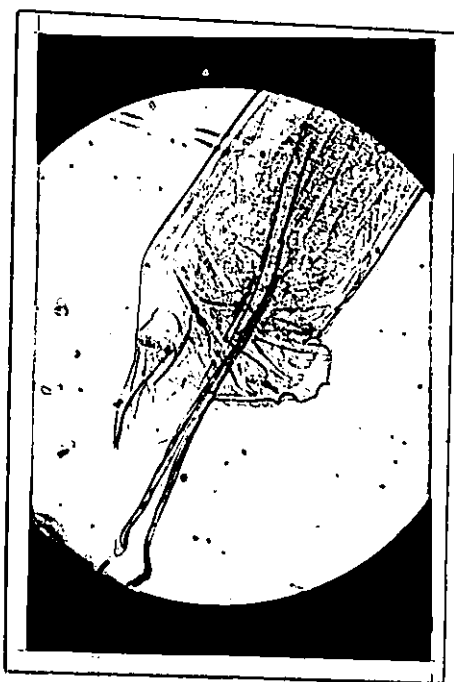


Fig. 2



Fig. 3

to that of *M. murshidia* except that the oral aperture was bound by 80 leaflets. The excretory pore was situated a little posterior to the junction of oesophagus and chyle-intestine and the lateral papillae were situated shortly caudad of the junction.

Male: The male worms measured 24 mm to 31 mm in length and the maximum diameter was from 0.93 mm to 1.06 mm at the equator. The diameter of the head ranged from 0.23 mm to 0.28 mm. The buccal capsule measured 0.10 mm by 0.13 mm. The diameters at the oesophageal bulb level and cephalad to bursa were 0.35 mm to 0.42 mm and 0.60 mm to 0.78 mm respectively. The length and width of oesophagus were 0.93 mm to 1.01 mm and 0.23 mm to 0.34 mm respectively. The nerve ring was at 0.42 mm to 0.50 mm, excretory pore 1.13 mm to 1.21 mm and the cervical papillae 1.51 mm to 1.55 mm respectively from the anterior end. The cuticular striations were 0.007 mm apart.

The lateral rays of the bursa were linear and uniform in thickness (Plate VI, Fig.3). The dorsal and externo-dorsal rays were smooth but some specimen showed ruggedness tendency towards the internal branches of the dorsal rays. The dorsal ray had a length of 0.60 mm to 0.65 mm. The externo-dorsal ray had a short fork like projection. Of the three divisions of the dorsal ray, the two laterals were close together and somewhat separated from the central one (Plate VI, Fig.4). In some worms, a tendency towards fusion of the lateral branches of the dorsal ray was noticed at least on one side.

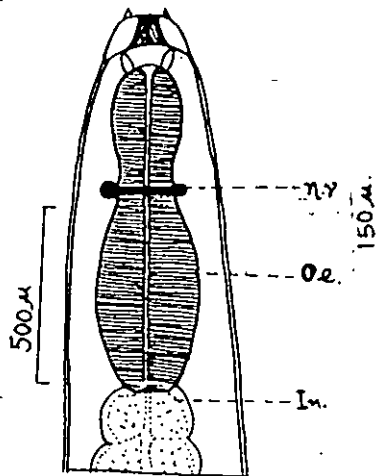


Fig. 1

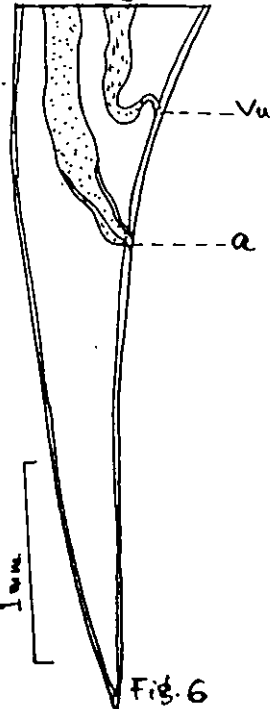


Fig. 6

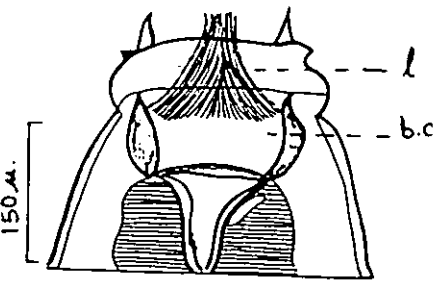


Fig. 2

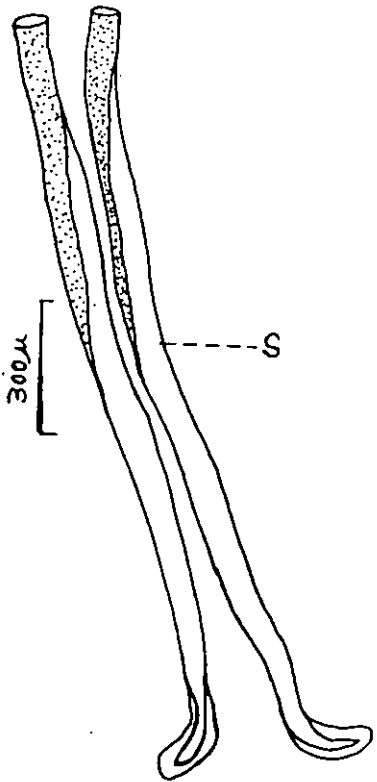


Fig. 5

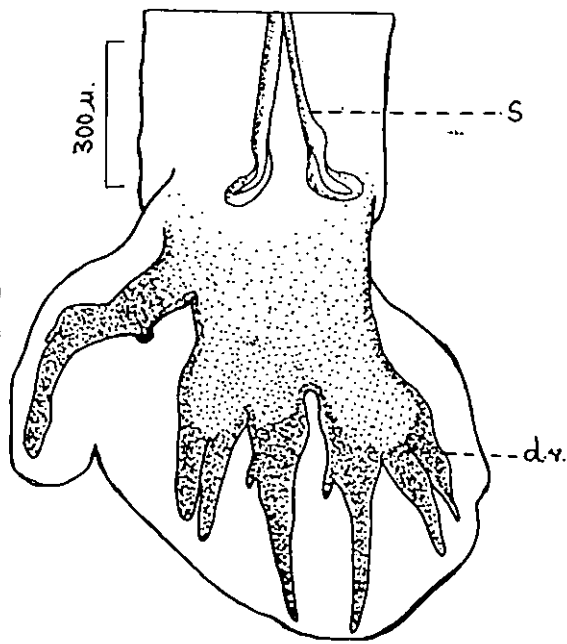


Fig. 4

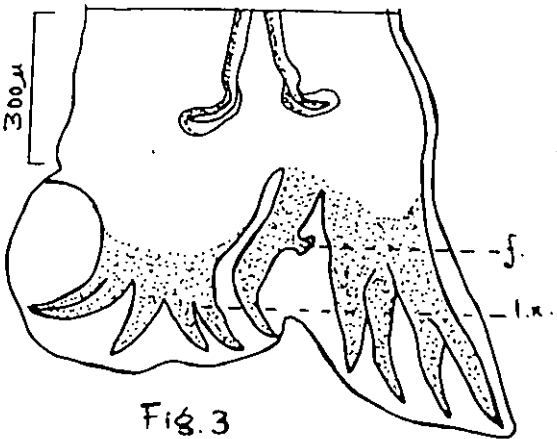


Fig. 3

The spicules were equal, similar and the shafts of the spicules were curved just cephalad of the terminal bent giving them a "lyrate" or "spoon" shape (Plate VI, Fig.5). The spicules measured 1.5 mm to 1.86 mm length. An "S" shaped accessory piece was present.

Female: The female worm measured 31 to 36 mm in length and 1.0 mm to 1.24 mm in width. The head had a diameter of 0.29 mm to 0.32 mm and the buccal capsule measured 0.11 mm by 0.14 mm. The diameter at the oesophageal bulb and cephalad to vulva were 0.48 mm to 0.50 mm and 0.65 mm to 0.68 mm respectively. The oesophagus measured 0.99 mm to 1.21 mm in length and 0.32 mm to 0.43 mm in width. The nerve ring located at 0.50 mm to 0.57 mm, the excretory pore at 1.39 mm to 1.52 mm and the cervical lateral papillae at 1.5 mm to 1.69 mm from the cephalic end.

Two caudal papillae were present posterior to anal opening at 2.0 mm from tail tip. The anus and vulva were located at 2.07 mm to 2.70 mm and 2.65 mm to 3.81 mm respectively from the tip of tail (Plate VI, Fig.6). The vaginal length was 1.79 mm to 2.23 mm. The uterus had a length of 6.0 mm to 6.8 mm and the ova measured 0.061 mm to 0.063 mm by 0.032 mm to 0.035 mm.

The comparative measurements of M. falcifera given by Lane (1914), Witenberg (1925), Westhuyzen (1938) and in the present study are furnished in table 3.

3. Quilonia renniei (Raill, Henry and Joyeux, 1913)

General morphological features

(Plate VII, Figs. 1, 2 and 3; Plate VIII, Figs. 1 and 2)

This species was fairly slender with discoid head. The mouth terminal was surrounded by a mouth collar which bore four prominent sub-median and two sessile lateral papillae. The leaflets were less when compared to Murshidia species. They were 18 in number characteristically curved and surrounded the mouth anteriorly. The leaf-crowns were thin and long and projected freely above the head. The oesophagus was nearly cylindrical in shape. The intestinal valves were as usual.

Male: The length of male worm ranged from 15 mm to 19 mm with a maximum width of 0.6 mm to 0.79 mm. The diameter of head was 0.20 mm to 0.29 mm and the buccal capsule measured 0.12 mm to 0.15 mm by 0.10 mm. The diameters at the region of oesophageal bulb and cephalad to bursa were 0.31 mm to 0.43 mm and 0.35 mm to 0.47 mm respectively. The oesophagus measured 0.68 mm to 0.80 mm in length and 0.23 mm to 0.27 mm in width. The nerve ring, the excretory pore and cervical papillae were at 0.31 mm to 0.37 mm, 0.6 mm to 0.7 mm and 0.7 mm to 0.75 mm respectively from the anterior extremity. The distance between the cuticular striations on the body was 0.028 mm to 0.03 mm.

The bursa was divided into three lobes. The dorsal lobe was longer than the lateral lobes. The dorsal ray was bifurcate, each branch gave three sub-divisions, and there was long common stem before bifurcation. The lateral sub-branches came first.

Plate VII

- Fig. 1. Quilonia renniei - head end (x 50)
Fig. 2. Quilonia renniei - male tail (x 80)
Fig. 3. Quilonia renniei - female tail (x 20)

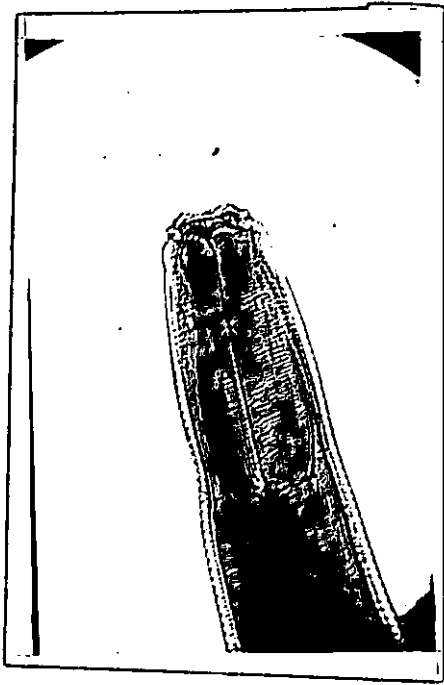


Fig. 1

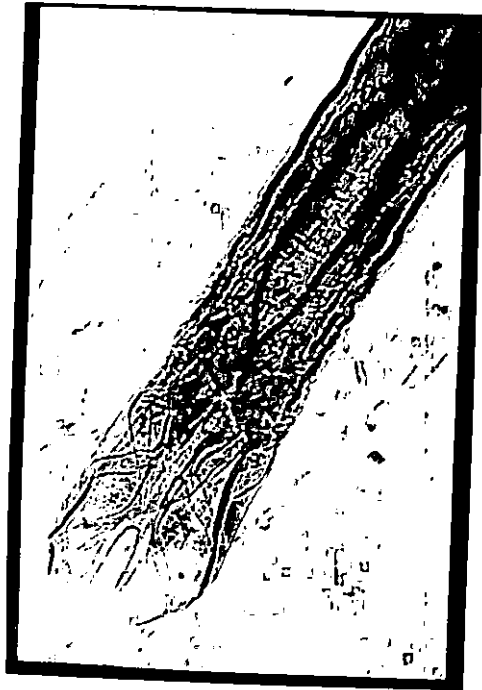


Fig. 2

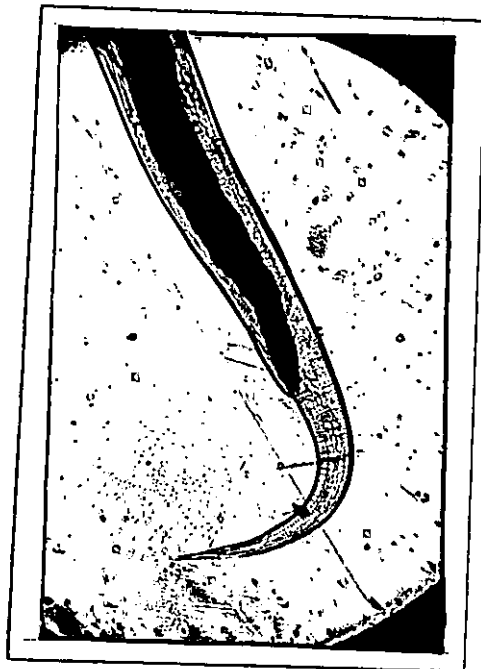


Fig. 3

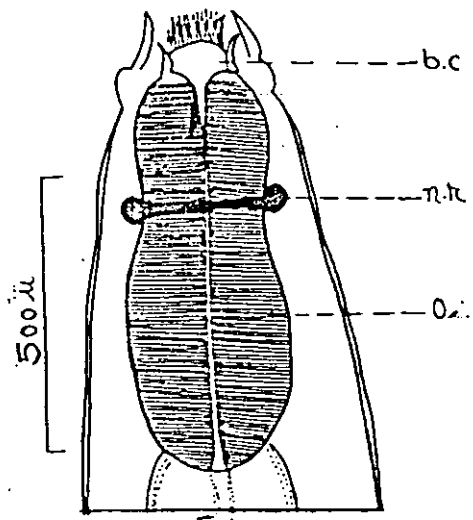


Fig. 1

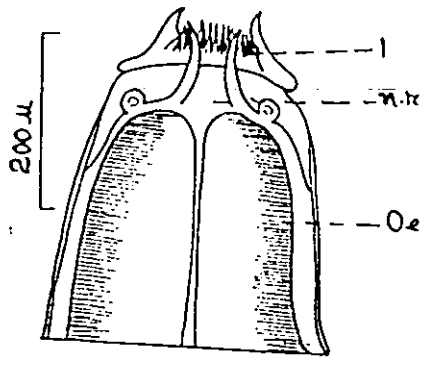


Fig. 2

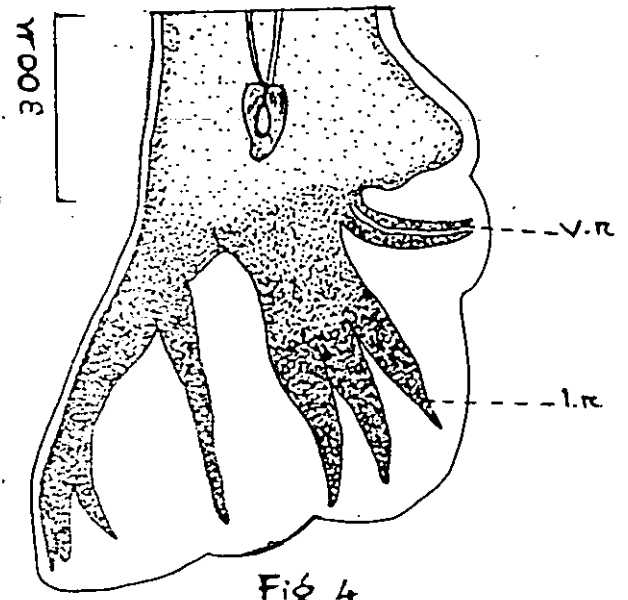


Fig. 4

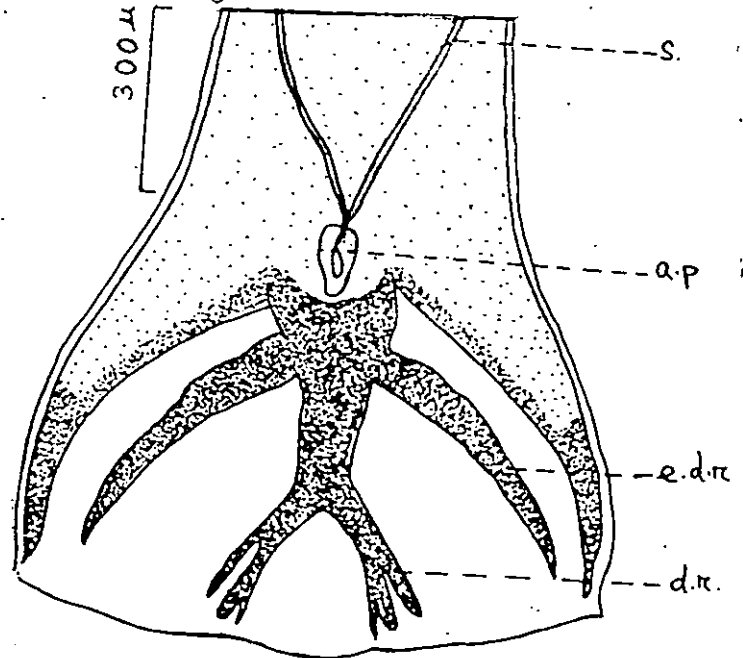


Fig. 3

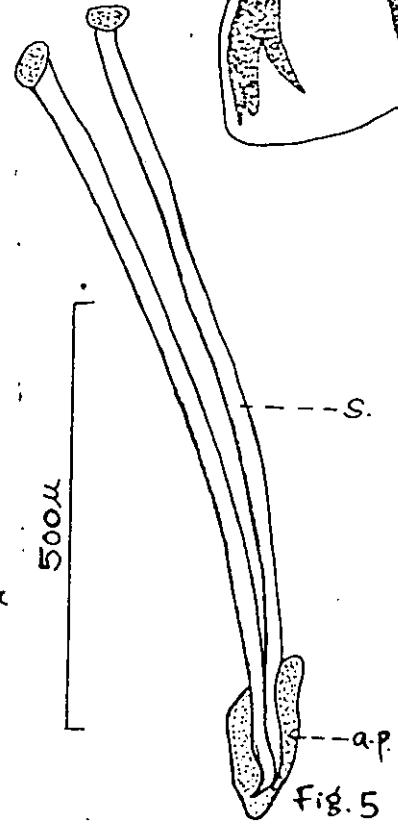


Fig. 5

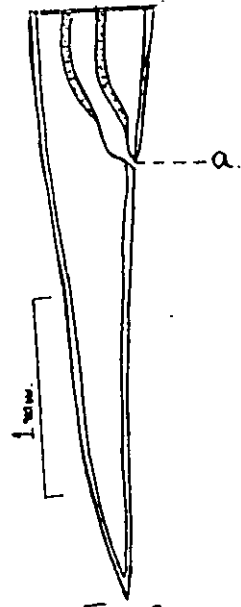


Fig. 6

and did not reach the edge of the bursa. The median and internal sub-branches were fused almost completely (Plate VIII, Fig.3).

The dorsal ray ranged from 0.35 mm to 0.54 mm in length and bifurcated, each branch giving three sub-branches. The lateral sub-branch of the bifurcated branch of dorsal ray came off first, at a distance of 0.11 mm to 0.14 mm and the median and internal sub-branches came off at a distance of 0.13 mm to 0.16 mm from the bifurcation point. The externo-dorsal ray had a length of 0.40 mm to 0.45 mm. The divergent branches of the lateral rays were slender (Plate VIII, Fig.4). The ventral rays measured 0.20 mm to 0.24 mm. The spicules were equal and similar and each had a sickle shaped point (Plate VIII, Fig.5). They measured 0.80 mm to 0.92 mm in length. The accessory piece was curved from side to side and measured 0.16 mm to 0.21 mm in length.

Female: The length of female worms ranged from 21 mm to 28 mm and the width ranged from 0.9 mm to 1.13 mm. The head measured 0.21 mm to 0.30 mm in diameter and the buccal capsule measured 0.12 mm to 0.22 mm by 0.10 mm. The diameters at the region of oesophageal bulb and cephalad to vulva were 0.44 mm to 0.57 mm and 0.47 mm to 0.71 mm respectively. The oesophagus measured 0.81 mm to 0.93 mm in length and 0.26 mm to 0.34 mm in width. The nerve ring excretory pore and cervical papillae were at 0.33 mm to 0.52 mm, 0.64 mm to 0.80 mm and 0.81 mm to 0.90 mm respectively from the cephalic end. The cuticular striations were 0.03 mm to 0.04 mm apart.

The caudal papillae were at 1.00 mm to 1.23 mm, the anus was at 1.9 mm to 2.28 mm and the vulva was at 5.4 mm to 7.06 mm from the tip of the sharply pointed tail (Plate VIII, Fig.6). The ovifectors were divergent, but the posterior portion of uterus, immediately turned cephalad. The two uteri ran cephalad side by side. The ova measured 0.06 mm to 0.07 mm by 0.035 mm to 0.04 mm.

The comparative measurements of Q. renniei recorded by Lane (1914), Westhuyzen (1938), Fernando and Fernando (1961) and in the present study are given in table 4.

4. Chonionqium epistomum (Plana and Stazzi, 1900)

General morphological features

(Plate IX, Figs.1, 2 and 3; Plate X, Figs.1 and 2)

Chonionqium epistomum worms were fairly stout and straight. The anterior extremity was obliquely truncated, so that the mouth was directed antero-dorsally. The oral aperture was surrounded by a corona of about 50 converging leaflets. Each leaflet was supported by an external cuticular flap and it extended little above the head. The buccal capsule was large and funnel shaped. There were no teeth at the base but four pairs of hemispheroidal cuticular prominences projected into the oral cavity. One pair was situated posterior of its equator close to the mid-dorsal duct. The second pair was more cephalad and on a more ventral line of the first pair. The third pair at the same level and just cephalad of the last pair, the fourth smaller pair was found anteriorly and



Fig. 1



Fig. 2

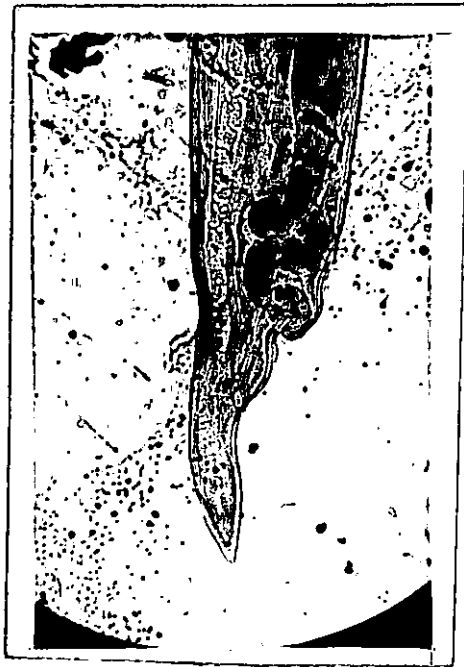


Fig. 3

ventrally in the anterior third of the buccal capsule. The dorsal gutter showed a thin line. No cervical gland was visible.

The valves of the chyle intestine were exceptionally large and the anterior extremity of the chyle intestine was wider than the posterior extremity of the oesophagus.

Male: The male worm measured from 16 mm to 21 mm in length and 0.73 mm to 0.91 mm in width. The diameter of head measured 0.47 mm to 0.52 mm and the buccal capsule measured 0.63 mm to 0.87 mm by 0.38 mm to 0.42 mm. The diameters at the region of nerve ring and cephalad to bursa were 0.60 mm to 0.75 mm and 0.35 mm to 0.52 mm respectively. The oesophagus was 1.4 mm to 1.76 mm in length and 0.32 mm to 0.42 mm in width. The nerve ring, the excretory pore and the cervical papillae were 1.10 mm to 1.28 mm, 2.0 mm to 2.23 mm and 2.1 mm to 2.34 mm from the cephalic end respectively. The cuticular striations were 0.02 mm apart.

The male bursa was longer dorsally than ventrally. The ventral rays were apposed. The points of the three branches of the lateral rays were divergent. A granular accessory lateral ray was present (Plate X, Fig.3). The dorsal ray was divided into three branches, each of which was bifurcated (Plate X, Fig.4).

The length of dorsal ray was 0.53 mm to 0.55 mm and the externo-dorsal ray was long and sinuous and measured 0.40 mm to 0.43 mm in length. The spicules were equal similar and

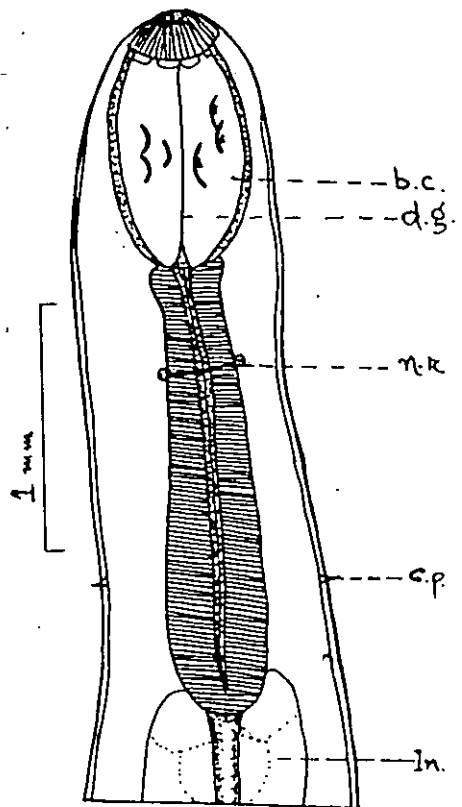


Fig. 1

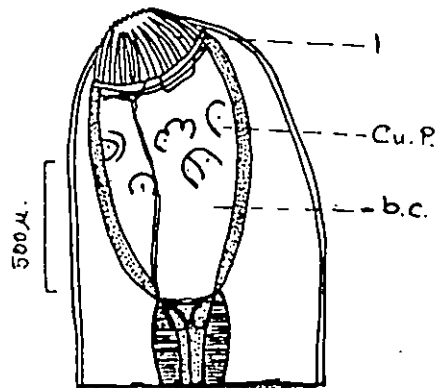


Fig. 2

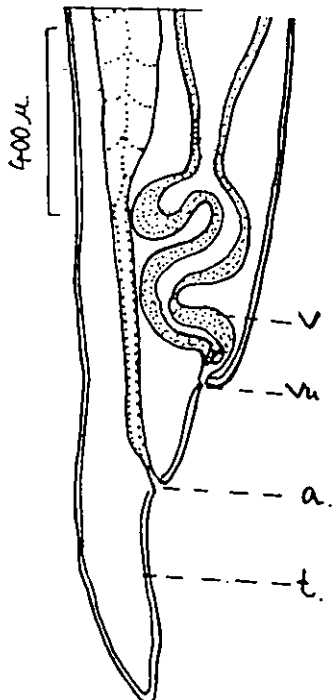


Fig. 6

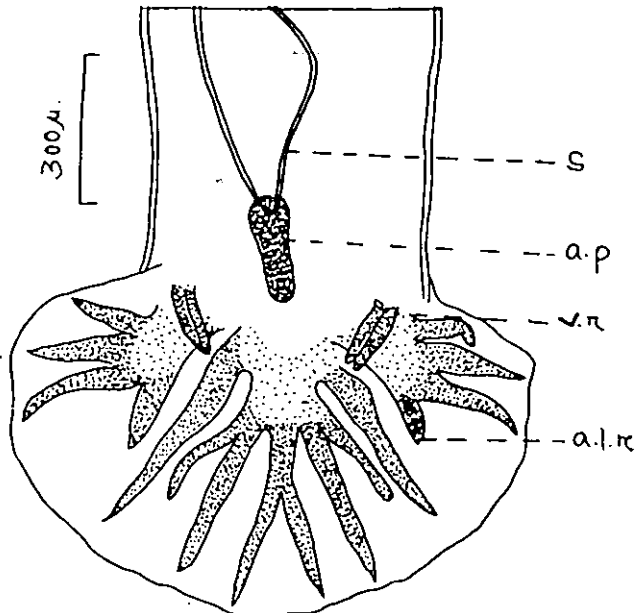


Fig. 4

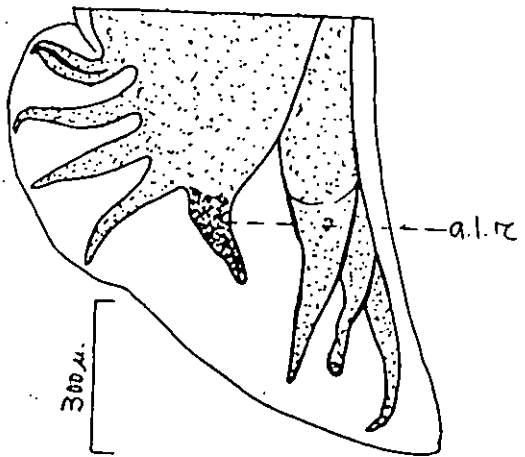


Fig. 3

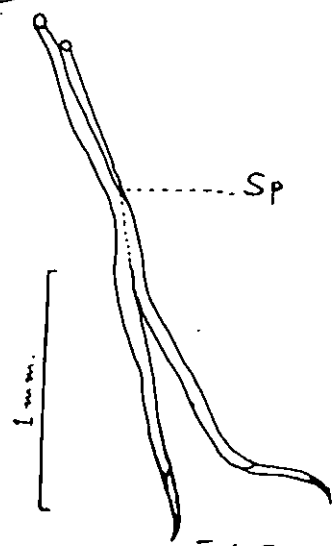


Fig. 5

terminated in fine points being widest at the equator and measured 2.23 mm to 2.4 mm in length (Plate X, Fig.5). The accessory piece was 0.20 mm to 0.25 mm long with wider posterior portion.

Female: The female worm measured from 18.5 mm to 23 mm in length and 0.97 mm to 1.09 mm in width. The diameter of the head ranged from 0.52 mm to 0.68 mm and the buccal capsule measured 0.75 mm to 0.86 mm by 0.40 mm to 0.52 mm. The diameters at the region of nerve ring and cephalad to anus were 0.69 mm to 0.78 mm and 0.19 mm to 0.21 mm. The length of oesophagus was from 1.72 mm to 2.10 mm and the width of bulb was from 0.31 mm to 0.42 mm. The nerve ring, the excretory pore and the cervical papillae were at 1.25 mm to 1.49 mm, 2.18 mm to 2.9 mm and 2.36 mm to 2.7 mm respectively from the anterior end. The cuticular striations were 0.028 mm to 0.030 mm apart.

The vulva of the female worm was situated close to the anus where the worm suddenly narrowed. The vagina was divided into two uteri running parallel towards the cephalic end. The tail was bluntly conical.

The lateral caudal papillae were at 0.15 mm, the anus 0.39 mm to 0.52 mm and vulva 0.64 mm to 0.85 mm respectively from the tip of tail (Plate X, Fig.6). The length of vagina was 1.05 mm to 1.50 mm.

The comparative measurements recorded by Lane (1914), Ware (1924) and in the present study are furnished in table 5.

5. Decrusia additictia (Railliet, Henry
and Bauche, 1914)

General morphological features

(Plate XI, Figs.1, 2 and 3; Plate XII, Figs.1 and 2)

Decrusia additictia were fairly stout worms tapering at both ends and the head was truncated with the mouth subterminal facing slightly dorsal. Dorsal wall of the oral cavity was slightly shorter than the ventral. The oral aperture was surrounded by an internal corona composed of numerous short and blunt leaflets, which were somewhat masked by the more pronounced external leaf crown, the elements of which were pointed and longer than those of the internal leaf crown. Both leaf crowns arose apparently at the same level. A cup shaped buccal capsule with two triangular shaped sub-ventral teeth at its base was present. The dorso-oesophageal duct was very pronounced and ran along the dorsal wall of the mouth cavity as a canal, bordered by scalloped marking. Six oesophago-intestinal valves were present. Cervical papillae were absent.

Male: The male worm measured 16 mm to 18 mm in length and 0.78 mm to 1.0 mm in width. The buccal capsule measured 0.34 mm to 0.4 mm by 0.32 mm to 0.43 mm. The diameters at the nerve ring region and cephalad to bursa were 0.52 mm and 0.47 mm respectively. The length of oesophagus was 1.39 mm to 1.62 mm and width ranged from 0.34 mm to 0.36 mm. The nerve ring and excretory pore were at 1.0 mm to 1.06 mm and 1.04 mm respectively from the cephalic end. The cuticular striation was 0.01 mm apart.



Fig. 1

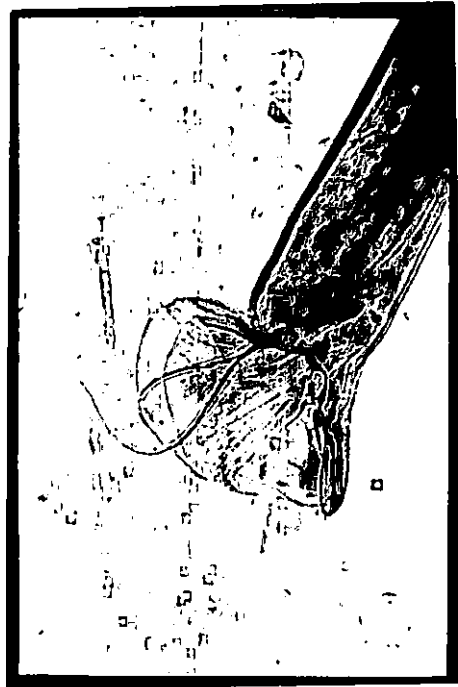


Fig. 2



Fig. 3

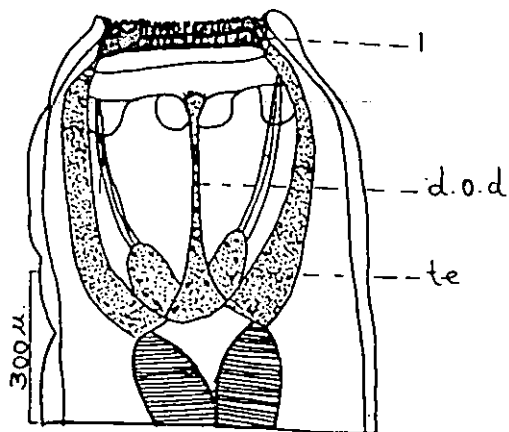


Fig. 1

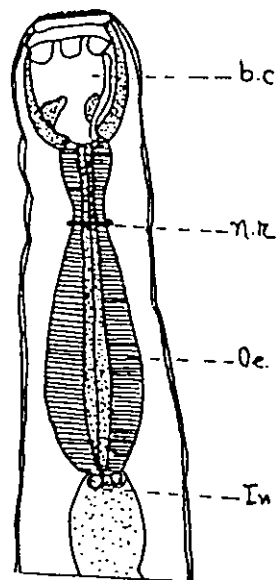


Fig. 2

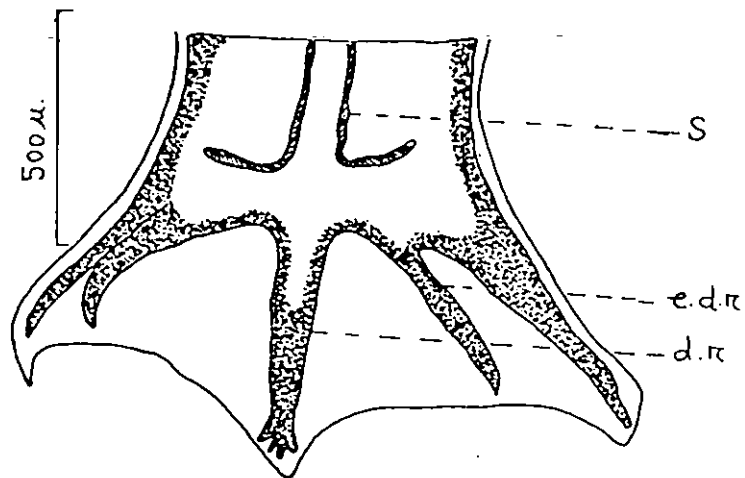


Fig. 4

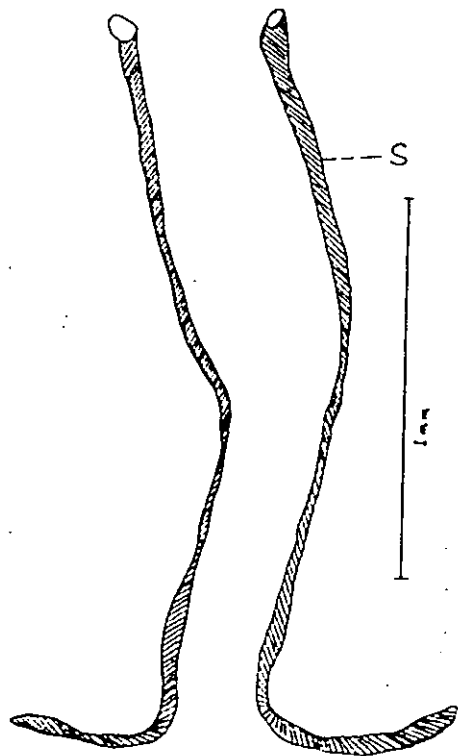


Fig. 5

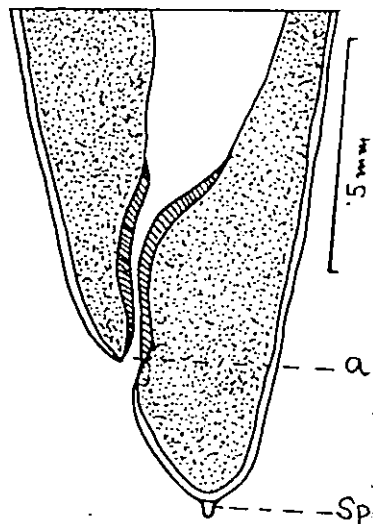


Fig. 6

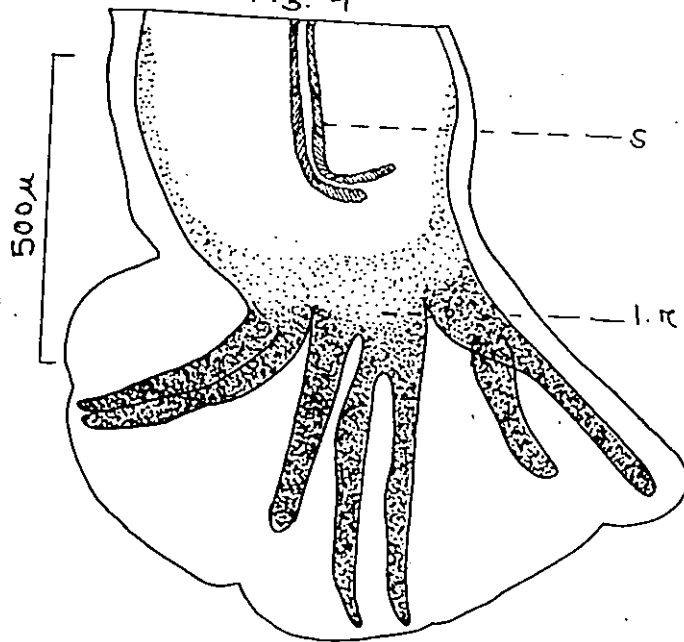


Fig. 3

The ventral rays of the bursa were long and stout, and measured 0.28 mm long (Plate XII, Fig.3). The dorsal ray was undivided except at its extreme tip (Plate XII, Fig.4).

The length of dorsal ray was 0.36 mm to 0.40 mm and at 0.05 mm to 0.1 mm cephalad to the extremity it gave off a stout branch and a small one, caudad to this. The externo-dorsal ray was comparatively short and measured 0.25 mm in length. The spicules had a length of 2.31 mm to 2.54 mm and were equal with a marked cross striations at the base and tapering extreme point (Plate XII, Fig.5). Accessory piece was absent.

Female: The female worms ranged from 18 mm to 22 mm in length and 1.10 mm to 1.31 mm in width. The diameter of the buccal capsule was 0.47 mm to 0.51 mm and the length was 0.45 mm to 0.48 mm. The diameters at the region of the nerve ring and cephalad to anus were 0.56 mm to 0.57 mm and 0.26 mm to 0.28 mm respectively. The oesophagus measured 1.76 mm to 1.96 mm in length and the width ranged from 0.39 mm to 0.44 mm. The nerve ring and excretory pore were at 1.06 mm to 1.16 mm and 1.06 mm to 1.11 mm respectively from the cephalic end. The sub-ventral teeth measured 0.20 mm by 0.07 mm.

The caudal papillae and the anus were at 0.05 mm and 0.28 mm to 0.31 mm respectively from the tip of tail (Plate XII, Fig.6). The vulva was situated in the posterior third of the body at 7.53 mm to 8.31 mm from tail tip and was marked by a cap of dark cement. The vagina was folded and joined with a

bilobed muscular ovijector from which the two uteri originated, the caudad running uterus turned immediately cephalad. The ova measured 0.07 mm by 0.035 mm.

The comparative measurements recorded by Lane (1914), Westhuysen (1938), Fernando and Fernando (1961) and in the present study are listed in table 6.

6. Amira pileata (Railliet, Henry and Bauche, 1914)

General morphological features

(Plate XIII, Figs. 1, 2 and 3; Plate XIV, Fig. 1)

Amira pileata were fairly small worms with a thick cuticle. The mouth collar was separated from the rest of the cephalic end by a groove. The mouth capsule was very short, circular and its dorso-ventral and lateral axis were equal in length. There were six head-papillae, four sub-median and two sessile laterals, none of which were prominent. The capsule was shallow and bore a row of tubercles at its base. The mouth was terminal and was surrounded by external and internal leaf crowns each with 32 elements. The external leaf crown elements extended slightly beyond the anterior rim of the mouth collar and internal leaf crown elements were short and formed anterior margin of the mouth capsule. The oesophagus was hour glass shaped with the nerve collar surrounding the constriction. The posterior extremity of the short oesophagus projected into the beginning of the chyle-intestine forming three small lobes. An oesophageal funnel was present extending from the mouth

Plate XIII

- Fig. 1. Amira pileata - head end (x 70)
Fig. 2. Amira pileata - male tail (x 40)
Fig. 3. Amira pileata - female tail (x 70)



Fig. 1



Fig. 2

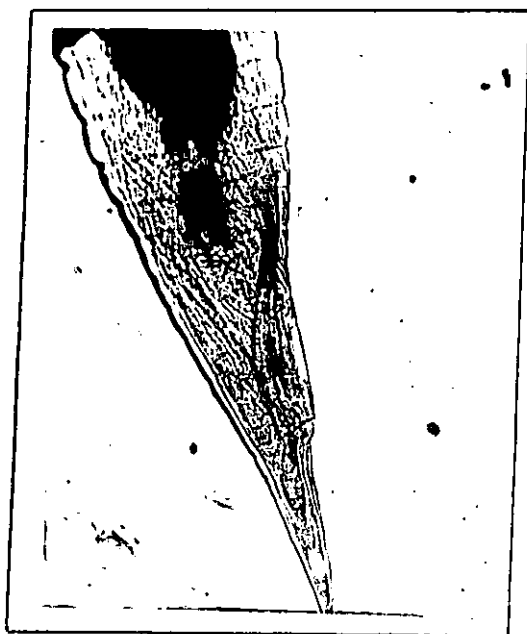


Fig. 3.

capsule to the level of nerve ring. The oesophagus had a cuticular lining.

Male: The male worm measured 12 mm to 12.5 mm in length and 0.56 mm to 0.74 mm in width. The diameter of head was 0.18 mm to 0.22 mm. The buccal capsule measured 0.11 mm to 0.14 mm by 0.03 mm to 0.05 mm. The length of oesophageal funnel was 0.16 mm to 0.17 mm. The oesophagus measured 0.48 mm to 0.61 mm by 0.27 mm to 0.35 mm. The nerve ring was at 0.25 mm to 0.31 mm from the anterior end. The excretory pore and cervical papillae had more or less equal distance (0.57 mm to 0.71 mm) from the anterior end. The cuticular striations were 0.02 mm to 0.04 mm apart.

The length of male bursa ranged from 1.9 mm to 2.15 mm. The dorsal lobe of the bursa was enormously elongated (Plate XIV, Fig.2). The cuticle in front of bursa was much thickened on the ventral surface. The prebursal papillae were long, thin, wavy and measured 0.22 mm in length. The ventral rays were closer together, of which the anterior one was thinner than the posterior. The three lateral rays had a common origin and the postero-lateral ray branched before the other two rays (Plate XIV, Fig.3). The outline of the edge of dorsal lobe of the bursa laid close to the edge of the sub-division of the ray so that the lobe was extraordinarily narrow and long. A gubernaculum was present. The externo-dorsal ray pursued a wavy course taking off from the main stem of the dorsal ray at a distance of 0.30 mm from its base. The dorsal ray had a

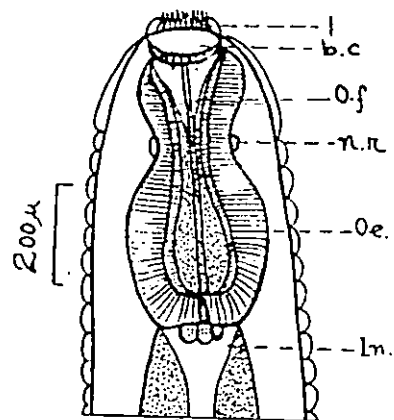


Fig. 1

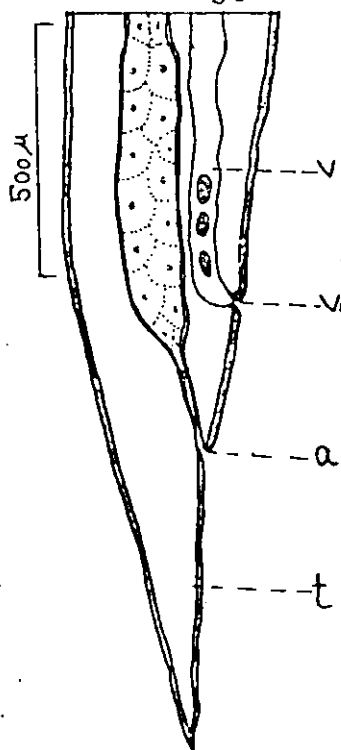


Fig. 5

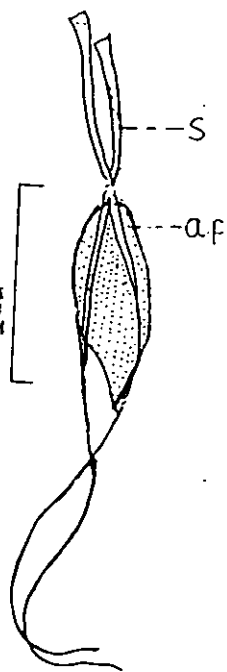


Fig. 4

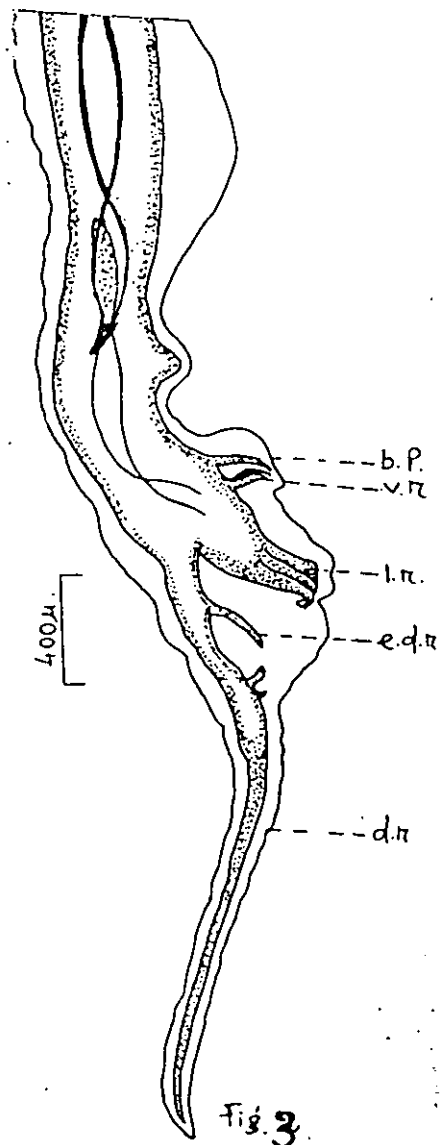


Fig. 3

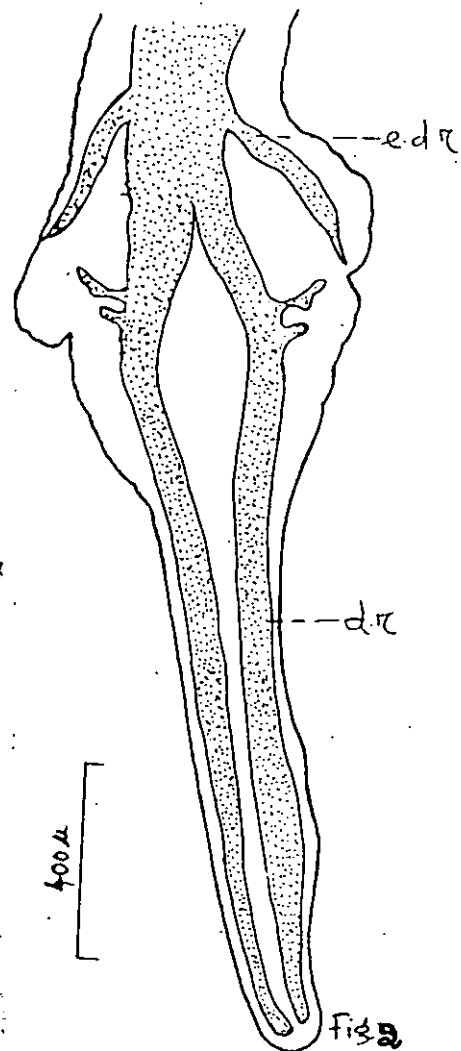


Fig. 2

length of 1.6 mm to 1.83 mm with a breadth of 0.52 mm to 0.55 mm. It divided high up within 0.18 mm of its origin, after a short course, each primary division gave off two branches close to each other, the longer branch had 0.13 mm in length and shorter branch 0.06 mm in length. These branches appeared as off-shoots from the main stem. The main branches of the dorsal ray continued a straight course parallel and close together. The spicules were long, fine and equal with a length of 3.62 mm to 3.97 mm. A gubernaculum was present (Plate XIV, Fig.4).

Female: The female worm had a length of 12.5 mm to 15.5 mm with a breadth of 0.63 mm to 0.78 mm. The diameter of head measured 0.19 mm to 0.24 mm and the buccal capsule measured 0.12 mm to 0.14 mm by 0.03 mm to 0.06 mm. The diameters at the region of nerve ring and cephalad to anus were 0.40 mm to 0.52 mm and 0.15 mm to 0.16 mm respectively. The oesophagus measured 0.55 mm to 0.61 mm in length and 0.32 mm to 0.36 mm in width. The nerve ring, excretory pore and cervical papillae were at 0.29 mm to 0.33 mm, 0.65 mm to 0.74 mm and 0.72 mm to 0.82 mm respectively from the anterior extremity. The length of oesophageal funnel ranged from 0.20 mm to 0.21 mm.

The vulva was found close to the anus. The caudal end gradually tapered to a rather blunt point. The anus and vulva were at a distance of 0.40 mm to 0.50 mm and 0.60 mm to 0.80 mm respectively from the tip of tail (Plate XIV, Fig.5). The long

vagina ran cephalad and divided into two parallel cephalad running uteri with ovifectors. The length of vagina was 2.4 mm to 2.76 mm. The ova measured 0.06 mm to 0.065 mm by 0.03 mm to 0.035 mm.

The comparative measurements of Amira pileata recorded by Lane (1914), Westhuysen (1938) and in the present study are given in table 7.

7. Equinubria sipunculiformis (Baird, 1859)

General morphological features

(Plate XV, Figs.1, 2 and 3; Plate XVI, Fig.1)

Equinubria sipunculiformis was fairly large and stout. The head separated from the body by a distinct neck. The oral aperture was surrounded by an external leaf crown consisting of 168 rays of which 56 were long and between each pair of these rays two shorter rays were located. The internal leaf crown was composed of numerous small, short and stout elements. The oral aperture was pointed slightly dorsad, and was surrounded by two lateral and four sub-median papillae none of which were very prominent. The buccal capsule was cup-shaped which bore upto ten teeth like structures at the base and the dorsal wall was shorter than the ventral one. The fine duct of the dorsal oesophageal gland ran along the mid-dorsal line which discharged through a dorsal gutter. The anterior end of the oesophagus was enlarged and its posterior bulb ended at the chyle-intestine with three valves.



Fig. 1

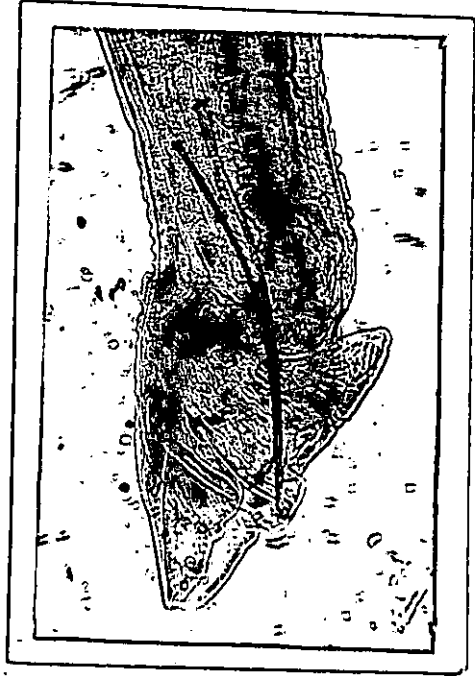


Fig. 2



Fig. 3

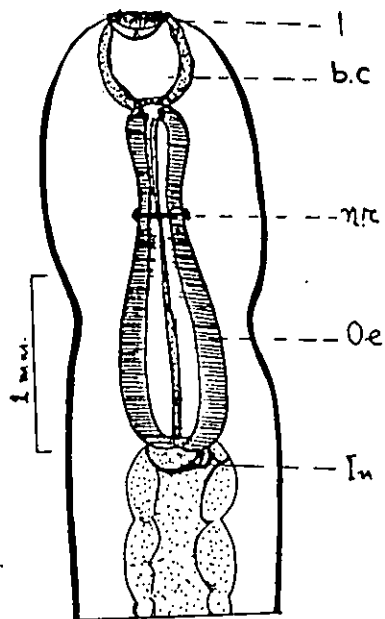


Fig. 1

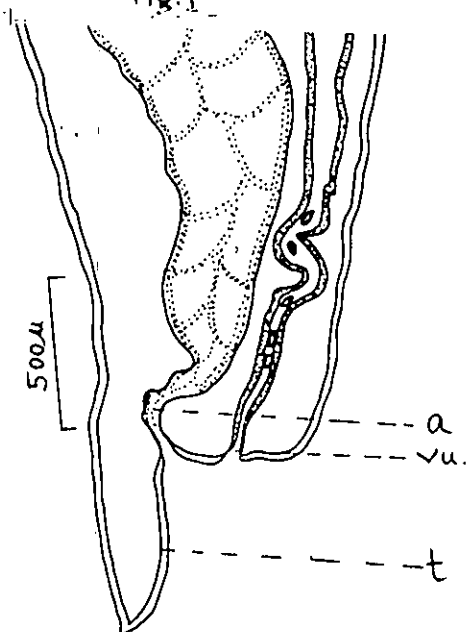


Fig. 5

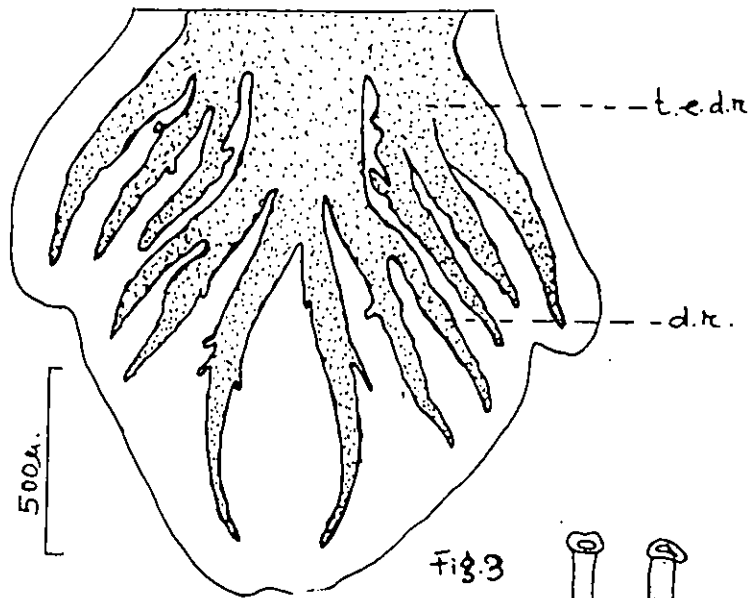


Fig. 3

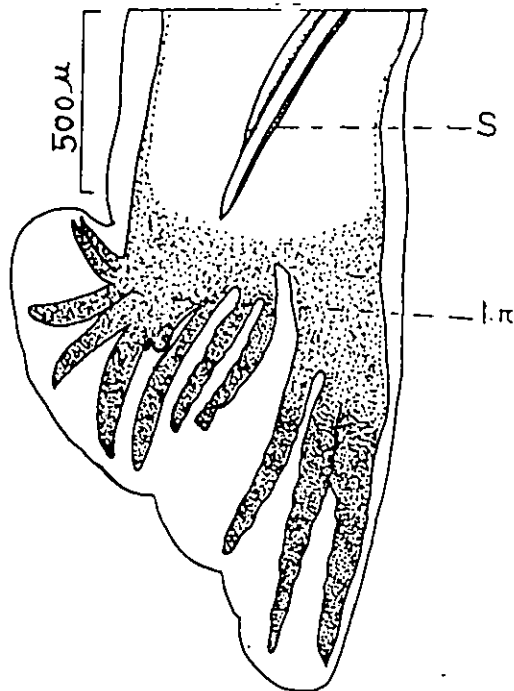


Fig. 2

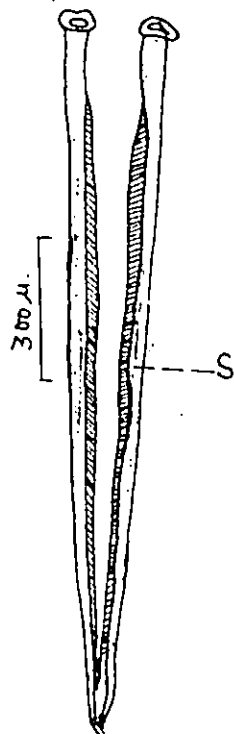


Fig. 4

Male: The male worms were straight but turned abruptly dorsad just cephalad to bursa and measured from 18.5 mm to 21.00 mm in length and 1.4 mm to 1.69 mm in width. The diameter of the head measured from 0.8 mm to 0.95 mm and the buccal capsule measured 0.30 mm to 0.37 mm by 0.41 mm to 0.44 mm. The diameters of the body at the level of nerve ring and cephalad to bursa were 1.02 mm to 1.05 mm and 0.79 mm to 0.81 mm respectively. The length and width of oesophagus measured 1.92 mm to 2.10 mm and 0.39 mm to 0.41 mm respectively. The nerve ring and excretory pore were situated at a distance of 0.9 mm to 1.1 mm and 2.4 mm respectively from cephalic end. The cuticular striations were 0.003 to 0.004 mm apart.

The ventral rays were apposed and the lateral rays had marked diverged points (Plate XVI, Fig.2). The posterior-lateral ray had a boss at its base. The dorsal lobe of the bursa was longer than the laterals. The dorsal ray had a length of 1.2 mm and had three subdivision on each side marked in the irregular prominences. The externo-dorsal ray trifurcated of which the ventral branch was the longest with a measurement of 0.55 mm to 0.60 mm than the other two branches, which were considerably shorter and irregular in outline (Plate XVI, Fig.3). The spicules were strong, equal and similar and measured 1.4 mm to 1.6 mm (Plate XVI, Fig.4). Accessory piece was absent.

Female: The female worms were also straight but showed a slight dorsad deviation at the tail end and measured 20 mm to 25 mm in length and 1.55 mm to 1.9 mm in width. The diameter

of head was 0.8 mm to 0.99 mm and the buccal capsule measured 0.30 mm to 0.40 mm by 0.36 mm to 0.42 mm. The oesophagus measured 2.0 mm to 2.50 mm in length and 0.41 mm to 0.47 mm in width. The nerve ring, the excretory pore and the cervical papillae were at 0.96 mm to 1.26 mm, 2.73 mm and 2.76 mm from the cephalic end respectively. The anus was found at the bottom of a depression between the tail and a marked caudal projecting conical prominence on which the vulva opened. The length of tail was 0.7 mm to 0.83 mm and the distance of vulva from anus was 0.25 mm to 0.28 mm (Plate XVI, Fig.5). The vagina ran cephalad for 1.7 mm to 1.9 mm and then divided into two uteri which also ran cephalad side by side and ended in weak ovifectors. The ova measured 0.06 mm to 0.062 mm by 0.030 mm to 0.032 mm.

The comparative measurements of Equinubria sipunculiformis recorded by Lane (1914), Westhuysen (1938), Fernando and Fernando (1961) and in the present study are given in table 8.

8. Parabronema indicum (Baylis, 1921)

General morphological features

(Plate XVII, Figs.1, 2 and 3; Plate XVIII, Figs.1 and 2)

They were rather smaller worms having the mouth bordered by paired lateral lips, each with three papillae. The head was conical and distinctly narrowed in front than behind. The cephalic extremity was provided with dorsal and ventral cuticular shields and was ornamented with six horse-shoe shaped cordons or auricular appendages which bore narrow groove on on their free edges of which two were lateral, two sub-ventral



Fig. 1

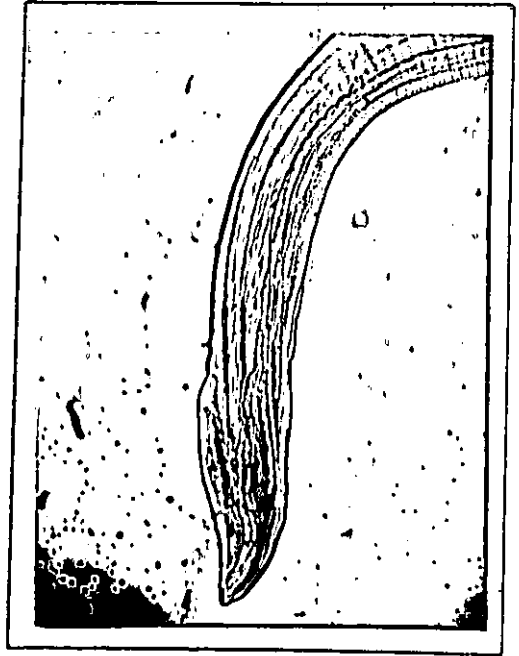


Fig. 2

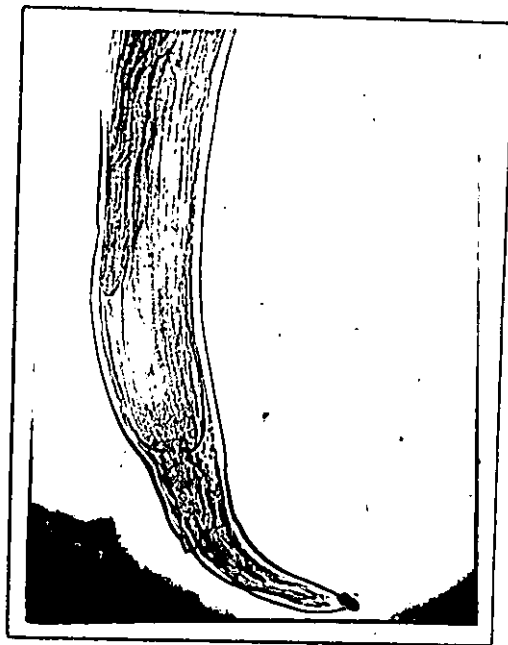


Fig. 3.

and two sub-dorsal. The oral aperture was of greater diameter dorso-ventrally and passed into a long vestibule or cuticular tube which led into the oesophagus. The oesophagus consisted of two portions, both muscular, the anterior part was short and narrow and the posterior part was long and broad. The cephalic portion of the oesophagus was surrounded by a thick nerve collar. The excretory pore was located anterior to the cervical papillae, which was more or less in the region of the nerve ring. The vulva opened near the posterior part of oesophagus.

Male: The caudal end of the male worm coiled ventrally with interrupted longitudinal ridges on ventral side of the hind end. The male worm ranged from 7 mm to 8 mm in length and 0.28 mm to 0.30 mm in width. The diameter of the head was 0.11 mm to 0.13 mm and the length of buccal tube was from 0.13 mm to 0.15 mm. The diameters at the region of nerve ring and anal region were 0.15 mm to 0.16 mm and 0.22 mm to 0.24 mm respectively. The length and width of oesophagus were 1.44 mm to 2.2 mm and 0.15 mm respectively. The nerve ring, the excretory pore and cervical papillae were from 0.23 mm to 0.27 mm, 0.18 mm to 0.22 mm and 0.24 mm to 0.28 mm respectively from the cephalic end. The cuticular striations were 0.03 mm apart.

The tail length was 0.18 mm to 0.22 mm. A small caudal alae was noticed and four pairs of pre-anal and two pairs of post-anal papillae were found arranged asymmetrically. One additional extra double papillae immediately in front of anus was also present. The anterior pair of post-anal papillae overlapped

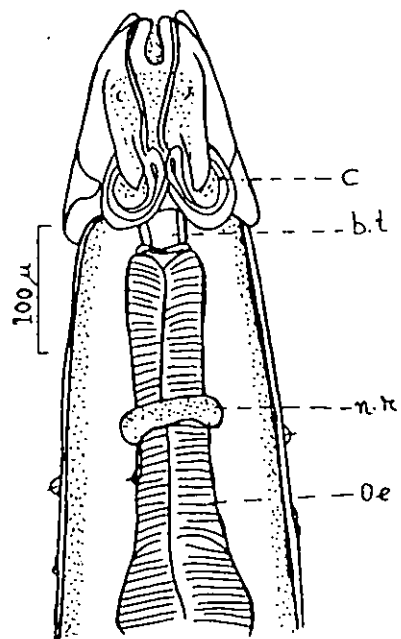


Fig. 1

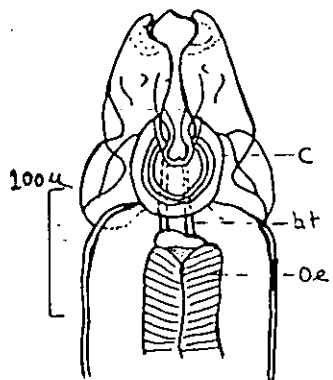


Fig. 2

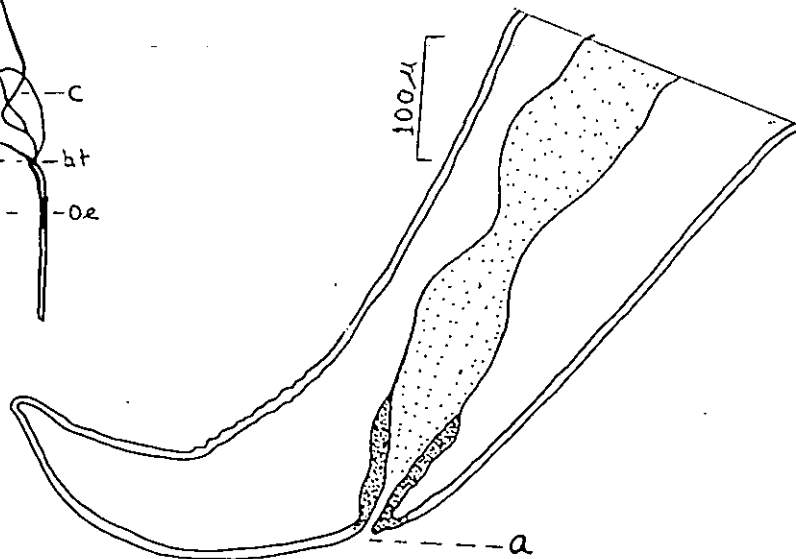


Fig. 6

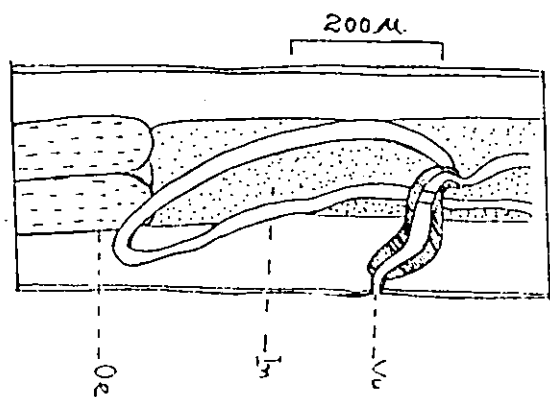


Fig. 5

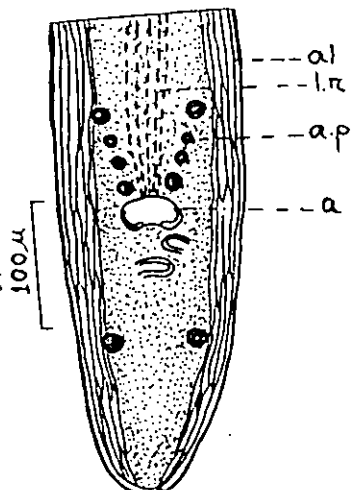


Fig. 3

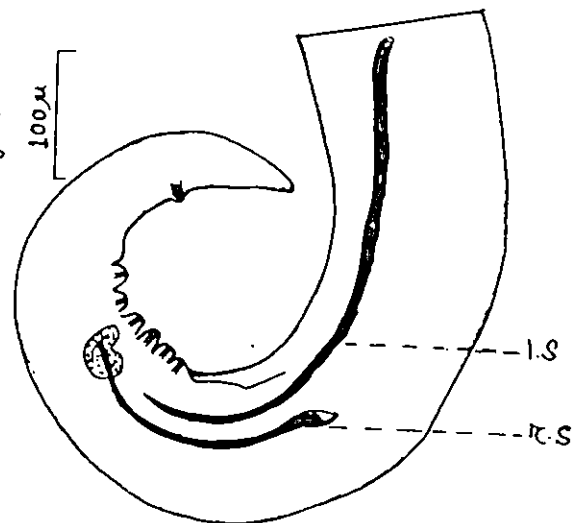


Fig. 4

each other so that the termination of the right papillae was well on the left of the mid-ventral line and posterior pair was symmetrically placed opposite to each other (Plate XVIII, Fig.3). The posterior-most pair of post-anal papillae was at 0.12 mm from the posterior end. The spicules were unequal, the left being very slender and about two and a half times longer than the right and measured 0.92 mm to 0.99 mm and 0.36 mm to 0.41 mm respectively. The accessory piece was somewhat triangular in shape and measured 0.05 mm in length (Plate XVIII, Fig.4).

Female: The posterior extremity was curved dorsally and the female worms were considerably larger than male and measured 11 mm to 13 mm in length and 0.33 mm to 0.36 mm in width. The posterior diameter of the head was 0.14 mm to 0.16 mm and the length of buccal tube was from 0.15 mm to 0.17 mm. The oesophagus measured 1.90 mm to 2.26 mm in length and 0.16 mm to 0.20 mm in width. The nerve ring, the excretory pore and the cervical papillae were at 0.24 mm to 0.34 mm, 0.22 mm to 0.80 mm and 0.28 mm to 0.35 mm respectively from cephalic end.

The vulva was located at a distance of 0.15 mm to 0.43 mm posterior to the bulb of oesophagus. The vagina was about 0.22 mm in length and formed a characteristic "U" shape (Plate XVIII, Fig.5). After a further course of 0.4 mm, it widened into a fusiform swelling which gave off the two uterine branches posteriorly. One branch ran posterior to a point about 0.30 mm to 0.60 mm from the anus where it turned anterior again. The other branch turned anterior, a short distance from its

origin and ran upto about the level of posterior end of oesophagus. This formed a loop and ran once more posterior. The tail was short and measured 0.28 mm to 0.40 mm in length (Plate XVIII, Fig.6). The caudal papillae were at a distance of 0.03 mm from tail tip.

The comparative measurements of Parabronema indicum recorded by Baylis (1921), Westhuysen (1938) and in the present study are furnished in table 9.

9. Parabronema smithi (Cobbold, 1882)

General morphological features

(Plate XIX, Figs.1, 2 and 3; Plate XX, Fig.1)

The general morphological features of Parabronema smithi were similar to that of P. indicum.

Male: The male worm measured 4.1 mm to 5.10 mm in length and 0.19 mm to 0.21 mm in width with the tail coiled ventrally into a spiral and provided near the extremity with lateral ala-like expansion and largely covered on the ventral surface with interrupted, longitudinal ridges (Plate XX, Fig.2). The diameter of head measured 0.08 mm to 0.09 mm and the length of the buccal tube was 0.08 mm to 0.10 mm. The length of oesophagus was 1.06 mm to 1.25 mm and width was 0.08 mm to 0.11 mm. The nerve ring and cervical papillae were at 0.17 mm to 0.23 mm and 0.17 mm to 0.27 mm respectively from the cephalic end. The diameters at the nerve ring region and at the spicule region were 0.10 mm to 0.12 mm and 0.13 mm to 0.16 mm respectively. The cuticular striations were 0.025 mm to 0.03 mm apart.



Fig. 1



Fig. 2

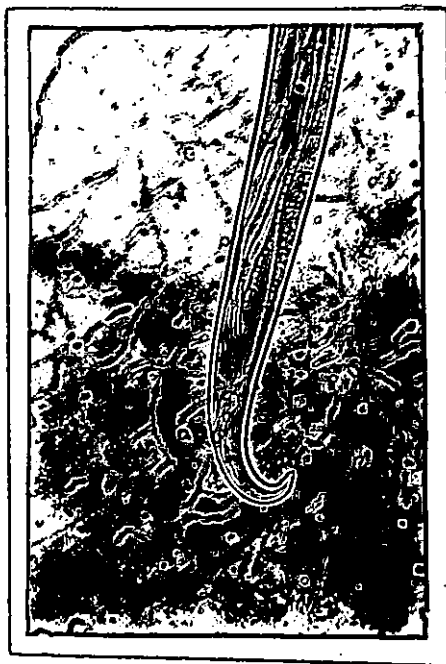


Fig. 3

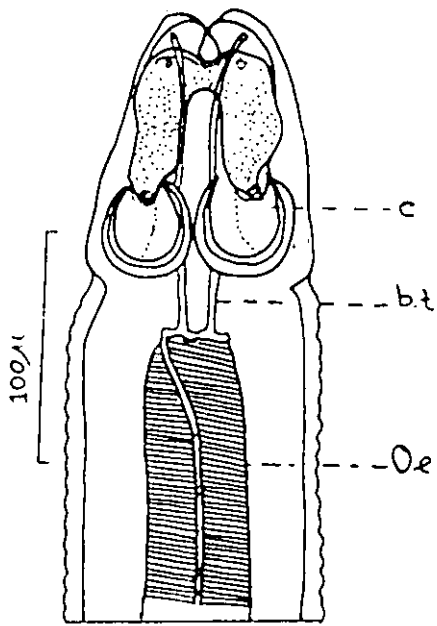


Fig. 1

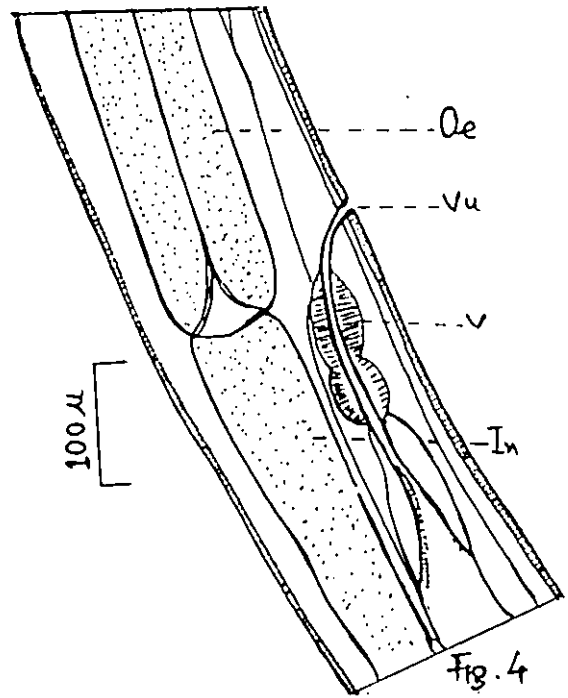


Fig. 4

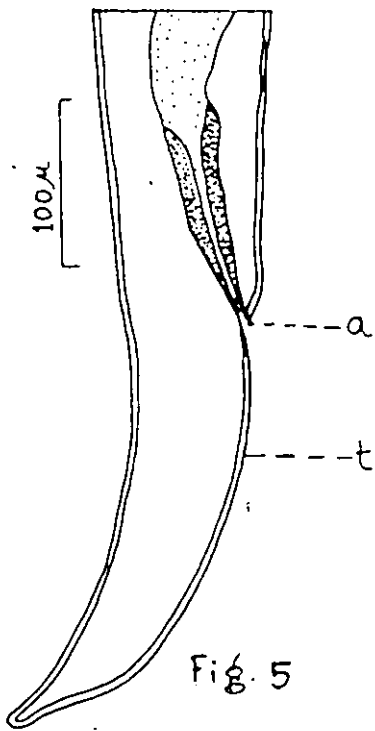


Fig. 5

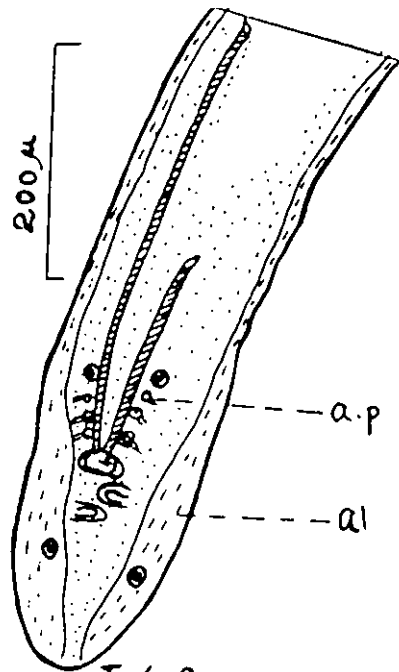


Fig. 2

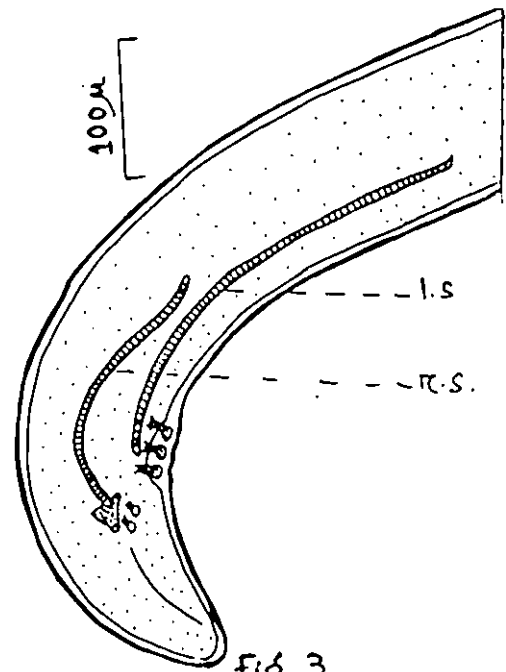


Fig. 3

The spicules were markedly unequal, the left being stouter and double the length of the right spicule (Plate XX, Fig.3). The left spicule was 0.38 mm to 0.43 mm and right spicule was 0.20 mm to 0.22 mm long. But in one case the left spicule was 0.58 mm long and right spicule was 0.20 mm. The accessory piece was 0.03 mm long.

The tail length was 0.16 mm to 0.20 mm. The anteriormost pre-anal papillae and posterior-most post-anal papillae were 0.22 mm to 0.26 mm and 0.09 mm to 0.11 mm from the posterior end respectively.

Female: The female worms were larger than the male worms and the tail was directed dorsally. They measured 7 mm to 8.5 mm in length and 0.24 mm to 0.29 mm in breadth. The diameters at the nerve ring region and anal opening were 0.12 mm to 0.14 mm and 0.08 mm to 0.11 mm respectively. The posterior diameter of the head was 0.09 mm to 0.10 mm and the length of buccal tube was 0.08 mm to 0.10 mm. The oesophagus had a length of 1.29 mm to 1.48 mm and a width of 0.09 mm to 0.12 mm. The nerve ring, the excretory pore and cervical papillae were at a distance of 0.19 mm to 0.26 mm, 0.18 mm to 0.21 mm and 0.21 mm to 0.27 mm respectively from the cephalic end. The cuticular striations were 0.03 mm apart.

The vulva was located at 0.05 mm anterior to the oesophageal end or 0.45 mm posterior to it (Plate XX, Fig.4). The posterior branch of uterus turned about 0.13 mm to 0.16 mm from the anus anteriorly. The tail length was 0.25 mm to 0.33 mm

and a small papilla was found 0.02 mm to 0.03 mm from the tip of tail (Plate XX, Fig.5).

The comparative measurements of P. smithi recorded by Baylis (1921), Westhuyzen (1938) and in the present study are furnished in table 10.

10. Grammocephalus hybridatus (Westhuyzen 1938)

General morphological characters

(Plate XXI, Figs.1, 2 and 3; Plate XXII, Fig.1)

These worms were fairly stout worms with dorsally bent anterior extremities. The buccal capsule was wide but narrowed posteriorly. The fold in the dorsal wall of the buccal capsule was not marked. The semilunes situated at the oral margin were not large. The buccal capsule had a pair of lateral teeth and a pair of sub-ventral teeth. The apical notches of the sub-ventral teeth were small and their anterior edges faced anteriorly and dorsally. The ventral anterior edge was produced into an acute point. The anterior edges of the lateral lancets were found anterior to the corresponding edges of the sub-ventral teeth. The single dorsal tooth was not prominent but received the duct of the dorsal oesophageal gland. The intestine had a long anteriorly directed dorsal diverticulum which arose closely with the oesophagus.

Male: The male worm had a length of 35 mm to 38 mm and width of 1.39 mm to 1.47 mm. The buccal capsule measured 0.48 mm to 0.50 mm by 0.22 mm to 0.25 mm.

The oesophagus measured 3.7 mm to 3.75 mm in length and



Fig. 1



Fig. 2



Fig. 3

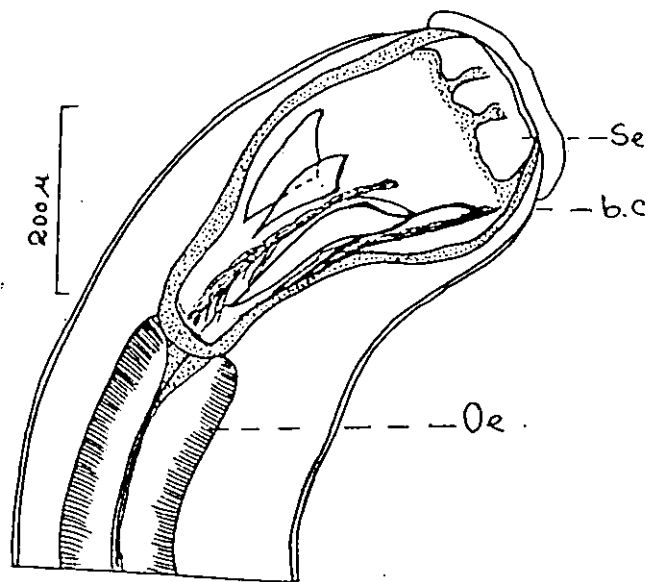


Fig. 1

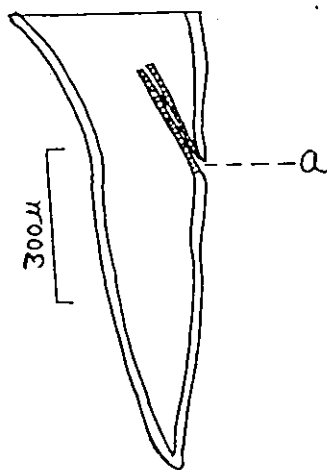


Fig. 6

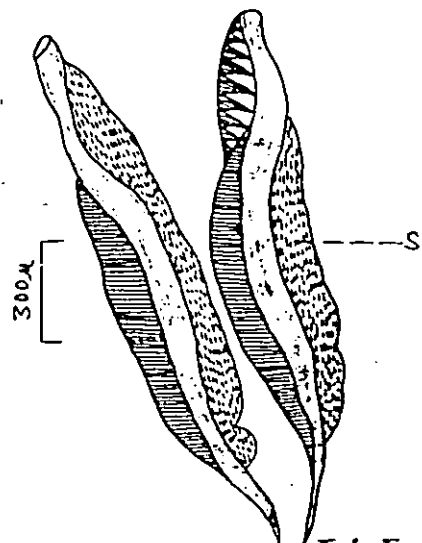


Fig. 5

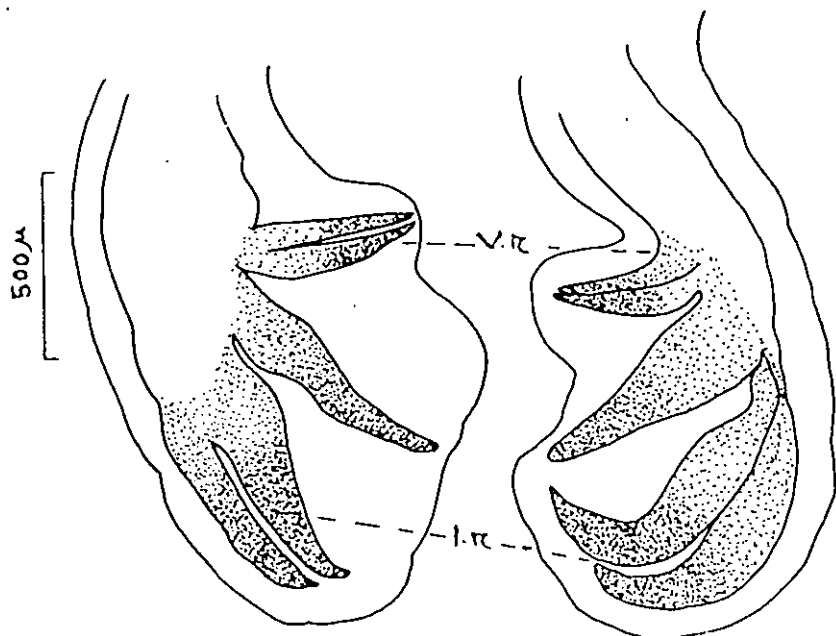


Fig. 2

Fig. 3

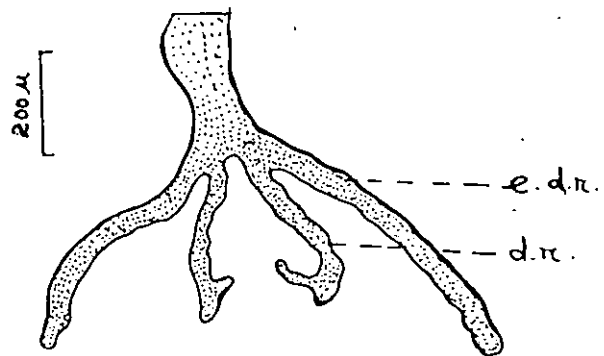


Fig. 4

0.27 mm in width. The nerve ring, excretory pore and cervical papillae were at a distance of 1.05 mm, 1.20 mm and 1.25 mm respectively from the cephalic end. The cuticular striations were 0.008 to 0.012 mm apart.

The bursa was elongated. The medio and postero-lateral rays were close together (Plate XXII, Figs.2 and 3). The dorsal ray and externo-dorsal rays arose from a common trunk. The dorsal ray was divided into two branches which were again bidigitate (Plate XXII, Fig.4). The length of dorsal ray and externo-dorsal ray was 0.45 mm and 0.60 mm respectively. The spicules were stout, alate and had a length of 1.55 mm to 1.67 mm and a width of 0.2 mm to 0.25 mm (Plate XXII, Fig.5). An accessory piece was absent.

Female: The female was shorter than male and measured 31 mm to 32 mm in length and 1.33 mm to 1.36 mm in width. The buccal capsule measured 0.45 mm to 0.46 mm by 0.21 mm. The length and width of oesophagus were 3.52 mm to 3.66 mm and 0.26 mm respectively. The nerve ring, the excretory pore and cervical papillae were respectively at a distance of 1.0 mm, 1.05 mm and 1.08 mm from the cephalic end.

The vulva was situated at 15.69 mm to 16.51 mm and anus from 0.61 mm to 0.63 mm from the tail tip. The uteri were divergent. The tail end was slightly bent dorsally and ended in a long conical point (Plate XXII, Fig.6). The ova measured 0.054 mm to 0.058 mm by 0.029 mm to 0.032 mm.

The measurements of G. hybridatus recorded by Westhuysen (1938) and in the present study are given in table 11.



Fig. 1

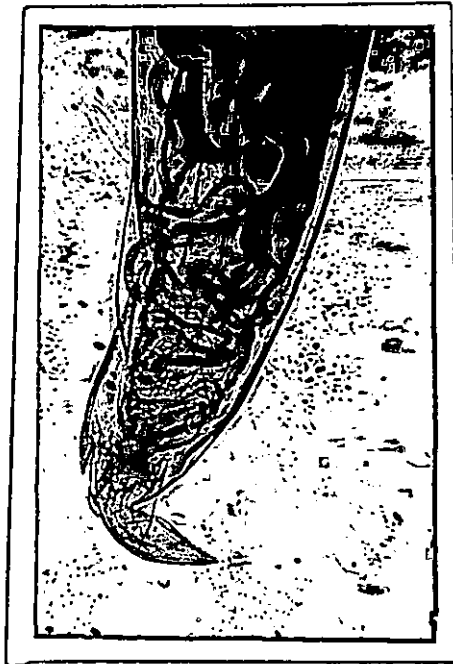


Fig. 2

11. Grammecephalus varedatus (Lane, 1921)

General morphological characters

(Plate XXIII, Figs. 1 and 2; Plate XXIV, Figs. 1 and 2)

The worm was fairly stout with dorsally bent anterior extremity. The buccal capsule was wide but narrow posteriorly. The fold in the dorsal wall of the buccal capsule was not markedly prominent. The semilunes situated at the oral margin were small. The apical notches of the sub-ventral teeth were small, and the anterior edges of these teeth faced anteriorly and dorsally. The oesophagus was long and simple and the intestinal diverticulum arose close to the oesophagus.

Female: The female worm measured 42 mm in length and 1.18 mm in width. The buccal capsule measured 0.42 mm by 0.20 mm. The length and breadth of oesophagus were 3.44 mm and 0.28 mm respectively. The nerve ring, the excretory pore and cervical papillae were at a distance of 1.18 mm, 1.31 mm and 1.31 mm from the cephalic end respectively. The intestinal diverticulum was 2.0 mm in length. The cuticular striation was 0.018 mm apart.

The vulva was situated at 19.85 mm and the anus at 0.71 mm from the tail tip (Plate XXIV, Fig. 3). The uteri was divergent (Plate XXIV, Fig. 4) and the tail end was conical. The egg measured 0.065 mm by 0.035 mm.

The comparative measurements of Grammecephalus varedatus by Westhuyzen (1938), Fernando and Fernando (1961) and in the present study are furnished in table 12.

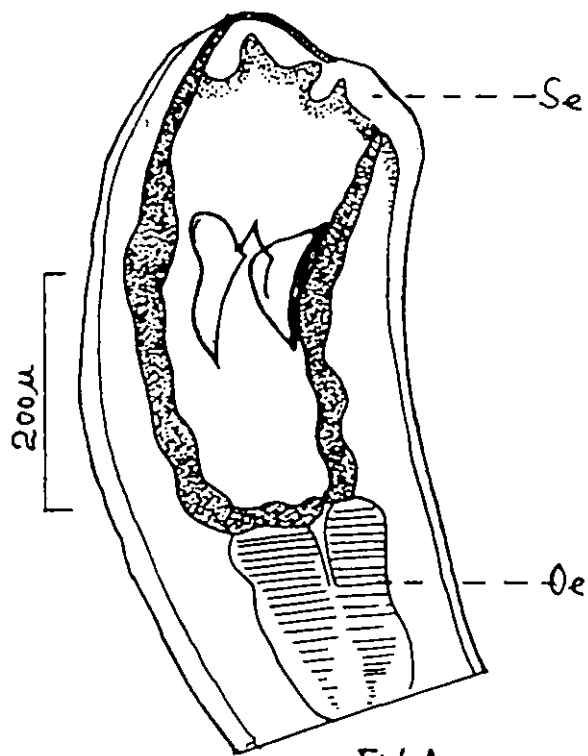


Fig. 1

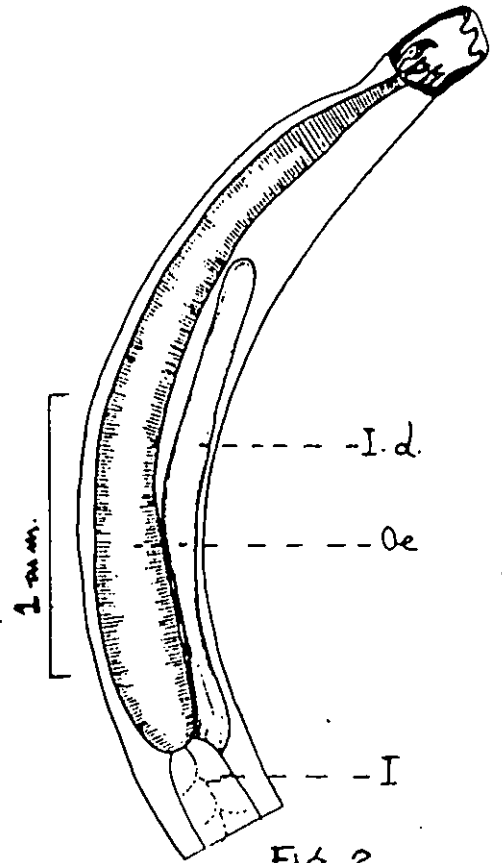


Fig. 2

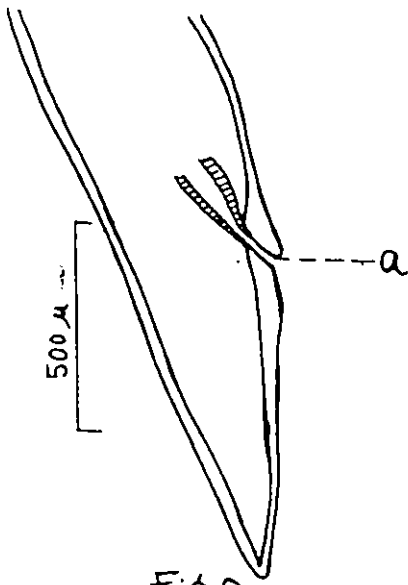


Fig. 3

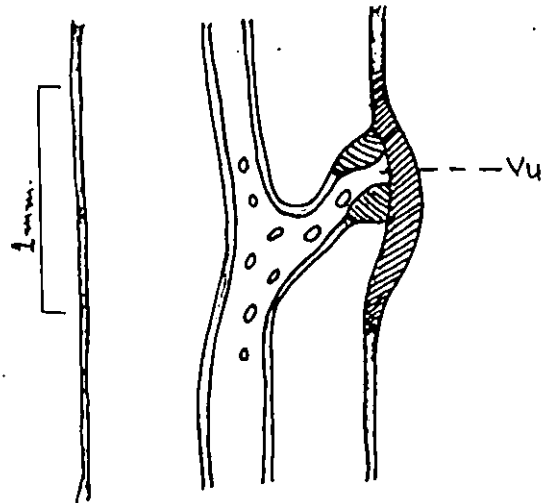


Fig. 4

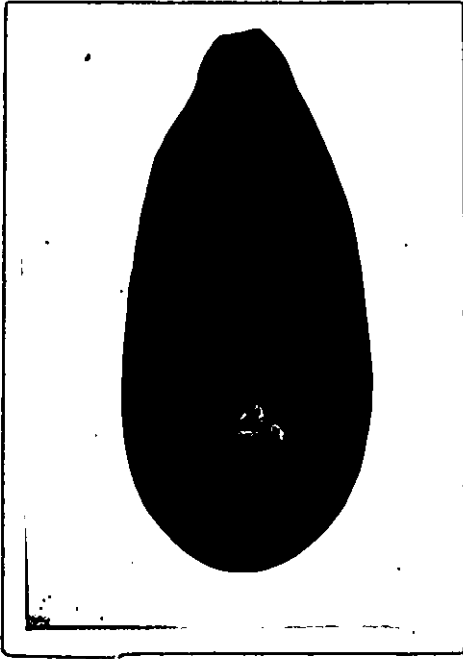


Fig. 1

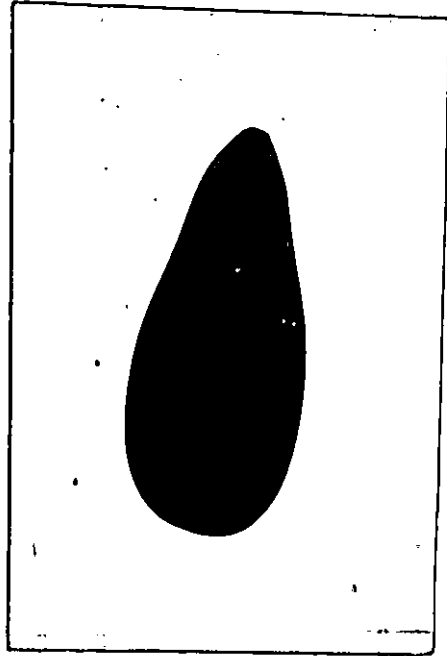


Fig. 2

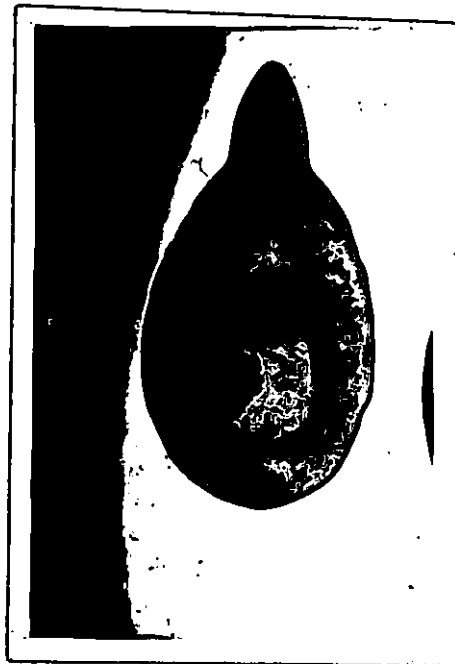


Fig. 3

12. Pseudodiscus collinsi (Cobbold, 1875)General morphological features

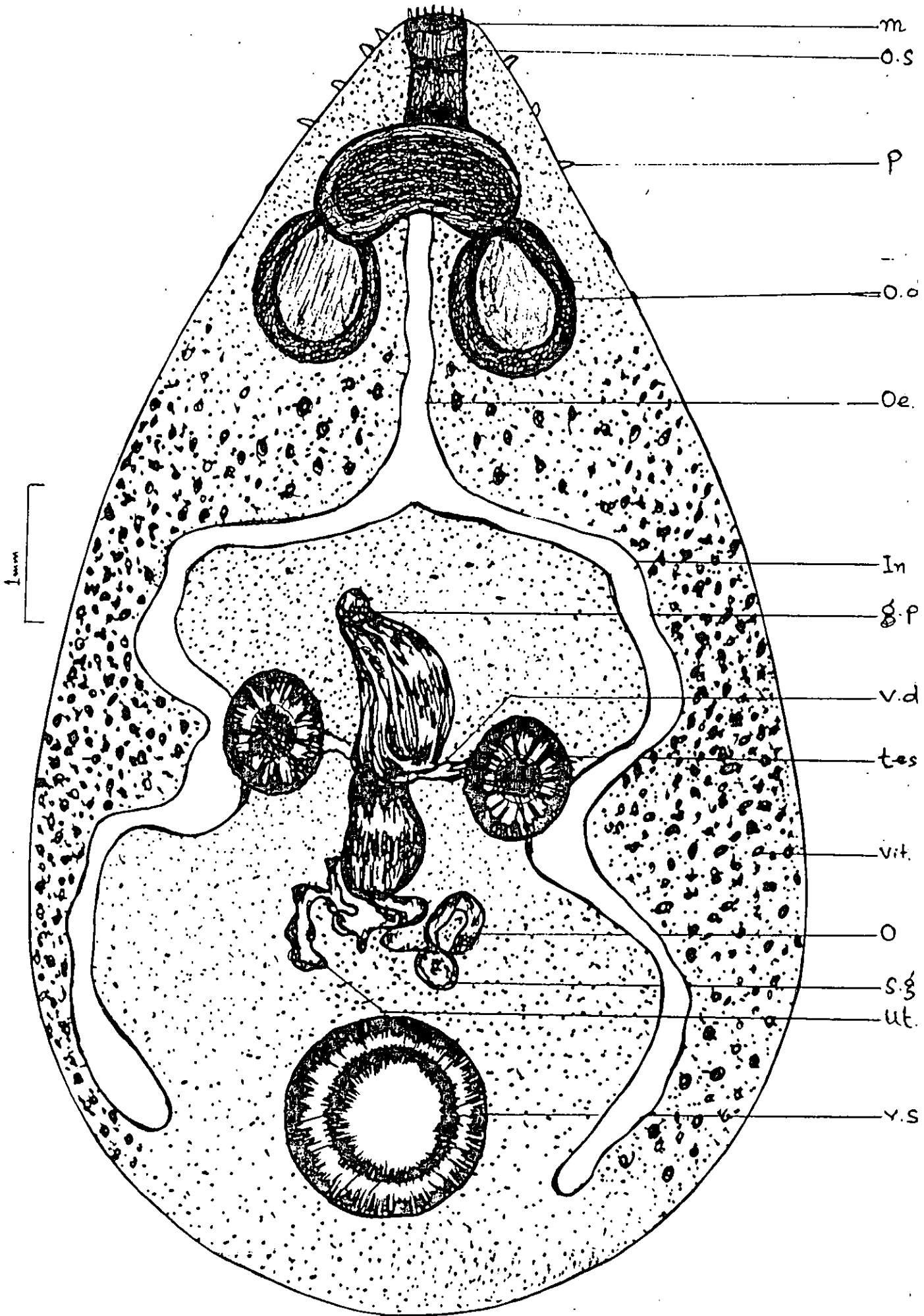
(Plate XXV, Fig.1; Plate XXVI, Fig.1)

The body was oval in shape, the ventral surface was concave in mature specimen while the dorsal surface showed convex appearance. The anterior extremity was bluntly pointed and bore some conical papillae. The posterior extremity was semicircular and acetabulum was strong and subterminal.

The mouth was anteriorly situated and was surrounded by an oral sucker, constricted at the middle which formed a globular oral portion and bulbous posterior portion. The bulbous portion was bilobed and had a well developed muscular diverticula posteriorly. The oesophagus originated from the portion between the two oral pouches and often took a posterior straight course. It was divided into two intestinal caeca, making inward bend at the level of testes and extended upto the middle of the acetabulum and sometimes upto the posterior margin of acetabulum.

Testes were lobed and were situated post-equatorial and side by side. Ovary was post-testicular in position. The uterus was dorsal and pre-ovarian. The vitelline glands located extracaecally and extended from the middle of oesophageal region anteriorly to blunt ends of intestinal caeca.

The worm had a length of 6.5 mm to 13 mm and a breadth of 5 mm to 6 mm. The diameter of mouth was 0.47 mm to 0.78 mm.



The vertical and transverse diameter of the globular oral portion were 0.39 mm to 0.78 mm and 1.05 mm to 1.60 mm respectively. The diverticulum measured 0.78 mm to 1.57 mm by 0.52 mm to 1.7 mm. The length of oesophagus was 1.05 mm to 2.13 mm.

The testes were deeply lobed bodies placed horizontally and measured 0.55 mm to 1.44 mm by 0.47 mm to 1.13 mm. The vas-efferentia arose from the centre of testes and united anteriorly to form a thin coiled structure, vesicule seminalis. The seminal vesicles passed into a less coiled but thicker structure pars-musculosa. This lead to a short narrow duct pars-prostatica. From its ventral aspect, a short muscular duct, ductus ejaculatorius originated, which united with the terminal portion of uterus, the metratum, to form a ductus hermaphroditicus. The latter was a short duct and opened into the genital atrium which communicated ventrally with the genital pore. The genital pore was 3.4 mm to 5.0 mm from the anterior end.

The ovary was 0.26 mm to 0.65 mm by 0.26 mm to 0.57 mm and was situated on the left side between the testes and posterior sucker. Sometimes it was also found in the right or at the centre of the body. The oviduct arose from the anterior aspect of the ovary and ran dorsally through the shell gland. The vitelline glands had follicles scattered on outer side of intestinal caeca, extending from the middle of oesophagus upto the ends of the intestinal caeca. The shell gland measured

0.13 mm to 0.20 mm by 0.10 mm to 0.17 mm. The diameter of acetabulum was 1.41 mm to 2.49 mm and distance of acetabulum to the posterior end ranged from 0.47 mm to 1.3 mm. The ova were oval, operculated and measured 0.150 mm to 0.152 mm by 0.08 mm to 0.085 mm.

The comparative measurements of Pseudodiscus collinsi recorded by Bhalerao (1933), Westhuysen (1938), Mukherjee and Chauhan (1965) and in the present study are given in table 13.

13. Pseudodiscus hawkesii (Cobbold, 1875)

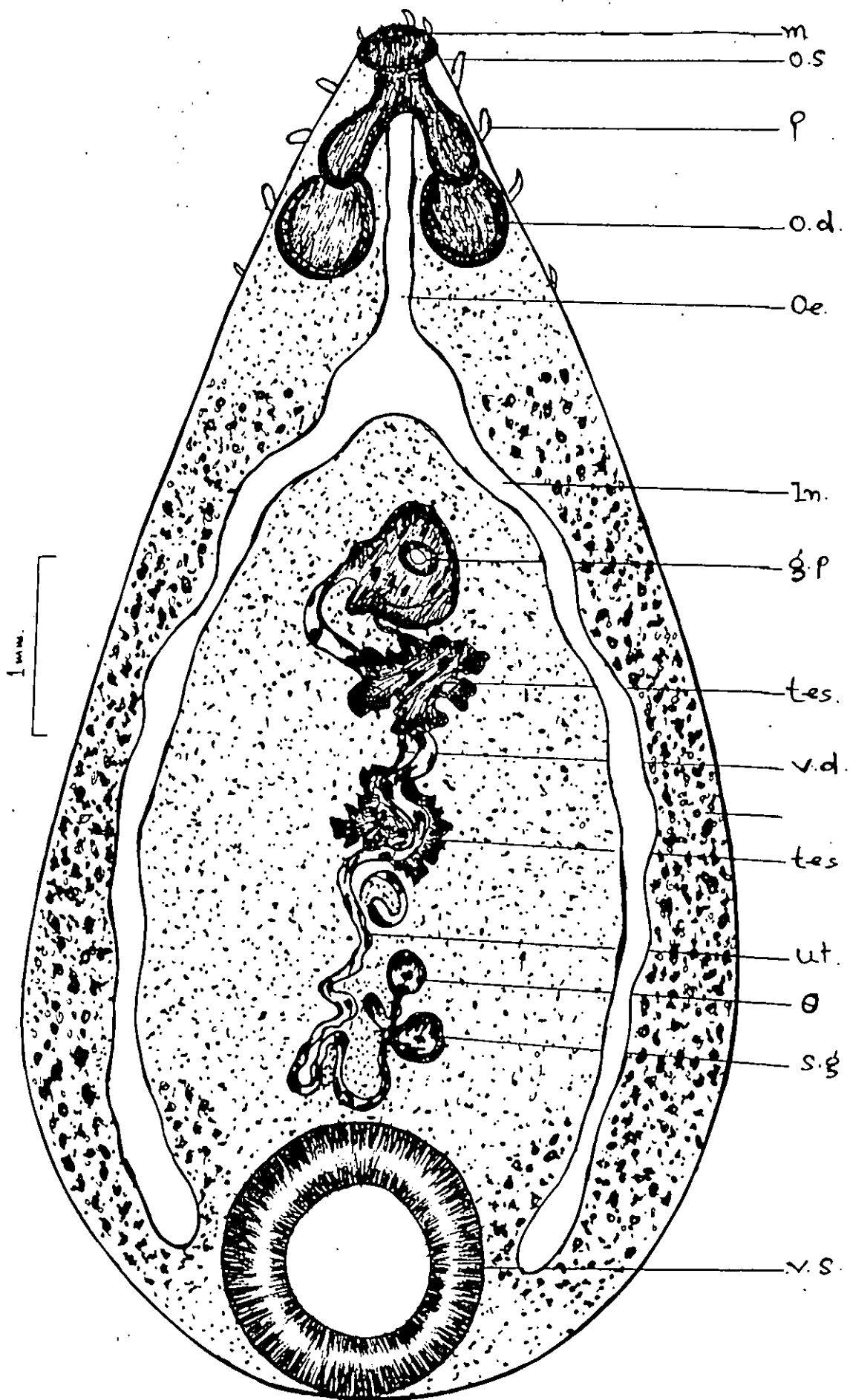
General morphological features

(Plate XXV, Fig.2; Plate XXVI, Fig.1)

The worms were conical with tapered anterior end and hemispherical posterior end. The ventral surface was slightly concave and flat while the dorsal surface was convex.

The mouth was directed dorso-ventrally and elliptical in outline. The oral sucker had one anterior globular oral portion and a short posterior portion. The diverticula originated from the latter which were oval in shape. The oesophagus led into a muscular pharynx and then bifurcated into wavy intestinal caeca which ended in the equatorial zone of the acetabulum. Some specimen showed infolding of caeca in front of the acetabulum or one branch ending upto the middle portion and another branch not reaching to the acetabulum.

The testes were branched and deeply lobulated. They were situated one behind the another and in some cases overlapped their zones slightly. The vas-efferens came out from the



dorsal aspect of each testis and united to form a much coiled structure vas-deferens. This passed into a less coiled well developed musciosa, which again passed into a short prostatica. The ductus ejaculatorius which was the terminal portion of vas-deferens united with the terminal portion of the uterus to form the ductus hermaphrodiaticus.

The ovary was situated behind the testis on the left side and close to acetabulum. The vitelline glands were composed of small follicles and extended throughout the length of caeca on the lateral side but some follicles were seen intracaecally at posterior part of the caeca.

The worms measured 5.5 mm to 11 mm in length with a maximum breadth of 3.5 mm to 5 mm. The thickness was 5 mm to 6 mm. The oral diameter was 0.23 mm to 0.47 mm. The vertical length and transverse diameter of the globular oral portion was 0.13 mm to 0.39 mm and 0.39 mm to 0.73 mm. The oesophageal diverticulum measured 0.39 mm to 0.92 mm by 0.28 mm to 0.78 mm. The oesophagus was 1.05 mm to 2.63 mm in length.

The posterior sucker had a diameter of 1.44 mm to 1.73 mm and situated at a distance of 0.18 mm from the posterior end. The acetabulum laid very close to the posterior end in most of the cases. The genital pore was 2.5 mm to 4.52 mm from the anterior end.

The testes measured 0.52 mm to 1.05 mm by 0.42 mm to 1.10 mm. The ovary measured 0.26 mm to 0.52 mm by 0.26 mm to 0.59 mm. The shell gland laid behind the ovary and measured

0.10 mm to 0.34 mm by 0.10 mm to 0.26 mm. The ova were oval, operculated and measured 0.120 mm by 0.07 mm.

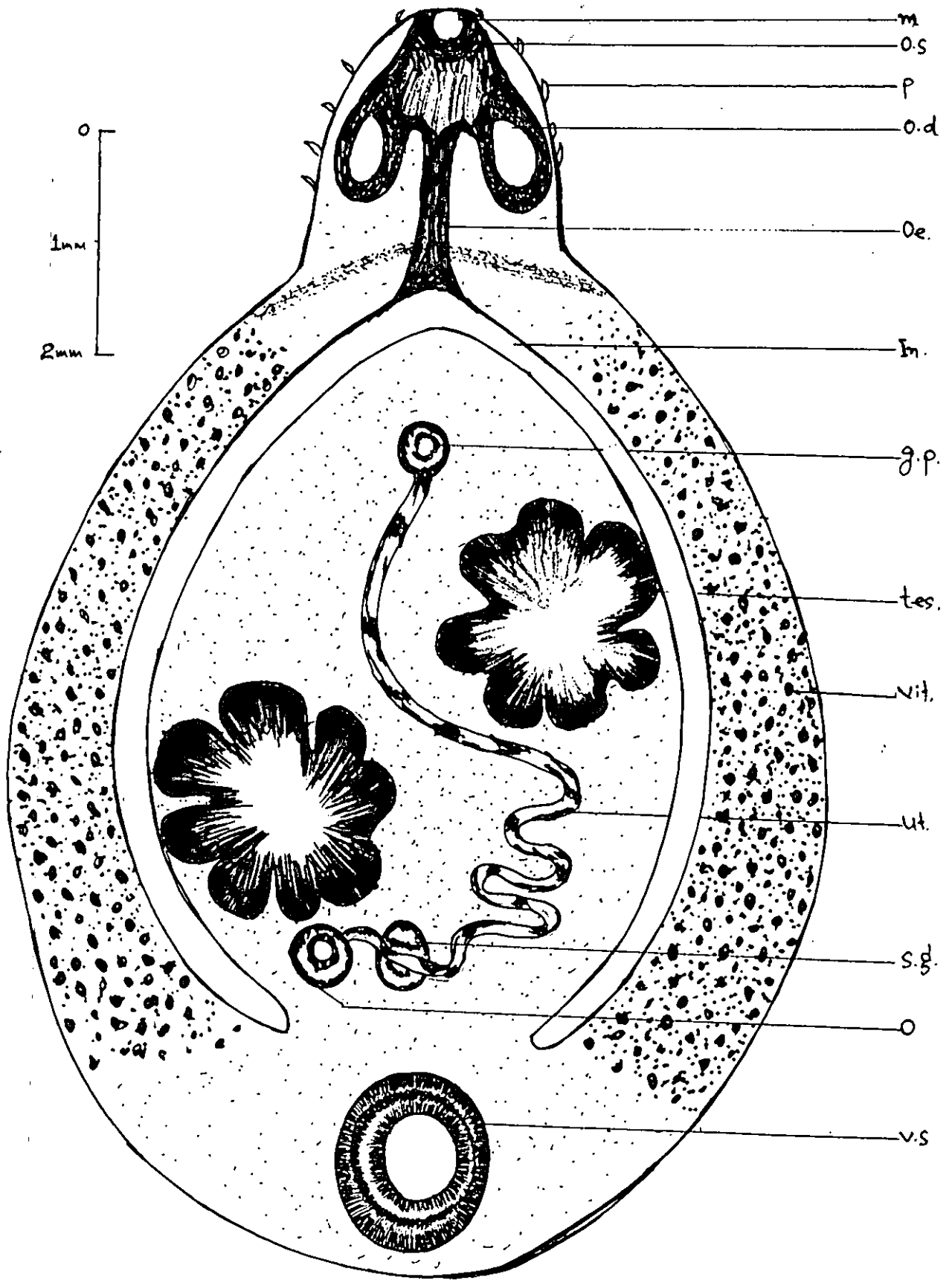
The comparative measurements of Pseudodiscus hawkesii recorded by Stiles and Goldberger (1910), Fukui (1929), Westhuysen (1938), Malik et al. (1959) and in the present study are furnished in table 14.

14. Gastrodiscus secundus (Bhalerao, 1933)

General morphological features

(Plate XXV, Fig.3; Plate XXVIII, Fig.1)

These worms were flattened leaf like bodies and the body was divided by a constriction into a small, cylindrical, anterior portion and a large, discoidal posterior portion. The posterior portion was concave ventrally and was covered with regular rows of large papillae. The genital sucker and ventral pouch were absent. The oral sucker with paired diverticula was present. The posterior sucker was small and sub-terminal and was situated at the middle. The oesophagus was long, narrow and its wall was glandular. Then it was divided into two intestinal caeca which passed along the sides of the body, but most of them did not reach the acetabulum. The genital pore was situated behind the bifurcation of the caeca and posterior from base of cephalic core. Testes were lobed, situated diagonally each other, the left one in front at the centre of the body. Ovary was post-testicular and situated on the left side of the body commonly. The uterus had a sinuous course between the



testes and passed on the right side of the vas-deferens. The shell gland was situated to the right side of the ovary. The vitelline glands extended from the level of the genital pore to the middle portion of the posterior sucker. The follicles were found mostly in extracaecal area but some of them were found on the intestinal caeca also.

The body measured 10.5 mm to 12 mm in length and 6 mm to 8 mm in breadth. The cephalic portion was 1.97 mm to 2.26 mm long and 2.20 mm to 2.68 mm broad. The disc portion was 8.5 mm to 9.77 mm long and 6 mm broad.

The diameter of mouth was 0.27 mm to 0.39 mm. The oral sucker measured 0.26 mm to 0.39 mm by 0.49 mm to 0.52 mm. The diverticula measured 0.76 mm to 0.92 mm in length and 0.42 mm to 1.76 mm. The intestinal caeca was 6.3 mm to 6.8 mm long and the oesophagus was bifurcated at 0.65 mm to 0.75 mm from the cephalic end of the disc. The caeca ended at a distance of 1.6 mm to 2.05 mm from the posterior end.

The posterior sucker was 1.23 mm to 1.47 mm in length and 1.15 mm to 1.26 mm in width. The genital opening was post-bifurcation of the intestinal caeca and was 1.44 mm to 1.84 mm from the anterior end of the discoidal portion.

The testes were branched deeply lobed and measured 1.84 mm to 2.49 mm by 1.57 mm to 2.5 mm. The ovary measured 0.29 mm to 0.35 mm by 0.21 mm to 0.30 mm. The shell gland measured 0.57 mm to 0.60 mm by 0.39 mm to 0.52 mm.

The Ova were oval, operculated and measured 0.15 mm to 0.16 mm by 0.091 mm to 0.1 mm.

The comparative measurements of Gastrodiscus secundus given by Bhalerao (1933), Mukherjee and Chauhan (1965) and in the present study are furnished in table 15.

Tables

Table 6. Comparative measurements of *Decrusia additictia* recorded by Lane (1914), Westhuysen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant

Sl. No.	Particulars	Lane (1914)		Westhuysen (1938)		Fernando and Fernando(1961)		Present study	
		Male mm	Female mm	Male mm	Female mm	Male mm	Female mm	Male mm	Female mm
1	Total length	14	15		20-21	10-14	13-18	16-18	18-22
2	Maximum diameter	1.0	1.4			1.36	1.36	0.78-1.0	1.10-1.31
3	Diameter of capsule				0.5			0.32-0.43	0.47-0.51
4	Length of capsule				0.4			0.34-0.4	0.45-0.48
5	Length of oesophagus	1.9	1.9		1.8			1.39-1.62	0.45-0.48
6	Maximum diameter of oesophagus	0.37	0.37		0.41			0.34-0.36	0.39-0.44
7	Nerve ring from anterior end	1.1	1.1		1.07			1.0-1.06	1.05-1.16
8	Excretory pore from anterior end	1.0	1.0					1.04	1.06-1.11
9	Length of spicule	2.4						2.31-2.54	
10	Width of spicule	0.045						0.045	
11	Vulva to anus		7.3		7.5				7.25-8.0
12	Tail length		0.3		0.29				0.28-0.31
13	Cuticular striation	0.01	0.01		0.013			0.01	0.015
14	Ova								0.07 x 0.035
15	Diameter of cephalad to bursa	0.56						0.47	
16	Length of dorsal ray							0.36-0.40	

Three male and three female worms were measured in this study

Table 8. Comparative measurements of *Equinubria sipunculiformis* recorded by Lane (1914), Westhuysen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant

Sl. No.	Particulars	Lane (1914)		Westhuysen (1938)		Fernando and Fernando (1961)		Present study	
		Male mm	Female mm	Male mm	Female mm	Male mm	Female mm	Male mm	Female mm
1	Total length	15	27.5	23-27	24-28	16-23	20-25	18.5-21	20-25
2	Maximum diameter	1.3	1.5	1.2	1.4	1.44	1.44	1.40-1.69	1.65-1.90
3	Diameter of head			0.81	0.81-0.86			0.8-0.95	0.8-0.99
4	Diameter of capsule			0.30	0.36			0.41-0.44	0.36-0.42
5	Length of capsule			0.20	0.27			0.30-0.37	0.30-0.40
6	Number of leaflets			168	168			168	168
7	Length of oesophagus		2.3	2.2	2.2	2.2	2.2	1.92-2.10	2.0-2.50
8	Maximum width of oesophagus			0.54	0.54			0.39-0.41	0.41-0.47
9	Nerve ring from anterior end		1.0	1.0	1.0			0.9-1.1	0.96-1.26
10	Excretory pore from anterior end			2.7	3.0			2.4	2.73
11	Cervical papillae from anterior end								2.76
12	Spicule length	1.5		1.6				1.4-1.6	
13	Vaginal length		1.7		1.8				1.7-1.9
14	Tail length		0.8		0.82				0.7-0.83
15	Vulva to anus								0.25-0.28
16	Cuticular striations	0.004	0.004	0.004	0.004			0.003-0.004	0.003-0.004
17	Ova								0.060x0.030

Four male and six female worms were measured in this study

Table 9. Comparative measurements of *Parabronema indicum* recorded by Baylis (1921), Westhuysen (1938) and in the present study in Indian elephant

Sl. No.	Particulars	Baylis (1921)		Westhuysen (1938)		Present study	
		Male mm	Female mm	Male mm	Female mm	Male mm	Female mm
1	Total length	7.9	13.0	9.0	13.0	7-8	11-13
2	Maximum diameter	0.31	0.39	0.24	0.30	0.28-0.30	0.33-0.36
3	Diameter of head	0.14	0.15	0.12	0.14	0.11-0.13	0.14-0.16
4	Length of buccal tube	0.17	0.18	0.13	0.16	0.13-0.15	0.15-0.17
5	Length of oesophagus	2.2	2.5	2.5	2.8	1.44-2.2	1.90-2.26
6	Maximum width of oesophagus					0.15	0.16-0.20
7	Nerve ring from anterior end	0.32	0.34	0.32	0.32	0.23-0.27	0.24-0.34
8	Cervical papillae from anterior end	0.33	0.35	0.38	0.38-0.43	0.24-0.28	0.28-0.35
9	Excretory pore from anterior end	0.39	0.42	-	0.34	0.18-0.22	0.22-0.30
10	Vulva to posterior oesophagus		0.4(P)		0.24-0.56(P)		0.15-0.43(P)
11	Tail length			0.20	0.33	0.18-0.22	0.28-0.40
12	Caudal papillae		0.03		0.042		0.03-0.031
13	Cuticular striation	0.03	0.03	0.006	0.004	0.03	0.03
14	Left spicule length	0.93		0.95		0.92-0.99	
15	Right spicule length	0.39		0.40		0.36-0.41	
16	Length of accessory piece	0.06		0.05		0.05	

Ten female and four male worms were measured in this study.

(P) = Posterior to bulb of oesophagus

Table 10. Comparative measurements of Parabronema smithi recorded by Baylis (1921), Westhuysen (1938) and in the present study in Indian elephant

Sl. No.	Particulars	Baylis (1921)		Westhuysen (1938)		Present study	
		Male mm	Female mm	Male mm	Female mm	Male mm	Female mm
1	Total length	4.2	8.5	6.5	6.6-9.3	4.1-5.10	7-8.5
2	Maximum diameter	0.2	0.25	0.22	0.24	0.19-0.21	0.24-0.29
3	Posterior diameter of head				0.09	0.08-0.09	0.09-0.10
4	Length of buccal tube				0.10	0.08-0.10	0.08-0.10
5	Length of oesophagus		1.5		1.5-1.9	1.06-1.25	1.29-1.48
6	Maximum width of oesophagus					0.08-0.11	0.09-0.12
7	Nerve ring from anterior end			0.22-0.24	0.25	0.17-0.23	0.19-0.26
8	Cervical papillae from anterior end			0.24-0.27	0.27	0.17-0.27	0.21-0.27
9	Excretory pore from anterior end				0.32		0.18-0.21
10	Vulva from posterior oesophagus				0.06(A)-0.45(P)		0.05(A)-0.45(P)
11	Tail length			0.20	0.28-0.35	0.16-0.20	0.25-0.33
12	Caudal papillae from posterior end				0.04		0.03
13	Cuticle striations			0.04	0.03	0.025	0.03
14	Left spicule length	0.32		0.63		0.38-0.43	
15	Right spicule length	0.18		0.23		0.20-0.22	
16	Length of accessory piece			0.03		0.02-0.03	
17	Posterior uterus from anal opening				0.40-0.48		0.13-0.16

Ten male and ten female worms were measured in this study.
 (A) = Anterior to bulb of oesophagus. (P) = Posterior to bulb of oesophagus

Table 11. Comparative measurements of Grammocephalus hybridatus recorded by Westhuysen (1938) and in the present study in Indian elephant

Sl. No.	Particulars	Westhuysen (1938)		Present study	
		Male mm	Female mm	Male mm	Female mm
1	Total length	37	37	35-38	31-32
2	Maximum diameter	1.4	1.0	1.39-1.47	1.33-1.36
3	Length of buccal capsule	0.5	0.46	0.48-0.50	0.45-0.46
4	Width of buccal capsule			0.22-0.25	0.21
5	Length of oesophagus	3.64	3.7	3.7-3.75	3.52-3.66
6	Maximum width of oesophagus			0.27	0.26
7	Nerve ring from anterior end	1.09	1.0	1.05	1.0
8	Excretory pore from anterior end	1.29	1.07	1.20	1.05
9	Cervical papillae from anterior end	1.15	1.15	1.25	1.08
10	Vulva to anus		16.7		15.08-15.86
11	Tail length		0.80		0.61-0.65
12	Length of spicule	1.54		1.55-1.67	
13	Width of spicule			0.2-0.25	
14	Cuticular striation	0.012	0.012	0.008-0.012	0.008
15	Ova		0.058-0.063 x 0.029-0.034		0.054 x 0.029- 0.032-0.058
16	Length of dorsal ray			0.45	
17	Length of externo-dorsal ray			0.60	

Two male and two female worms were measured in this study

Table 12. Comparative measurement of Grammocephalus varedatus recorded by Westhuysen (1938), Fernando and Fernando (1961) and in the present study in Indian elephant

Sl. No.	Particulars	Westhuysen (1938)		Fernando and Fernando (1961)		Present study	
		Male mm	Female mm	Male mm	Female mm	Male mm	Female mm
1	Total length	55	47	44-45	41-44		42
2	Maximum diameter	1.35	1.11	1.40	1.20		1.18
3	Length of buccal capsule						0.42
4	Width of buccal capsule						0.20
5	Length of oesophagus	3.6	3.6	3.40	3.40		3.44
6	Width of oesophagus						0.28
7	Nerve ring from anterior end	1.16	1.16				1.18
8	Excretory pore from anterior end	1.5	1.5				1.31
9	Cervical papillae from anterior end	1.7	1.7				1.31
10	Length of spicule	1.35					
11	Vulva to anus		22				19.14
12	Tail length		0.80				0.71
13	Cuticular striation	0.014	0.014				0.018
14	Ova		0.068 x 0.037				0.065 x 0.035

One female worm was measured in this study.

Table 13. Comparative measurements of Pseudodiscus collinsi recorded by Bhalerao (1933), Westhuysen (1938), Mukherjee and Chauhan (1965) and in the present study in Indian elephant

Sl. No.	Particulars	Bhalerao (1933) mm	Westhuysen (1938) mm	Mukherjee and Chauhan (1965) mm	Present study mm
1	Total length	5.7-12.5	5-12	5.7-12.5	6.5-13
2	Maximum width	3-7	3-7	3-7	5-6
3	Maximum thickness	2.5-3.5	2-3.5	2.5-3.5	2-3.5
4	Oral diameter	0.34-0.57		0.85-1.05	0.47-0.78
5	Oesophagus diverticulum (Length x breadth)	0.98-1.57 x 0.7-1.27	0.4-1.5 x 0.7-1.25		0.78-1.57 x 0.52-1.7
6	Posterior portion of oral opening (vertex x transverse)	0.7-1.1 x 0.64-1.36			0.39-0.78 x 1.05-1.60
7	Genital pore from anterior end	2.5-4.7	2.5-4.5		3.4-5.0
8	Length of oesophagus	0.93-1.62	0.9-1.5	0.93-1.92	1.05-2.13
9	Testes (Length x breadth)	1-2.48 x 0.73-2.28	1-2.5 x 0.75-2.25	1-2.48 x 0.73-2.28	0.55-1.44 x 0.47-1.13
10	Ovary (Length x breadth)	0.42-0.87 x 0.27-0.34	0.40-0.87 x 0.25-0.75	0.42-0.87 x 0.27-0.74	0.26-0.65 x 0.26-0.57
11	Shell gland (Length x breadth)		0.16 x 0.18		0.13-0.20 x 0.10-0.17
12	Diameter of acetabulum	1.34-2.11	1.2-2.1	1.4-1.8	1.41-2.49
13	Distance of acetabulum from posterior end				0.47-1.3
14	Excretory pore - posterior end	0.42-0.84	0.4-0.84		
15	Ova		0.135 x 0.086	0.125-0.158 x 0.085-0.088	0.150 x 0.08- 0.152-0.085

Nine worms were measured in this study

DISCUSSION

Prevalence of helminths

Prevalence of helminth parasites in Indian elephants was one of the major aspects of studies during the present investigation. Out of 203 naturally infected elephants of different sex, age and from different habitats, 117 elephants were found to be infected with either one or more species of helminth parasites. Three monospecific infections of *Bivitellobilharzia*, two monospecific infections of amphistomes, three monospecific infections of cestodes, eighty-nine monospecific infections of strongyles and twenty mixed infections (either two or more) were found during the study.

Season had some influence on the helminthic infection. The infection was found more during the rainy season (70 per cent) than the summer season (52.44 per cent).

All the adult male, female and young elephants were found to harbour different types of helminth parasites, proving the fact that age and sex had no direct effect on the prevalence of helminthic infection in elephants.

The adult worms of cestode, *Anoplocephala manubriata* and blood fluke *Bivitellobilharzia nairi* could not be recovered during the study, but the eggs of those helminths were studied in detail.

The circular and pentagonal shape with irregular outline of the ova of *Anoplocephala manubriata* agreed with the

descriptions given by Westhuysen (1938) but it was slightly smaller in size. The measurements of the eggs of Bivitellobilharzia nairi obtained during the present study were two times more than the measurements reported by Mudaliar and Ramanujachari (1945) but more or less tallied with the findings of Rao and Hiregauder (1953) and Sundaram et al. (1972).

Out of 25 valid species of nematodes reported by previous workers from Indian elephants, viz., Murshidia murshidia (Lane, 1914); M. falcifera (Cobbold, 1882), M. indica (Ware, 1924), M. neveulemairei (Witenberg, 1925), M. lanei (Witenberg, 1925), Quilonia renniei (Raill, Henry and Joyeux, 1913), Q. travancra (Lane, 1914), Q. sedecimradiata (Kries, 1956), Q. sinhai (Gupta and Trivedi, 1984), Q. guptai (Gupta and Jaiswal, 1985), Amira pileata (Raill, Henry and Bauche, 1914), Equinubria sipunculiformis (Baird, 1859), Decrusia additictia (Raill, Henry and Bauche, 1914), Choniangium epistomum (Piana and Stazzi, 1900), Bunostomum foliatum (Cobbold, 1882), Grammocephalus varedatus (Lane, 1921), G. hybridatus (Westhuysen, 1938), Syngamus indicus (Moning, 1932), Leiperenia galebi (Khalil, 1922), Toxocara lonchoptera (Leiper, 1907), Parabronema indicum (Baylis, 1921), P. smithi (Cobbold, 1882), Indofilaria pattabiramaning (Alwar et al., 1959) and Indofilaria elephantis (Chandrasekharan et al., 1972), only 11 species namely, Murshidia murshidia, M. falcifera, Quilonia renniei, Amira pileata, Equinubria sipunculiformis, Decrusia additictia, Choniangium epistomum, Grammocephalus varedatus, G. hybridatus,

Parabronema indicum and P. smithi could be collected and studied.

Out of nine trematode parasites reported earlier namely Fasciola jacksoni (Cobbold, 1869), Pfenderius papillatus (Cobbold, 1882), P. biramanicus (Bhalerao, 1935), P. heterocaeca (Fukui, 1926), Pseudodiscus collinsi (Cobbold, 1875), P. hawkesii (Cobbold, 1875) and Gastrodiscus secundus (Cobbold, 1876), only P. collinsi, P. hawkesii and Gastrodiscus secundus were collected and studied.

The morphological features of the recorded helminths, more or less agreed with the descriptions given by previous observations except in certain aspects as followed.

Murshidia murshidia

The morphological descriptions of the worms were tallied more or less with those described by Westhuysen (1938). The length of male worms and vagina in female worms examined during the present study were found to be much larger than what was reported by Lane (1914). Witenberg (1925) reported a leaflet number of 48 whereas in the present study, it was found to be 60 which agreed with the findings of Lane (1914) and Westhuysen (1938). The female tail length and spicules of male worms of the present study were also longer than those described by Lane (1914) and Westhuysen (1938).

Murshidia falcifera

The male and female worms studied were longer than those

reported by Lane (1914), Fernando and Fernando (1961a) and Fernando and Fernando (1961b) but more or less agreed to Witenberg (1925) and Westhuysen (1938). The tail length, distance from vulva to anus and vaginal length were found more or less equal to that of Westhuysen (1938) but more in measurements than that described by Lane (1914). The length of spicule was shorter as compared to the findings of Westhuysen (1938) but longer than that reported by Lane (1914).

The ruggedness of internal branches of the dorsal ray and presence of a short fork like structure of the externo-dorsal ray agreed to Westhuysen (1938) but differed from Lane (1914) and Witenberg (1925). The closely paralleled arrangement of medio and posterior rays of lateral rays agreed with Westhuysen (1938).

Quilonia renniei

The maximum length and width of the worms were comparatively more than that reported by Lane (1914) and Westhuysen (1938), Fernando and Fernando (1961a) and Fernando and Fernando (1961b).

Amira pileata

The worms studied showed more or less similar characteristics reported by Lane (1914) and Westhuysen (1938) but the maximum length of the female worm was less than that of Westhuysen (1938) but was more than that reported by Lane (1914). The vagina was longer than that described by Westhuysen (1938).

Chonionqium epistomum

Lane (1914) described five pairs of hemispheroidical cuticular prominences inside the buccal capsule but only four pairs were noticed in this study. The bulbous nature of the short external branches of the bifid branch of the dorsal ray described by Lane (1914) was also noticed in the present study.

Decrusia additictia

The specimens examined during the study agreed very favourably in characters with those recorded by Lane (1914), Westhuysen (1938) and Fernando and Fernando (1961b), except for the total length, which was more in the present study. The specimens definitely showed a double leaf crown supporting the findings of Westhuysen (1938). A spine like short projection was present at the tip of the tail of female worms as against the description given by Fernando and Fernando (1961a).

Equinubria sipunculiformis

The male worms were longer than that of Lane (1914) but shorter than that of Westhuysen (1938).

Grammocephalus hybridatus

The present study revealed only shorter worms as compared to Westhuysen (1938).

Grammocephalus varedatus

The single female worm recorded was found to be shorter than that of Westhuysen (1938).

Parabronema indicum

The present investigation supported the measurements reported by Baylis (1921) and Westhuyzen (1938) except shorter oesophagus. The ratio between the left and right spicule was more as against the report of Baylis (1921).

Parabronema smithi

The body length of male, the oesophageal length and the left spicule were shorter than that of Westhuyzen (1938).

Pseudodiscus collinsi

The total length and maximum thickness of the worms were tallied with the findings of previous workers. The oral diameter of the worm was more or less similar to that of Bhalerao (1933) but quite smaller in comparison to that of Mukherjee and Chauhan (1965). The oesophagus was longer than other findings but the testes were smaller than that of Bhalerao (1933), Westhuyzen (1938) and Mukherjee and Chauhan (1965). The acetabulum diameter was greater than that of Mukherjee and Chauhan (1965). The intestinal caeca extended somewhat posterior to the middle of the acetabulum as described by Bhalerao (1933) and Westhuyzen (1938) but disagreed with Mukherjee and Chauhan (1965).

Pseudodiscus hawkesii

The length and breadth of the worms were tallied with the descriptions given by Fukui (1929) and Malik et al. (1959) but greater than that of Stiles and Goldberger (1910) and Westhuyzen

(1938). The length of oesophagus was nearly equal to the measurement recorded by Westhuysen (1938) but longer than the findings of Malik et al. (1959). The size of testes in the present study was larger than the findings of Westhuysen (1938) but the ovary was smaller in the present study.

Gastrodiscus secundus

The size of the worms and the length of oesophagus were more than that described by Bhalerao (1933) and Mukherjee and Chauhan (1965).

Treatment

TREATMENT

Helminthiasis is a common disease condition in all types of elephants as in the case of cattle, sheep, goat etc. Recently new broad spectrum anthelmintics have been employed to control helminthiasis in animals and birds. The usage of these anthelmintics was very limited in elephants due to lack of informations about its safe and effective dosages.

During the present study, the efficacy of a new benzimidazole group of drug, albendazole (Albomar) was estimated against natural infection of gastro-intestinal nematodes in elephant.

Review of literature

Sundaram et al. (1971) reported that Tetramisole hydrochloride (Nilverm) at a dose of 5 mg per kg body weight, was almost 100 per cent effective and safe against strongylosis in captive elephants.

Thereafter the safe and effective dosages of other new anthelmintics like Thiabendazole (Chandrasekharan et al., 1972), Morantel tartrate (Chandrasekharan et al., 1973), Parbendazole (Chandrasekharan et al., 1974), Oxibendazole (Sathianesan et al., 1979), Methyridine (Chandrasekharan et al., 1979a), Thiophanate (Chandrasekharan et al., 1979), Mebendazole, Levamisole, Bephenium hydroxynaphthoate and Disophenol (Chandrasekharan et al., 1982), Fenbendazole (Roy and Majumdar, 1988; Lahkar and Das, 1988) were estimated against natural infection of different strongyles in elephants.

Albendazole

The efficacy and safety of albendazole have been widely studied by several workers against nematodes, trematodes and cestodes of cattle, sheep, goat, equines, dogs and poultry.

Albendazole was first introduced by Theodorides et al. (1976) and reported high efficacy at a dose rate of 5 to 10 mg/kg by body weight against gastro-intestinal nematodes in cattle.

Benz and Ernst (1978) reported 99.1% efficacy of albendazole at a dose rate of 7.5 mg per kg body weight against adult nematodes in calves.

The efficacy of albendazole at a dose rate of 7.5 mg per kg body weight was evaluated upto 93.5 per cent and 53.4 per cent against adult and 4th stage larvae of Ostertagia ostertagi respectively in cattle and sheep by William et al. (1981). Han et al. (1982) reported 100 per cent efficacy of albendazole at a dose of 5-10 mg per kg body weight against Ascaridia galli, Rallietina tetragona and R. echinobothrida in fowls.

Romanuk (1982) showed high anthelmintic efficacy of albendazole at 5 mg per kg body weight against Strongylus and Trichonema species in horses. A dose of 7.5 mg per kg body weight of albendazole was found to be very effective against naturally infected nematodes in cattle (Todd and Mansfield, 1982; Jacob, 1984).

Single dose of 3.5 or 5 mg per kg body weight of albendazole showed 100 per cent effective against gastro-intestinal nematodes except Trichuris sp. in goat without any adverse effect (Guha et al., 1986).

RESULTS

Treatment

Albendazole (Albomar) at 2.5 and 3 mg/kg body weight as single oral dose was 100 per cent effective against naturally infected strongyles in 24 captive elephants (Table 16).

The faecal culture kept on the first day after medication failed to show larvae on second, third and fourth day and thus proved its ovicidal property.

The drug at the above mentioned dose rates was well tolerated by all the medicated elephants and showed no signs of toxicity.

Table 16. Efficacy of Alb

Name of elephant	E.P.G.	
	3rd day	Percentage of efficacy
1. Gopalakrishnan	N11	100
2. Unnikrishnan	N11	100
3. Sudhivan	N11	100
4. Mukundan	N11	100
5. Murali	N11	100
6. Balakrishnan	N11	100
7. Ramankutty	N11	100
8. Satyanarayani	N11	100
9. Reshmi	N11	100
10. Tara	N11	100
11. Anjali	N11	100
12. Chandrasekharan	N11	100
13. Nandini	N11	100
14. Rajasekharan	N11	100
15. Kuttynarayanan	N11	100
16. Jr. Madhavankutty	N11	100
17. Kuttysankaran	N11	100
18. Uma	N11	100
19. Keshavankutty	N11	100
20. Radhakrishnan	N11	100
21. Prakashan	N11	100
22. Kuttykrishnan	N11	100
23. Shankaran	N11	100
24. Gopalan Kutty	N11	100

DISCUSSION

Treatment

Albendazole at the dose rates of 2.5 mg and 3 mg per kg body weight was found to be 100 per cent effective against naturally infected strongylosis in captive elephants, for the first time. The present finding was in full agreement with the observations made by Sundaram et al. (1971) with Tetramisole hydrochloride, Chandrasekharan et al. (1972) with Thiabendazole, Chandrasekharan et al. (1973) with Morantel tartrate, Chandrasekharan et al. (1974) with Parbendazole, Sathianesan et al. (1979) with Oxibendazole, Chandrasekharan et al. (1979a) and (1979b) with Methyridine and Thiophanate respectively, Chandrasekharan et al. (1982) with Mebendazole and Levamisole, Ray and Majumdar (1988) and Lahka and Das (1988) with Fenbendazole. As in the case of tetramisole hydrochloride (Sundaram et al., 1971), Parbendazole (Chandrasekharan et al., 1974) and Thiophanate (Chandrasekharan et al., 1979b), albendazole also showed ovicidal activity against strongyle eggs.

SUMMARY

1. Prevalence of helminthic infection in Indian elephants

A detailed study on the prevalence of helminthic infection in captive elephants in different parts (urban, village and forests) of Kerala was conducted by examining the dung samples of elephants and viscera in post-mortem cases, during the period from March 1987 to February 1988.

It was found that out of 203 elephants, 117 elephants (57.6%) were infected with one or more species of helminths.

The percentages of monospecific infection of strongyles, Bivitellobilharzia nairi, Anoplocephala manubriata, amphistomes and mixed infection were 76.10, 2.60, 2.60, 1.70 and 17.00 respectively.

Different age groups and sexes of elephants were found to suffer from different helminths.

2. The prevalence of helminthic infection was more during the rainy season, June to November (70%) than the dry season, from December to May (52.44%).

3. The adult worms of the single cestode parasite, Anoplocephala manubriata and the blood fluke Bivitellobilharzia nairi could not be collected but the eggs of the worms found in the dung sample of infected elephants were studied and described.

4. Eleven species of adult nematode parasites and three species of amphistomes have been recorded during this study. They are:

1. Murshidia murshidia (Lane, 1914)
2. M. falcifera (Cobbold, 1882)
3. Quilonia renniei (Rail, Henry and Jayeux, 1913)
4. Chonionqium epistomum (Pianna and Stazzi, 1910)
5. Decrusia additictia (Railliet, Henry and Bauche, 1914)
6. Amira pileata (Railliet, Henry and Bauche, 1914)
7. Equinubria sipunculiformis (Baird, 1859)
8. Parabronema indicum (Baylis, 1921)
9. P. smithi (Cobbold, 1882)
10. Grammocephalus hybridatus (Westhuyzen, 1938)
11. G. varedatus (Lane, 1921)
12. Pseudodiscus collinsi (Cobbold, 1875)
13. P. hawkesii (Cobbold, 1875)
14. Gastrodiscus secundus (Bhalerao, 1933)

The details of specific identity of the above parasites have been studied and described.

5. Murshidia murshidia and M. falcifera were found most commonly in all the infected elephants.

6. The efficacy of the new anthelmintic drug Albendazole (Albomar) was tried at the dose rate of 2.5 and 3 mg per kg body weight orally in 24 naturally infected captive elephants. The drug showed 100 per cent efficacy against strongylosis on the basis of egg per gram and ovicidal activity.

References

REFERENCES

- Alwar, V.S. and Lalitha, C.M. (1958). Notes on parasitological interest. Madras Vet. Coll. Ann., 16: 15-19.
- Alwar, V.S., Seneviratna, P. and Gopal, S. (1959). Indofilaria pattabiramaning n.sp. a filarial from the Indian elephant (Elephas maximus) causing haemorrhagic dermatitis. Indian Vet. J., 36: 409-414.
- Bauyer, C. and Stoye, M. (1985). Endoparasites of African and Asian elephants. Praktische Tierarzt. 66(1): 55-60.
Helminth. abstr. (1985), 54: 1518.
- Baylis, H.A. (1921). A new genus of nematode parasite in elephants. Parasitol., 13: 57-66.
- Benz, G.W. and Ernst, J.V. (1978). Anthelmintic activity of albendazole against gastro-intestinal nematodes in calves. Am. J. Vet. Res., 39(9): 1425-1426.
- Bhalerao, G.D. (1933). The trematode parasites of the Indian elephant (Elephas indicus). Ind. J. Vet. Sci., 3(1): 103-105.
- Bhalerao, G.D. (1947). Applied helminthology, its past and future. Science and Culture, India, 12(10): Suppl. 2-3.
- Bhattacharjee, M.L. (1967). Stephanofilarial dermatitis in an Indian elephant. Curr. Sci., 36(21): 584-585.
- Cagle, I.W., Jainudeen, M.R., Buick, T.D. and Sang, S.T. (1978). Some clinico-pathologic findings in elephants (Elephas maximus) infected with Fasciola jacksoni. J. Wild Dis., 14(1): 110-115. Vet. Bull. (1978), 48: 6091.

- Chabaud, A.G. (1957). Revue critique des nematodes du genera Quilonia Lane, 1914 et du genera Murshidia Lane, 1914. Annale de Parasitologie Humaine et comparee, 32(1/2): 28-40. Helminth. abstr. (1957), 26: 69.
- Chandrasekharan, K., Nair, K.P.D., Sundaram, R.K. and Peter, C.T. (1979). Use of Morantel tartrate (Banminth II) as an anthelmintic in zoo animals. Kerala J. Vet. Sci., 4(2): 193-195.
- Chandrasekharan, K., Pythal, C., Radhakrishnan, K. and Sundaram, R.K. (1979a). Methylidine as an effective anthelmintic against strongylosis in elephants. Kerala J. Vet. Sci., 10(1): 163-166.
- Chandrasekharan, K., Pythal, C. and Sundaram, R.K. (1972). A clinical note on the use of Thiobendazole (Thiabendole) against Murshidiasis in Indian elephants (Elephas maximus). Kerala J. Vet. Sci., 3(1): 56-58.
- Chandrasekharan, K., Pythal, C., Sundaram, R.K. and Peter, C.T. (1974). Efficacy of Parbendazole against gastro-intestinal nematodes of domestic animals. Kerala J. Vet. Sci., 5(1): 26-31.
- Chandrasekharan, K., Radhakrishnan, K., Cheeran, J.V., Muraleedharan Nair, K.N. and Ramanujam, K.N. (1982). Comparative efficacy of six anthelmintics against strongylosis in elephants. Kerala J. Vet. Sci., 13(1): 15-20.
- Chandrasekharan, K., Rajamohanam, K. and Sundaram, R.K. (1979). A case of cestode infection in an Indian elephant. Kerala J. Vet. Sci., 10(1): 157-158.
- Chandrasekharan, K., Sathianesan, V., Pythal, C. and Sundaram, R.K. (1979). Anthelmintic activity of thiophanate (Nemafax) in elephants and zoo animals. Kerala J. Vet. Sci., 10(1): 167-170.

- Chandrasekharan, K., Sundaram, R.K. and Peter, C.T. (1972).
On Indofilaria elephantis n.sp. from Indian elephant
(Elephas maximus). Ind. Vet. J., 49(9): 857-862.
- Chatterjee, A. (1984). Association of a stephanofilaria
indistinguishable from S. assamensis with lesions on the
feet of Indian elephants (Elephas maximus). Ind. J. Anim.
Hlth., 23(1): 29-35.
- Chatterjee, A., Greve, J.H., Chakrabarti, A., Biswas, S.K. and
Gupta, J.S. (1982). Aetiopathogenesis of dermatoses in
Elephas maximus in some domesticated animals in North
Bengal. Moitri. Res. Lab., 1: 911. Helminth.abstr.
(1982): 2339.
- Datta, B., Chakrabarty, A.K. and Raquib, A. (1972). A successful
treatment of Choniastium spietomum and Cobboldia elephantis
larvae infection in elephants with tetramisole (Nilvern-
I.C.I.). Ind. Vet. J., 49(11): 1158-1159.
- Dutta, S.C. and Srivastava, H.D. (1955). A revision of the
genus Ornithobitharzia, Osthner 1912 (Trematoda Schistosom-
atidae). Proc. Ind. Sci. Cong. III, No.288. Helminth.
abstr. (1955), 24: 623(c).
- Dutta, S.C. and Srivastava, H.D. (1961). On the epidermal
structure of the miracidia of six species of mammalian
schistosome and a new technique of specific diagnosis of
animal schistosomiasis. Ind. J. Helminth., 13(2): 100-111.
- Fernando, A. and Fernando, C.H. (1961a). Report of helminth
parasite of an Asian elephant which died in Singapore.
Ceylon Vet. J., 2(4): 99-106.
- Fernando, C.H. and Agnes Fernando (1961b). Some helminth
parasites from elephants in Ceylon. Ceylon Vet. J.,
2(1,2): 2-4.

- Frank, W. (1924). Two bursate nematodes from the Indian elephants. J. Comp. Path., 37: 278-286.
- Gnevo, J.H. (1969). Strongyloides elephantis sp.N. from an Indian elephant (Elephas maximus). J. Parasit., 55(3): 498-499.
- Guha, C., Roy, S. and Banerjee, A.K. (1986). Efficacy of albendazole (Analogon) in the treatment of gastro-intestinal nematodes in goats in West Bengal. Ind. Vet. J., 63(12): 1042-1044.
- Gupta, V. and Jaiswal, R.K. (1985). On a new nematode Quilonia guptai sp. new (Strongyloidea: Cyathostomidae, Yamaguti, 1961) from an Indian elephant (Elephas indicus) from Kanpur, U.P. Ind. J. Helminth., 36(2): 139-142. Helminth. abstr. (1987), 56: 3000.
- Gupta, N.K. and Kalia, D.C. (1984). Record of some nematodes from an Indian elephant. Res. Bull. Punjab Univ., 25(1/2): 7-9. Helminth. abstr. (1985), 54: 4639.
- Gupta, S.P. and Trivedi, K.K. (1984). Nematode parasites of Vertebrate IV, a new nematode parasite Quilonia sinhai n.sp. from an Indian elephant. Ind. J. Helminth., 36(1): 61-67.
- Han, Y., Liu, D., Li, P.Y. and Huang, Z.G. (1982). Anthelmintic experiments with albendazole against gastro-intestinal parasites of fowls. Liaoning Xunyu Shuyi (1): 1-3. Vet. Bull. (1983), 53: 1235.
- Huang, D.S. (1981). Three trematodes parasitizing an elephant (Elephas maximus). Chin. J. Vet. Med., 7(4): 17-18.
- Jacob, A. (1984). Use of valbazen pellets (albendazole) in fattening bullocks. Tierarzflische Umschau, 39(4): 275-277. Helminth. abstr. (1986), 55: 1840.

- Kalapesi, R.M. and Purohit, B.L. (1957). Histopathological observations of some lesions due to schistosome infection in an Indian elephant. Bombay Vet. J., 6: 8-11. Helminth. Abstr. (1957), 3: 192(a).
- Kries, H.A. (1956). Parasitische Nematodes quidem Indischen Elefanten (Elephas maximus). Wiener Tierärztliche Monatsschrift, 43(11): 751-760. Helminth. Abstr. (1956), 29: 558.
- Lahkar, B.C. and Das, M.R. (1988). A note on the successful treatment of Trichostrongyle infection of elephant (Elephas maximus) with Panacur (Fenbendazole). Ind. Vet. J., 65(6): 538.
- Lane, C. (1914). Bursate nematode from Indian elephants. Ind. J. Med. Res., 2(1): 380-398.
- Lane, C. (1915). A further note on bursate nematode from Indian elephants. Ind. J. Med. Res., 2: 105-108.
- Lane, C. (1921). Some bursate nematodes from Indian and African elephants. Ind. J. Med. Res., 2(1): 163-172.
- Maggit, F.J. (1926). On a collection of Burmese cestodes. Parasitol., 18: 230-237.
- Malik, B.S., Rai, P. and Ahluwalia, S.S. (1959). A note on helminth of Indian elephant. I. Amphistomatous parasites. Ind. J. Vet. Sci., 29: 11-17.
- McGaughy, C.A. (1962). Diseases of elephants, Part V, Internal parasites. Ceylon Vet. J., 10(2 & 3): 61-64.
- Mudaliar, S.V. and Ramanujachari, G. (1945). Schistosoma nairi n.sp. from an elephant. Indian Vet. J., 22(1): 1-4.

- Mukherjee and Chauhan (1965). Indian amphistomes. J. Zool Soc. India, 17(1,2): 196-220.
- Nasmark, K.E. (1937). "A revision of the trematode family Paramphistocidae". Zool. Bidrag fran Uppsala, 16: 301-365. Helminth.abstr. (1937), 6: 690(a).
- Nickel (1949). Uber einen Elefantertrematodes der Gattung Hawkesius. Deutsche Tierarztliche Wochenschrift, 56(23,24): 184-186. Helminth.abstr. (1949), 18: 74(b).
- Peter, C.T. and Srivastava, H.D. (1960). Studies on the life history of Pseudodiecus collinsi (Cobbold, 1875) Sansino (1895), an amphistomatous parasites of equines and elephants in India. J. Helminth. 12: 1-17.
- Rajamohanam, K. (1970). Acute parasitic enteritis in an elephant. Kerala J. Vet. Sci., 1(1): 73-75.
- Ramanujachari, G. and Alwar, V.S. (1954a). Parafilariasis of elephants. Ind. Vet. J., 31(1): 37-40.
- Ramanujachari, G. and Alwar, V.S. (1954b). Further observation on parafilariasis of elephants. Ind. Vet. J., 31(3): 206-210.
- Ramboli, B., Pellegrini, N., Braca, G. and Macchioni, G. (1976). Grammocephalus hybridatus infection in the liver of Indian elephants: Histological and parasitological findings. Atti della Societa Italiana delle Scienze Veterinarie, 79: 540-543. Helminth.abstr. (1978), 48(2): 1947.
- Rao, R.S. and Hiregauder, L.S. (1953). Schistosomiasis in elephants in Bombay State. Ind. Vet. J., 30(3): 241-242.
- Romaniuk, K. (1982). Value of the Ciba-Geigy preparation of valbazen (albendazole) for the control of nematodes in horses. Medycyna Weterynaryjna, 38(4): 164-165. Vet. Bull. (1982), 52: 7059.

- Roy, S. and Majumdar, B.K. (1988). Anthelmintic activity of Fenbendazole (Panacur) against Murshidia murshidia in zoo elephants. Ind. Vet. J., 65(6): 531-532.
- Sarwar, M.M. and Shaikh, I.Y. (1956). Helminthiasis in an East Pakistan elephant with a short review of the literature. Cey. Vet. J., 4(3): 1.
- Sathianesan, V., Chandrasekharan, K., Sundaram, R.K. and Pythal, C. (1979). Anthelmintic efficacy of oxibendazole against common strongylids in elephants. Kerala J. Vet. Sci., 10(1): 153-156.
- Seneviratna, P., Jayasinghe, J.B. and Jainudeen, M.R. (1967). Filariasis of elephants in Ceylon. Vet. Rec., 81(27): 716-717.
- Seneviratna, P. and Jayasinghe, J.B. (1968). Some parasites from the Ceylon elephant. Cey. Vet. J., XVI(1,2): 23.
- Soulsby, E.J.L. (1982). Helminths, arthropods and protozoa of domesticated animals. The English Language Book Society and Bailliere Tindall, London, 7th ed.
- Southerland, A.K., Sullivan, P.J. and Ohman, B.V.S. (1950). Helminthiasis in an elephant. Aus. Vet. J., 26: 288-290.
- Steel, J.H. (1978). A manual of the disease of the elephant (Cited by McGaughey, 1962).
- Stiles, C.W. and Goldberger, J. (1910). A study of the anatomy of Watsonius (n.g) watsoni of a man and of nineteen allied species of mammalian trematode worms of super family paramphistomoides. Washington Hyg. Lab. Bull. No.60, 1-264. (Cited by Bhalerao, 1933).
- Sundaram, R.K. (1966). Some common elephant parasites. Kerala Vet Coll. Mag., 10: 13-21.

- Sundaram, R.K., Chandrasekharan, K. and Madhavan Pillai, K. (1971). Tetramisole (Nilverm) as an anthelmintic against gastro-intestinal nematodes of elephants. Kerala J. Vet. Sci., 2(1): 55-58.
- Sundaram, R.K., Padmanabha Iyer, Peter, C.T. and Alvar, V.S. (1972). On Bivitellobilharzia nairi (Mudaliar and Ramanujachari, 1945). Dutta and Srivastava, 1955 (Trematoda: Schistosomatidae) parasitic in Indian elephants (Elephas maximus) with description of the species. Ind. Vet. J., 42(1): 1-10.
- Southerland, A.K., Sullivan, P.J. and Ohman, B.F.S. (1950). Helminthiasis in an elephant. Aus. Vet. J., 26: 288-290.
- Theodorides, V.J., Nawalinski, T., Murphy, J. and Freeman, J. (1976). Efficacy of albendazole against gastro-intestinal nematodes of cattle. Am. J. Vet. Res., 37(12): 1517-1518.
- Todd, K.S. Jr. and Mansfield, M.E. (1982). Evaluation of albendazole in cattle naturally infected with nematodes. Am. J. Vet. Res., 43(3): 551-552. Vet. Bull. (1982), 52: 4821.
- Vogel, H. and Minning, W. (1940). "Bilharziose bei Elefanten". Archiv für Schiffs- und Tropen-Tygiene, 44: 562-574. Helminth. abstr. (1940), 305(c).
- Vogelsang, E.G. and Mayaudon, T.H. (1956). Observaciones Sobre parasitismo del tracto digestivo del elefante (Elephas maximus). Revista de Medicina Veterinaria y Parasitología, Caracas, 15(1/4): 19-22. Helminth. abstr. (1956), 25: 523(b).
- Westhuysen, O.P., Van der (1938). A monograph on helminth parasites of the elephant. Onder. J. Vet. Sci., 10(1): 49-190.

- William, J.C., Knox, J.W., Baumann, B.A., Snider, T.G. and Hoerner, T.J. (1981). Anthelmintic efficacy of albendazole against inhibited larvae of Ostertagia ostertagi. Am. J. Vet. Res., 42(2): 318-321. Vet. Bull. (1981), 31: 6216.
- Witenberg, G. (1925). Notes on strongylidae of elephants. Parasitol., 17(3): 284-294.
- Zahedi, M., Vellayan, S., Jeffery, J. and Krishnasamy, M. (1986) Some data on microfilaria of Loxodontofilaria asiatica (Filarioidea: Onchocercidae). Annales de Parasitologie Humaine et Comparee., 61(3): 387-388. Helminth. abstr. (1986), 55: 3853.

HELMINTH PARASITES OF INDIAN ELEPHANTS

By

KHOMDRAM SOMORENDRO SINGH

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Parasitology
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Trichur

1988

ABSTRACT

The present study was conducted over a period of one year, during which dung samples from 203 captive Indian elephants from different parts (urban, village and forests) of Kerala of different age and sex were examined. Out of this, 117 elephants were found to be infected with different helminth parasites either as pure or mixed infection. The overall prevalence of helminthiasis was 57.6 per cent. Helminthiasis was more during rainy season (70 per cent) than dry or summer season (52.44 per cent).

Eleven species of adult nematodes and three species of adult amphistomes and eggs of Bivitellobilharzia nairi and Anoplocephala manubriata were recorded during this study. The nematode parasites were Murshidia murshidia, Murshidia falcifera, Quilonia renniei, Amira pileata, Chonionchium epistomum, Equinubria sipunculiformis, Deerusia additictia, Grammocephalus hybridatus, Grammocephalus varedatus, Parabronema indicum, Parabronema smithi and the amphistomes were Pseudodiscus collinsi, Pseudodiscus hawkesii and Gastrodiscus secundus. The more common species were Murshidia murshidia and Murshidia falcifera.

Anthelmintic efficacy of albendazole (Albomar) was assessed on the basis of the reduction of eggs in the dung samples. A single oral dosage of 2.5 and 3 mg per kg body weight was found 100 per cent effective against strongyle infection in naturally infected captive Indian elephants.