TREMATODES OF PARAMPHISTOMATIDAE INFECTING DOMESTIC RUMINANTS

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled TREPONEMES OF PARAPIETOMATIDAE INFECTING DOMESTIC RUMINANTS 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.

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Certified that this thesis, entitled TREMATODES OF PARAMPHISTOMATIDAE INFECTING DOMESTIC RUMINANTS is a record of research work done independently by Sri. Tarun Shankar Nath 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.

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Dedicated to my

Beloved Parents

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ABBREVIATIONS USED

c.s.	Cirrus sac
ct.	Cuticular tubercles
ex.b.	Excretory bladder
ex.d.	Excretory duct
ex.p.	Excretory pore
g.p.	Genital pore
g.s.	Genital sucker
i.c.	Intestinal caecum
lt.	Left testis
m.	Mouth
mh.	Metraterm
oes.	Oesophagus
o.d.	Oral diverticulum
ot.	Ootype
o.s.	Oral sucker
ov.	Ovary
ph.	Pharynx
p.o.	Pouch opening
pap.	Papillae
p.p.	Para prostatica
rt.	Right testis
s.g.	Shell gland
sp.	Spines
t_1.	Anterior testis

t_p.	Posterior tunic
th.	Thorax
vas.d.	Vas deferens
vas.e.	Vas efferens
ves.	Vesicula seminalis
vit.	Vitellaria
v.s.	Ventral sucker

INTRODUCTION

INTRODUCTION

Amphistomes constitute an important and interesting group of trematodes, and amphistomiasis is now regarded as a disease of great economic importance in livestock. Although the first amphistome of ruminants, Amphistomum conicum (Rudolphi) was discovered in 1793, the association of paramphistomes with the clinical symptoms had not been much recognised till 1906 when Baldrey found that a kind of sickness in sheep in Punjab was actually due to the immature amphistomes in their small intestine.

Paramphistomes of livestock have been recorded from different parts of the world and many of them are found in our animals also. Some of the amphistomes of domesticated animals are known to occur in wild animals which are as natural reservoir hosts and thereby serving as a potential source of infection to the domestic animals.

In India, for a long time, owing to their common occurrence in domesticated animals, amphistomes were regarded as harmless parasites. But investigations (Mukherjee and Sharma Dwarak, 1962) have proved that Indian livestock industry suffers much due to fatal enteritis caused by immature forms of various species of these flukes. Although the extent of economic loss due to amphistomiasis in India is not available they are likely to be one of the most important group of helminth parasites in undermining the health of domesticated ruminants.

Kerala State, though one of the smallest in Indian Union, the topography and the climatic conditions are most favourable for the permanent population of the domesticated and wild animals. The annual rainfall ranges from 130-700 cm with two distinct seasons; South West and North East. The entire monsoon season can be further divided into cold-wet, extending from June to August and warm-wet, from September to November and May (Nammalwar, 1980). The prevalence of many helminth parasites, to a greater extent is influenced by these monsoon seasons.

PRESENT INVESTIGATION

PRESENT INVESTIGATION

The present investigation includes a detailed study of the morphology of the trematodes of family Paramphistomatidae infecting domesticated ruminants, collected from various slaughter houses in Kerala and their specific identification and the prevalence of amphistome infections in different seasons in cattle, buffaloes, sheep and goats as revealed from the examination of faecal samples collected from these animals of representative areas of the State.

These information would help to a considerable extent in formulating the control programmes against amphistomiasis in Kerala State.

REVIEW OF LITERATURE

HISTORICAL REVIEW

Rudolphi (1801) nomenclatured the trematodes with an opening at either end as amphistomes. He, in 1809, divided amphistomes into two groups: "capite discreto" and "capite continuo".

Nitsch (1809) proposed the genus "Holostomum" for the former group and retained the name "Amphistomum" for the latter.

Monticelli (1888) created the family Amphistomidae.

Fischoeder (1901) proposed genus Paramphistomum and created family Paramphistomidae to include all the paramphistomes occurring in mammalian hosts.

Baldrey (1906) first studied the disease produced by amphistomes in sheep in India and collected immature amphistomes from the infected animals.

Walker (1906) made a preliminary note on Gillar, a disease affecting sheep and goats caused by amphistomes in Punjab.

Stiles and Goldberger (1910) proposed four subgenera for the species of Paramphistomum. These are Paramphistomum (Paramphistomum), P. (Orthocoelium), P. (Cauliorchis) and P. (sub-genus uncertain).

Faust (1919) studied and described in detail the excretory system of Digenia which help in the identification of various species of digenic trematodes.

Maplestone (1924) made a revision of amphistomes infecting mammals.

Fukui (1929) split up the genus Paramphistomum into three sub-genera: (Paramphistomum), (Bunifrons) and (explanatum) and also reduced the genus Cotylophoron Stiles and Goldberger, 1910 to a sub-genus under Paramphistomum.

Rao and Ayyar (1932) studied amphistome cercariae and adults of Paramphistomum cervi and Fischoederius elongatus.

Barshey (1934) identified Gastrothylax elongatus and G. crumenifer and discovered Cotylophoron ovatum n.sp., C. orientalis n.sp. and C. elongatum n.sp. from sheep and goats at Allahabad.

Travassos (1934) made a systematic study of Paramphistomes and recognised only two subgenera, namely Paramphistomum (Paramphistomum) and P. (Cauliorchis).

Bhalerao (1935) described the helminth parasites of domesticated animals in India.

Raji (1935) made a preliminary note on a disease of sheep and goats locally known as "piet or pitto" caused by amphistomes.

Nandi (1935) reported acute amphistomiasis in cattle of Kamrup district, Assam and identified Cotylophoron sp. as the causative agent.

Bennett (1936) studied the life history of Cotylophoron cotylophorum from ruminants and also described the adult fluke.

Dawes (1936) made a collection of paramphistomidae from Malaya and reviewed the genera Paramphistomum Fischoeder, 1901 and Gastrothylax Poirier, 1883.

Nasmark (1937) split up the genus Paramphistomum into eight genera excluding the genus cotylophoron. These eight genera are Paramphistomum Fischoeder, 1901 (restricted), Gigantocotyle, calicophoron, Homalocotyle, Zygocotyle, Diplocotyle, Duriformo and Engycotheremx. Nasmark in the same year included two new and eight already known forms into the genus Paramphistomum. These are P. cervi (Zeder, 1790); P. hetericophoron (Braun, 1902); P. gracile (Fischoeder, 1901); P. epiclitum (Fischoeder, 1904); P. microcephalum (Fischoeder, 1901); P. liocephis (Fischoeder, 1901); P. ceylonicum (Stiles and Goldberger, 1910); P. ichikawai (Fukui, 1922); P. ootoi (Fukui, 1922); P. clavula (Nasmark, 1937) and P. leydeni (Nasmark, 1937).

Khalorao (1937) made a systematic study on the helminths of Indian trematodes.

Srivastava (1938) made a study on the life history of Cotylophoron cotylophorum (Fischoeder, 1901) Stiles and Goldberger, 1910, of Indian ruminants suggesting biological control to check infection.

Filley (1938) studied the life history of Gastrothylax lunata from sheep.

Vaidyanathan (1941) induced experimental infection with Fischoederius elongatus in a calf at Madras.

Gupta (1943) recorded incidence of Paramphistomum cervi, P. crumenum and P. explanatum infecting oxen and buffaloes in Lahore.

Bhalerao (1944) ascertained the condition known as "immature amphistomiasis" caused by several species of Cotylophoron in Indian ruminants.

Kagsood (1944) reported acute amphistomiasis in north Indian cattle.

Srivastava (1944a&b) studied the life history of Paramphistomum explanatum and Gastrothylax crumenifer respectively, from Indian ruminants.

Bhalerao (1945) studied the common amphistomes of domestic animals along with their intermediate hosts in central India.

Hoghe (1945) studied the seasonal incidence of various helminthic infection and suggested further study of the life history and prevention of Cotylophoron cotylophorum and Gastrothylax crumenifer.

Mudaliar (1945) recorded fatal enteritis in goats due to immature amphistomes in Madras.

Srivastava (1945) made a survey of helminthic infections of sheep, goats, cattle and buffaloes of Punjab and Sindh and established widespread occurrence of Cotylophoron cotylophorum; Paramphistomum cervi; P. explanatum and Gastrothylax crumenifer.

Thapar and Sinha (1945) described in detail the morphology of a new amphistome, Olveria indica from the rumen of cattle and buffaloes in U.P.

Muppuswamy (1946) furnished a scheme to elucidate the etiology of "Giller" and "Pitto" in sheep and goats in Bihar.

D'souza (1948) studied the so called obscure sheep disease at the Livestock research station, Hosur, caused by immature amphistomes mainly, Cotylophoron cotylophorum and Gastrothylax crumenifer.

Kuppuswamy (1948) studied the condition 'Pitto' and 'Collar' in sheep and goats.

Alwar (1949) made a detailed study on amphistomiasis of cattle, buffaloes, sheep and goats.

Skrjabin (1949) made a revision of the systematics of the trematode of order Paramphistomata, Skrjabin and Schulz (1937).

Millmott (1950) found three species of amphistomes commonly occurring in cattle in United Kingdom and Ireland viz., Paramphistomum cervi (Zeder, 1790) Fischoeder, 1901 and two new species, which she named and described as P. hibernicus and and P. leydeni Nasmark, 1937.

Gupta (1950) studied the anatomy of Paramphistomum (Gastrothylax) crumenum, obtained from cattle in Lahore.

Sinha (1950) studied the life history of Cotylophoron cotylophorum, a trematode parasite from the rumen of cattle, sheep and goats.

Tandon (1951) reported a new amphistome Olveria bosi from the rumen of buffalo (Bos bubalis) from Lucknow.

Ramakrishnan (1951) reported an outbreak of acute amphistomiasis among cattle of Nellore district.

Gupta (1951) described and figured the morphology of Paramphistomum bathmostylis and made a comparative study with that of the findings of Nasmark (1937).

Durie (1953) reviewed the paramphistomes of Australian ruminants.

Price and McIntosh (1953) reported two new trematodes of the genus Cotylophoron viz., C. parabaracensis and C. panamensis. Stiles and Goldberger, 1910 from American sheep.

Ramanujachari and Alwar (1954) in their check list of parasites in the Department of Parasitology, Madras Veterinary College, included Cotylophoron cotylophorum (Fischoeder, 1901), Carmyerius spatiosus (Brandes, 1898) Stiles and Goldberger, 1910 and Olveria indica (Thapar and Sinha, 1945).

Swart (1954) made a detailed study on the commonly occurring amphistomes of ruminants in South Africa and identified as Paramphistomum microbothrium (Fischoeder, 1901) and Calicophoron calicophorum (Fischoeder, 1901) Nasmark, 1937.

Dinnik (1954) reported a new species Paramphistomum zukari from the reticulum of Bos taurus in Kenya.

Dinnik and Dinnik (1954) studied the life history of Paramphistomum microbothrium (Fischoeder, 1901) an amphistome parasite of ruminants.

Tandon (1955a) presented a redescription of Paramphistomum gotoi (Fukui, 1922) and made a comparative study with that of

the findings of Pukui (1922) and Dawes (1936).

Tandon (1955b) again reported a new amphistome, Paramphistomum aniniocephalus from the rumen of Bos bubalis at Lucknow.

Thapar (1956) made a systematic survey of helminth parasites of animals in India.

Dinnik (1956) made a detailed study on the morphology of Ceylonocotyle scoliocoelium (Fischoeder, 1904) and its intermediate host in Kenya.

Gupta (1958) discovered a new species Ceylonocotyle dawesi from Bos indicus in Madras.

Singh (1958) redescribed Gigantocotyle explanatum (Creplin, 1047) Nasmark, 1937 from India.

Lengy (1960) studied Paramphistomum microbothrium, Fischoeder, 1901, a rumen parasite of cattle in Israel.

Mukherjee (1960a&b) studied the life history of Ceylonocotyle scoliocoelium Fischoeder, 1904, an amphistome parasite of sheep and goats and Cotylophoron indicum Stiles and Goldberger, 1910 an amphistome parasite of buffaloes, sheep and goats.

Mukherjee (1960c) recorded Ceylonocotyle scoliocoelium from cattle, buffaloes, sheep and goats, C. aniniocephalus from buffaloes and Gigantocotyle explanatum from cattle, buffaloes and goats respectively.

Mukherjee and Srivastava (1960) carried out studies on the life cycle of Gigantocotyle explanatum (Crepiin, 1047)

Nasmark, 1937, which parasitises in the bile duct and gall bladder of buffaloes, with a description of the species.

Dinnik (1961) reported Paramphistomum phillerouxi n.sp. from rumen of cattle at Namabuka, Northern Rhodesia and its development in Bulinus forskalii.

Alwar and Lalitha (1961) published a check list of helminth parasites in the Department of Parasitology, Madras Veterinary College, in which they had included the following species of amphistomes also: Paramphistomum cervi (Zeder, 1790) Fischoeder, 1901, Cotylophoron cotylophorum Stiles and Goldberger, 1910; Olveria hoei Tandon, 1921 and Gastrothylax crumenifer (Creplin, 1847) Poirier, 1883.

Thapar (1961) studied the life history of Olveria indica, an amphistome parasite from the rumen of Indian cattle at Lucknow.

Dinnik (1962) reported Paramphistomum daubneyi sp.nov. from cattle and its snail host in the Kenya highlands.

Mukherjee (1962) studied the amphistomatous trematodes of domesticated animals.

Gupta (1963) briefly described Paramphistomum epiclitum Fischoeder, 1904, a parasite of rumen of the farm animals in Punjab.

Katiyar and Varshney (1963) made a detailed survey on amphistomiasis in sheep and goats in Uttar Pradesh and found the following species were involved: Gastrothylax crumenifer

Cotylocheron cotylocheron, Paramphistomum cervi, P. explanatum and Fischoederius elongatus.

Mukherjee (1963) made a morphological study on two new species of amphistomes viz., Ceylonocotyle nagmarki n.sp. and Cotylocheron shrivastavi n.sp. from the rumen of sheep and goats respectively, at Bareilly, Uttar Pradesh.

Saxena (1964) reported 26.3% infection of domesticated ruminants around Agra with amphistomes of which 51.6% being Ceylonocotyle scoliocoelium.

Schad et al. (1964) reported the occurrence of Gastrothylax elongatus, G. symethes, G. cobboldi, Ceylonocotyle streptocoelium, G. scoliocoelium and G. gigantocheryus in ruminants in Malaysia.

Dinnik (1964) described and figured Paramphistomum subulatum n.sp. from the stomach of cattle in Tanganyika. He also described intestinal paramphistomiasis and P. microbothrium Fischoeder, 1901 in Africa.

Mukherjee and Chauhan (1965) studied the trematode fauna of India and mentioned the occurrence of the following species of amphistomes in domestic ruminants: Paramphistomum cervi (Zeder, 1790) Fischoeder, 1901; P. gotoi Fukui, 1922; Calicophoron calicophorum (Fischoeder, 1901) Nasmark, 1937; C. cauliorchis (Stiles and Goldberger, 1910) Nasmark, 1937; C. orientalis Mukherjee, 1966; C. papillosum (Stiles and Goldberger, 1910) Nasmark, 1937; Ceylonocotyle scoliocoelium (Fischoeder, 1904) Nasmark, 1937; C. dawesi Gupta, 1958; C. nagmarki, Mukherjee,

1963; C. orthocoelium (Fischoeder, 1901) Nasmark, 1937; C. spinicephalus, Tandon, 1955; Cotylophoron cotylophorum (Fischoeder, 1901), Stiles and Goldberger, 1910; C. indicum Mukherjee, 1960; C. madrasensis Gupta, 1958; C. bareilliensis Mukherjee, 1963. Gigantocotyle explanatum (Creplin, 1847) Nasmark, 1937; Olveria indica Thapar and Sinha, 1945; O. bosi Tandon, 1951; Himalayastar palonias (Poirier, 1883) Mukherjee 1966; Gastrothylax crumenifer (Creplin, 1847) Poirier, 1883; Carmerius carmerius (Looss, 1896) Stiles and Goldberger, 1910; Fischoederius elongatus (Poirier, 1883) Stiles and Goldberger, 1910; F. cobboldi (Poirier, 1883) Stiles and Goldberger, 1910; Johnsonitrema nasutum (Johnson, 1939) Yamaguti, 1958.

Gupta (1966) reported Calicophoron papillosum from Bos bubalis and C. gauliorchis from Bos indicus.

Mukherjee (1966a) reported the occurrence of Calicophoron gauliorchis (Stiles and Goldberger, 1910) Nasmark, 1937 from Indian buffaloes. Mukherjee (1966b) also studied and described Fischoederius elongatus (Poirier, 1883) Stiles and Goldberger, 1910, an amphistome parasite of cows and buffaloes in India. Mukherjee (1966c) further reported a new species, Calicophoron orientalis from the rumen of Capra hircus.

Fukui (1967) listed ninetysix generic names of trematodes which have been named as amphistomes.

Gupta and Dutt (1967a&b) reported the occurrence of Fischoederius cobboldi from the stomach of cattle at Madras

and Bombay and also Gastrothylax crumenifer, a common pouched amphistome parasite of ruminants in India.

Velichko (1969) described two new species Paramphistomum scotiae and P. hibernicae from USSR.

Bhattacharyulu and Pande (1968a) made a specific evaluation on a collection of adult amphistomes in sheep in India. Bhattacharyulu and Pande (1968b) also studied the excretory system in detail to identify the immature amphistomes in sheep.

Mukherjee (1968) studied the life history of Cotylophoron indicum Stiles and Goldberger, 1910, an amphistome parasite of ruminants in India.

Jain and Srivastava (1969) studied the life history of Ceylonocotyle scoliocoelium, a common amphistome parasite of ruminants in India.

Doray (1969) studied the intestinal amphistomiasis in sheep due to Paramphistomum ichikawai Fukui, 1922.

Singh (1970) recorded Srivastava indica n.g.n.sp. an amphistome parasite and studied the life history by infecting sheep and goats.

Van Strydonck (1970) made a contribution to the study of the anatomy, morphology and systematics of African Paramphistomidae.

Gupta and Gupta (1971) reported a new genus new species Cochinocotyle bovini from cattle at Ernakulam.

Nath (1971) established the observation on the seasonal incidence and severity of infection of immature amphistomiasis, a disease in sheep and goats of Uttar Pradesh.

Gupta and Gupta (1972a) reported a new species Ceylonocotyle narayani from cattle at Ernakulam.

Gupta and Gupta (1972b) reported a new species Cotylophoron chauhani from sheep at Ernakulam.

Bali (1972) reported the occurrence of Calicophoron calicophorum (Fischoeder, 1901) Nasmark 1937 for the first time in sheep in India.

Bali and Potedar (1972a) studied the morphology of Ceylonocotyle scoliocoelium an amphistome parasite of sheep at Jammu and Kashmir.

Bali and Potedar (1972b) recorded Paramphistomum skrjabini for the first time from Ovis aries in Jammu and Kashmir. This species had been previously reported from cattle and buffaloes in USSR.

Chu (1972) made a survey on the incidence of amphistomes and found Paramphistomum orthocoelium and Gastrothylax elongatus were most common. in Korea.

Bali (1973) made a survey on incidence of helminth parasites in sheep in Bihar.

Jain (1973) made an extensive study on the life history of amphistomes, the cercariae and the adults along with the hosts recorded in India and in other countries.

Mukherjee and Chauhan (1973) made a detailed study on Indian amphistomes and recorded the common species encountered in India.

Sinha and Sahai (1973) described the incidence and nature of helminthic infections in goats in Bihar.

Vellichko (1973) made a systematic study of trematodes of the genus Calicophoron Nasmark, 1937, based on world wide materials from ruminants.

Bali and Potdar (1974) reported a new species, Olyria thapari from the rumen of cross-bred sheep in Kashmir.

Griffiths (1974) made an extensive study on the helminths of buffaloes and reported Gigantocotyle explanatum as the most commonly occurring amphistome.

Chhabra and Gill (1975) studied the incidence of helminthic infection and control of amphistomiasis in animals in two villages of Punjab.

Chellape and Gopalakrishnan (1977) made an observation on gastro-intestinal helminthosis in sheep and goats in Coimbatore (Tamil Nadu).

Gupta and Nakhasi (1977a&b) made a detailed study on amphistomid parasites of India and mentioned the diagnostic features of 22 species of amphistomes based on whole mount and sagittal sections.

Nama (1977) described the occurrence of Gastrothylax crumenifer Dhaleraо, 1937, from buffaloes, a new host in Rajasthan.

Dutt (1978) described the Paramphistomes of bovines with a description of Gastrothylax indicus.

Gupta and Sen (1978) described the excretory, lymphatic and nervous systems of some amphistomes of India.

Srivastava and Gupta (1978) made efforts to diagnose prepat ent amphistomiasis in cattle in Haryana.

Shankar and Singh (1978) reported the incidence of Gigantocotyle explanatum (Creplin, 1847) infection in ruminants of Northern India.

Sharma and Asthana (1979) studied the outbreak of Paramphistomiasis in bovines in Aligarh.

Jayakumar (1979) studied the amphistome parasites of domestic animals with their prevalence in Karnataka.

Sey (1979a) reported the validity and systematic position of some Paramphistomids of Indian ruminants.

Sey (1979b) described the life history and geographical distribution of Paramphistomum daubneyi (Sinnik, 1962).

Sey and Graber (1979) described Cotylophoron macrosphinctria n.sp. from the African buffaloes.

Eduardo (1980) described Orthocoelium indonesiense n.sp. from the rumen of Bos indicus and Bos sp.

Hafeez and Rao (1980) studied the amphistomes and amphistomiasis of sheep and goats in Andhra Pradesh.

Dutt (1980) described and figured in detail the amphistomes found in domesticated ruminants in India.

Srivastava et al. (1980a) described two new species of amphistomes referable to a new genus Suraphiella (family Overiidae Fan Nov.) parasitic in Indian sheep, goats and buffaloes. They (1980b) also described a new pouched amphistome Duttiella cephalocercus Gen. et. sp. Nov. (Family Gastrothylacidae) from buffaloes.

Srivastava and Tripathy (1980) reported a new genus Palamphistomum with P. lobatum and P. dutti as its type species from sheep, goats and buffaloes.

Srivastava et al. (1980) studied the helminth parasites of sheep and goats in Punjab.

Tripathi and Srivastava (1980a&b) carried out detailed study on Palamphistomum lobatum and P. dutti amphistome of Indian sheep, goats and buffaloes.

Balbo et al. (1981) studied fasciolasis and Paramphistomiasis in cattle in the province of Vercelli, Italy.

Al-Janabi et al. (1983) reported Calicophoron calicophorum from the rumen of sheep for the first time in Iraq.

Barkakoty et al. (1984) reported an incidence of gastro intestinal parasitic infection in cattle in Kamrup district of Assam.

Faslaev (1984) reported Paramphistome infection in ruminants in the pre-ural region of southern Bashkiria (USSR).

Gupta et al. (1984) studied the life history and histological findings of Paramphistomum cervi in sheep in India.

Gurevich and Oshmrin (1984) studied the significance of Nasmark's method in systematics of trematodes of the sub-order Paramphistomata (Saidat, 1936).

Siddique and Shah (1984) described the helminthic infection of liver and respiratory tract of cattle of Peshawar and the life history of Paramphistomum cervi.

Sahai and Ansari (1985) made a detailed study on amphistomiasis and its control in Bihar.

Sahai (1985) made studies on amphistomatous flukes of some common vertebrates in Patna.

MATERIALS AND METHODS

MATERIALS AND METHODS

1. Collection of Amphistomes:

Amphistomes were collected from the visceral organs of cattle, buffaloes, sheep and goats slaughtered at the Municipal slaughter house, Kuriachira, Trichur; Corporation slaughter house, Trivandrum; private slaughter house at Mannuthy, Trichur; slaughter house attached to the Veterinary Public Health Department of the College of Veterinary and Animal Sciences, Mannuthy and from the animals brought for post-mortem at the Department of Pathology, College of Veterinary and Animal Sciences, Mannuthy.

2. Study of Morphology:

The amphistomes were mostly collected in normal saline solution after opening the rumen and bile ducts of the slaughtered animals. The specimens were brought to the laboratory, soon after collection to study the morphology of excretory and lymphatic system alive after pressing gently in between two micro-slides. The representative samples of different species of amphistomes were flattened and fixed in 10% formalin for 36 hours. These specimens were then washed for 12 hours in running tap water and afterwards in two changes of distilled water. They were kept overnight in working solution of acetic alum carmine.

Acetic alum carmine:

Stock solution: About 500 ml of distilled water was heated

in a 1000 ml conical flask to boil and ammonium alum ($AlNH_4(SO_4)_2 12 H_2O$) was added to make a saturated solution (tested by cooling when a little precipitate was formed). Again the solution was boiled and powdered carmine was added upto saturation, i.e., till a little quantity was left unlie-solved at bottom. The flask was then cooled and the stain solution was allowed to nature for 48 hrs, filtered through a coarse filter paper and 5 to 10% glacial acetic acid was finally added.

Working solution:

Stock solution	..	1 cc
Distilled water	..	25 cc

The specimens were generally overstained. They were destained in 1% acid alcohol (99 ml of 70% alcohol and 1 ml of conc. hydrochloric acid) washed in several changes of distilled water to remove the traces of acid if any and then dehydrated in ascending grades of alcohol (80%, 90% and absolute) allowing 30 minutes in each grade and lastly two changes of xylol, allowing to remain for clearing 15 minutes in each. In place of xylol, creosote was also used as a clearing agent and creosote was found more suitable for clearing the specimens which required longer time for clearing. The cleared specimens were then mounted in canada balsam. These prepared stained specimens were utilised for the study of detailed morphological features, measurements and camera lucida drawings.

3. Histology of genital pore and other structures:

a) Relaxation:

Various species of amphistomes have their own distinct shape and improper relaxation would distort the shape of the body and the shape and topography of the internal organs. Proper relaxation was obtained by the following method (Dutt, 1980).

The representative samples of live specimens were put in a 500 ml beaker which was filled with about 50 ml of physiological saline solution and shaken vigorously for about half a minute. Water heated to a temperature of 50 to 55°C was then gradually poured into the beaker till it was full. The flukes died in a completely relaxed state and the shape assumed was uniform for the same species.

b) Fixation:

Soon after the trematodes settled down to the bottom of the beaker, the supernatant fluid was thrown off and enough 10% formalin was added as a fixative and allowed 36 hours.

c) Microtomy:

The fixed specimens were washed in running tap water for about 12 hours and afterwards dehydrated in ascending grades of alcohol commencing from 70%, 85%, 90%, 95% and absolute, three changes of each and allowing half an hour in each, except 70% alcohol in which it was kept for 2 hours. The amphistomes were then cleared in xylol; two changes and 15 minutes in each.

They were kept in a mixture of equal parts of benzene and paraffin for 15-30 mts in an oven. Next, the specimens were embedded in paraffin wax, four changes, allowing, half an hour in each and finally blocks were made. The sections were prepared at eight microns in sagittal plane and stained with Haematoxylin and Eosin stain and mounted in canada bal sam.

4. Morphology of unflattened specimens:

The morphological study of unflattened specimen (Dutt, 1980) were also tried. This included the following steps: collection, relaxation, fixation, bleaching, staining, dehydration, clearing and examination. Collection, relaxation and fixation were done following the method described. Pigmented amphistomes (Olveria spp. and all species of the sub-family Gastrothylacinae) and large specimens of other groups of trematodes need bleaching to make their internal organs visible when cleared. Bleaching was done by keeping immersed the specimens in freshly prepared chlorinated alcohol.

Chlorinated alcohol:

About 1 g of potassium chlorate was taken in a 500 ml test tube held in an inclined position by means of a test tube holder and about 0.5 ml hydrochloric acid was added gradually. The mouth of the test tube was then plugged with cotton wool. Chlorine was liberated and the test tube was soon filled with yellowish green fumes. When there were no more bubbles at the bottom of the test tube, it was filled with 70% alcohol and closed again.

The fixed specimen, which had been previously washed in water and preserved in 70% alcohol were then introduced into the test tube containing chlorinated alcohol for bleaching, and required 3 to 12 hours depending upon the degree of pigmentation and size of the specimens. A change of chlorinated alcohol might be necessary depending on the number of flukes subjected for bleaching at the same time.

Staining:

The specimens were washed in 70% alcohol and stained with acetic alum carmine. The flukes were stained evenly and then differentiated in 1% acid alcohol so that the internal organs retained adequate stain but the body wall lost most of it.

Dehydration:

Dehydration was done in ascending grades of alcohol (80%, 90% and 95%) half an hour in each and one hour in absolute alcohol which was changed once during this time.

Clove oil was found to be the best clearing agent for this method (cedarwood oil was sticky and manipulation of specimens became difficult). Initially, there was much shrinkage of the specimens while in the oil but they regained their normal shape in about 6 to 12 hrs and found suitable for studies.

Examination of specimens:

The examination of entire specimen was done under a stereoscopic microscope provided with transillumination. The testes, uterus, para musculosa, etc. could be seen in dorso-ventral

view, and the oesophagus, intestinal caeca, genital bulb, parasprostatica, excretory canal, Laurer's canal etc. in lateral view.

5. Morphological study of thick sagittal section:

The specimens were also studied in thick sagittal sections, as suggested by Dimnik (1964). A petri dish of medium size (9.5 cm diameter) was coated with about 1 cm layer of paraffin wax to serve as a dissecting dish, and a groove of gradually varying width and depth was made at its middle by removing the paraffin between the two converging straight lines. The specimen was then taken out of the olive oil, wiped with a filter paper, and fitted into the groove, ventral side up at a suitable location according to its size. It was then cut into two equal halves with a razor blade by a median sagittal incision passing through the oral sucker, genital bulb and acetabulum. In case of small specimens, the incision was made under a stereoscopic microscope fitted with epi and transillumination. The two halves were then examined in clove oil on a slide under a microscope with cut surface up. In case of large specimens, each half was again cut into two by a sagittal incision, taking care that the median slices were of uniform thickness. These incisions were made by holding the specimen between the thumb and the fore finger of the left hand or between glass slabs of appropriate thickness placed on a tray (Dutt, 1930). The slices of the flukes were then mounted on a slide in clove oil under cover glasses. The two median slices,

mounted with their first cut surface up, showed the medio-sagittal surfaces of the oral sucker, genital bulb, acetabulum, testes, excretory bladder, Laurer's canal, etc. The lateral slides showed the configuration of the intestinal caeca, vitelline glands etc. Identification was done in clove oil, which only gave the clearest view. Later, permanent mounts in canada balsam were made.

Quick method:

For routine identification of common species, a quick method (Dutt, 1980) was followed in which the staining was avoided and the bleached specimens were cleared in toto or after making sagittal sections in a mixture of equal parts of lacto-phenol and phenol.

6. Prevalence of amphistomes in domestic ruminants:

Collection and examination of faecal samples:

Routine examination of faecal samples from cattle, buffaloes, sheep and goats brought to the clinics of College of Veterinary and Animal Sciences, Mannuthy and Trichur were done at random to assess the prevalence of infection in those animals. Faecal samples were collected from rectum in small empty vials and brought to the laboratory and examined by sedimentation technique. The examination of faecal samples were conducted as a routine work, monthwise, to find out the seasonal variation in prevalence if any. Faecal samples were also collected for examination from the cows and heifers brought

to the Artificial Insemination Centre of the College of Veterinary and Animal Sciences, Mannuthy and Trichur and from cattle maintained at Cattle Breeding Farm, Thumburmuthy; University Livestock Farm and Goat Farm, at Mannuthy.

Informations were collected pertaining to the total number of animals slaughtered/dead and the number of animals that actually harboured amphistomes. This was compared with the result of faecal examination.

RESULTS

RESULTS

PREVALENCE OF PARAMPHISTOMES

a) As revealed by Faecal Examination:

The prevalence of Paramphistomes in domesticated ruminants was detected by examining the dung samples collected from these animals from different places of Kerala State. Month-wise prevalence of amphistomes in respect of each class of domestic ruminants as revealed by faecal sample examination is presented in Table 1.

A total number of 1,490 samples were examined for infection with Paramphistomes in different classes of domestic ruminants, i.e., cattle, buffaloes, sheep and goats from April 1985 to March 1986. Out of these, 1,116 samples were from cattle, 63 from buffaloes, 311 from goats and none from sheep. A total of 253 samples from these animals were found positive (16.98%) for amphistomes. From the data collected it can be seen that buffaloes accounted for the maximum percentage of prevalence (28.57%) and the goats minimum (3.22%).

The maximum prevalence of amphistomes in the animals were found during the months of June and July, 1985.

Season-wise prevalence of amphistomes in cattle, buffaloes and goats is presented in Table II. It can be noted that the maximum prevalence in all classes of these animals was during south west monsoon (cold wet), i.e., from June to August. The

least of the prevalence was during dry season (i.e., December to April).

b) As revealed by post mortem examination:

The prevalence of amphistomes as revealed by examination of animals slaughtered in different slaughter houses of Kerala State and also the dead animals brought for post-mortem in the Department of Pathology shows that out of a total of 780 animals examined 17.95% were infected (Table III). Buffaloes accounted for the maximum prevalence (34.67%) while sheep the minimum (4.17%).

Different species of amphistomes recovered from each class of domestic ruminants and the percentage of prevalence in respect of each of them are set out in Table IV. It can be seen that in cattle Gastrothylax crumenifer accounted for the maximum prevalence (62.64%) and Ceylonocotyle spiniocephalus and C. narayani, the minimum (1.20%). In the case of buffaloes Gigantocotyle explanatum recorded the highest (57.69%) and Calicophoron gaulicorchis the lowest (15.38%). Cotylophoron cotylophorum had the highest (60%) in sheep and C. indicum, Fischoederius cobboldi, Olveria hani, Ceylonocotyle nagpurki and Gastrothylax crumenifer the least. In goats, Cotylophoron cotylophorum had the highest (30.69%) and Paramphistomum cervi, Cotylophoron shaubani and Ceylonocotyle spiniocephalus, the lowest (5.56%).

During the present investigation, a total number of 17 species belonging to eight different genera of family

Paramphistomidae could be recovered from cattle, buffaloes, sheep and goats. Sixteen of these were located in rumen, four in reticulum also and one in bile ducts and liver only.

While two species (Fischoederius cobboldi and Gastrothylax crumenifer) were parasitising in all the domestic ruminants (cattle, buffaloes, sheep and goats), two (Fischoederius elongatus and Cotylophoron cotylophorum) were found in three classes of animals, six species (Cotylophoron indicum, Calicophoron calicophorum, Ceylonocotyle scoliocoelium, Ceylonocotyle spinicephalus, Paramphistomum cervi and Paramphistomum epiclitum) in two classes and seven species (Calicophoron sauliorchis, Ceylonocotyle pagneriki, Cotylophoron chauhani, Ceylonocotyle naravani, Diveria indica, Diveria bosi and Gigantocotyle explanatum in a single ruminant host only.

The species of amphistomes recovered with their hosts and locations are presented in Table V.

DESCRIPTION OF THE SPECIES*

PARAMPHISTOMUM EPICLITUM (FISCHOEDER, 1904) STILES AND GOLDBERGER, 1910

(PLATE No. I)

The body is elongated, conical, ventrally curved and measures 10.51 mm x 3.61 mm. The ratio between the breadth and the length of the body is 1:2.95.

The oral sucker is spherical, subterminal and measures 0.38 mm x 0.36 mm. Its relation to the body length is 1:11.94. The oesophagus measures 0.91 mm in length.

Intestinal caeca are sinuous with several bends and terminate at about the level of the anterior border of the acetabulum.

The testes are tandem and slightly lobed. The anterior testis is larger and measures 1.10 mm x 1.46 mm, and the posterior one measures 0.94 mm x 1.43 mm.

Ovary is oval in shape, post-testicular in position and measures 0.39 mm x 0.47 mm in size. The coiled uterus arises from the right side of the ootype. The vitellaria are follicular and numerous, extending from the intestinal bifurcation upto the anterior end of the acetabulum in the extracaecal region.

The acetabulum is terminal, opening ventrally and measures 2.43 mm in diameter and its relation to the body length is 1:4.3.

*All measurements are in millimeter

The genital pore is post-bifurcal, and situated at a distance of 3.14 mm from the anterior end of the body and 1.13 mm away from the intestinal bifurcation.

Eggs are oval in shape with an operculum at the attenuated end and measure 0.141 mm x 0.070 mm in size.

PARAMPHISTOMUM CERVI (ZEDER, 1790) FISCHOEDER, 1901
(PLATE No. II)

The body is conical, elongated and curved ventrally. The dorsal and ventral borders are evenly curved. The cuticle bears prominent tubercles on the anterior third to half of the body, more extensive ventrally. The length of the body is 12.54 mm and breadth 3.92 mm. Dorso ventral thickness is 2.16 mm.

The acetabulum is subterminal, measures 1.88 mm in diameter. The acetabular index is 1:6.67. The oral organ measures 0.893 mm and its ratio to the length of the body is 1:14.04.

The oesophagus is 0.627 mm in length without any bulb. The intestinal caeca has seven nearly identical bends, the terminal part directed ventrally, and reaches upto the level of the acetabulum.

The testes are tandem and deeply lobed, the anterior testis measures 1.64 mm x 1.72 mm; the posterior testis measures 1.41 mm x 1.84 mm. The ovary is post testicular and measures 0.41 mm in diameter. The genital pore is situated at a distance of 2.97 mm from the anterior end and 1.41 mm behind the intestinal bifurcation.

Eggs are oval in shape, operculate and measure 0.148 mm x 0.078 mm.

COTYLOPHORON COTYLOPHORUM STILES AND GOLDBERGER, 1910

(PLATE No. XII)

The body is conical in shape, slightly curved ventrally, dorsal border evenly curved and the ventral border almost straight. The body measures 6.32 mm x 2.97 mm. The ratio between the length and the breadth of the body is 1:2.30. The cuticle bears small papillae around oral aperture only.

The oral sucker is sub-terminal in position and measures 0.66 mm x 0.53 mm. The ratio of the length of the oral organ to the body length is 1:9.6. The oesophagus is small and measures 0.55 mm in length. Its ratio to the body length is 1:12.45.

The intestinal caeca are wavy and terminate in the acetabular zone. They are with five to seven bends with the terminal parts directed dorsally. The testes are diagonal and strongly lobed. The anterior testis measures 0.94 mm x 0.88 mm and the posterior testis 0.94 mm x 0.69 mm.

Ovary is almost spheroidal in shape, 0.55 mm in diameter. Vitellaria are follicular, extending from oesophageal to midacetabular zone. The uterus is a simple tube lying in the median field.

Acetabulum is subterminal, spherical in shape, directed ventrally and its aperture is surrounded by a folded wreath like ridge. The diameter of acetabulum is 1.56 mm and the acetabular index is 1:4.3.

The genital pore is post bifurcal, located at a distance of 1.58 mm from the anterior end. The genital sucker is well developed and encloses the genital atrium.

Eggs are nearly oval in shape, operculate and measure 0.157 mm x 0.078 mm in size.

COTYLOPHORON INDICUM STILES AND GOLDBERGER, 1910

(PLATE No. IV)

The fresh specimens are light brown in colour and conical in shape with the maximum breadth across the posterior portion. The dorsal border is shallowly and evenly curved. The body measures 6.58 mm x 2.97 mm in size. The pharynx is subglobular in shape and 0.39 mm x 0.56 mm in size. The oesophagus measures 0.693 mm in length and is without any oesophageal bulb. The oesophagus gives rise to intestinal caeca, which are much coiled and terminate blindly a little posterior to the anterior margin of the acetabulum. The oral sucker measures 0.67 mm in length and 0.47 mm in breadth and its ratio to the body length is 1:9.8.

The testes are deeply lobed and are placed slightly diagonal, one behind the other. The anterior and the posterior testes measures 0.94 mm x 0.75 mm and 1.09 mm x 1.06 mm respectively.

The ovary is situated behind the posterior testis, anterior to the anterior margin of the acetabulum and measures 0.202 mm x 0.279 mm in size. The uterus is strongly convoluted. The vitelline glands are follicular in nature and distributed in between the bifurcation of the oesophagus and the anterior margin of the acetabulum in the lateral fields of the body. The acetabulum measures 1.59 mm in diameter. The acetabular index is 1:4.1.

The genital pore is surrounded by a genital sucker which is situated posterior to the oesophageal bifurcation.

SCHISTORCHIS GHOSHAL GUPTA AND GUPTA, 1972

(PLATE No. V)

The body is conical in shape and slightly curved ventrad. It measures 3.73 mm in length and 2.82 mm in breadth. The dorso-ventral diameter is 1.26 mm.

The acetabulum measures 1.56 mm in diameter. Its relation to the length of the body is 1:3.67. Pharynx measures 0.62 mm x 0.74 mm in size. The oesophagus is a small tube measuring 0.39 mm in length. Its relation to the body length is 1:14.70. The intestinal caeca are wavy forming some coils and terminate at the acetabular zone.

The testes are very small in size with regard to the body size of the fluke, lobed and diagonal in position. The anterior testis measures 0.47 mm x 0.43 mm and posterior measures 0.49 mm x 0.43 mm in size.

Ovary is somewhat rounded and measures 0.25 mm in diameter and is placed post-testicular. Vitellaria are well developed, extending along the lateral sides of the body from the level of the middle of the pharynx to the posterior extremity of the acetabulum.

The uterus is simple, tube like, originates from the ootype, runs anteriorly in the medial field to open into the genital pore.

The genital pore is situated at a distance of 1.89 mm

from the anterior end and is surrounded by a well developed genital sucker. The diameter of genital sucker is 0.32 mm and the relation between the length of the pharynx and the diameter of genital sucker is 1:0.5.

FISCHOEDERIUS ELONGATUS (POIRIER, 1883) STILES AND GOLDBERGER, 1910

(PLATE No. VI)

The body is cylindrical with the anterior end bluntly rounded and the posterior end truncated. It is slightly constricted at the preacetabular zone or at testicular zone.

The mouth is terminal and surrounded by an oral sucker. The opening of the ventral pouch is ventral to the oral sucker. The anterior end, mouth, the ventral pouch opening and the genital bulb are all moderately papillated. The size of the body is 6.43 mm x 2.12 mm, the ratio between the length and breadth of the body is 1:3.08.

The ventral pouch is triangular with its vertex directed ventral and its opening is located 0.32 mm from the anterior end. The oral sucker is terminal and measures 0.43 mm in length. The ratio between the length of the oral sucker and the body length is 1:14.8. The oesophagus is straight, smaller than the oral sucker and measures 0.41 mm in length.

The acetabulum is terminal, measures 0.71 mm x 1.10 mm in size and the index is 1:5.2. The caeca are slightly wavy, parallel to each other and placed in the dorsal field. They terminate a little behind the middle of the body length.

The two testes are placed dorsoventrally. The dorsal one is larger, unlobed or feebly lobed and measures 0.66 mm x 0.63 mm in size. The size of the smaller ventral testis is 0.55 mm x 0.47 mm.

Ovary is located in between the two testes and measures 0.37 mm x 0.25 mm in size. The uterus is spread in the median field, dorsal to the testes but ventral to pars prostatica, pars musculosa and seminal vesicle. The vitellaria are distributed in the ventral and lateral fields of the body from the post-oesophageal to preacetabular zone. The genital pore is situated at a distance of 0.95 mm from the anterior end and opens into the ventral pouch at the oesophageal level.

The eggs in the uterus measures 0.17 mm x 0.064 mm in size, oval and operculate.

FISCHOEDERIUS COBBOLDI (POIRIER, 1883) STILES AND GOLDBERGER, 1910

(PLATE No. VII)

The body is elongate and bluntly pointed anteriorly. It is truncated posteriorly and slightly constricted in front of the acetabulum. The dorsal border is evenly curved whereas the ventral border is almost straight. Body measures 14.52 mm in length and 5.18 mm in breadth. The ventral pouch is triangular in shape in cross-section and directed ventrally. The opening of the ventral pouch is 0.705 mm apart from the anterior end.

The acetabulum is terminal, measures 2.25 mm in length and 2.80 mm in breadth. The acetabular index is 1:6.4. The oral sucker is 1.2 mm x 1.00 mm in size. The ratio of the length of the oral sucker to the body length is 1:12.10. The oesophagus is short, 0.97 mm in length and bifurcate into two wavy intestinal caeca. The caeca are long each with six to eight bends and reach beyond the posterior border of the ventral testes.

The testes are irregular in shape, situated in the pre-acetabular zone. They are dorsoventral in position. The testes are deeply lobed and more or less equal in size and measures 1.42 mm x 1.48 mm. Pars prostatica and pars musculosa are well developed, the seminal vesicle is tubular and tightly convoluted.

Ovary located posterior to dorsal testis on the left of median line, is oval in shape and measures 0.470 mm x 0.540 mm in size. The uterus is placed in the median field. The vitellaria are spread in the ventral and median field and extend from the posterior end of the oral sucker to the testicular zone.

Genital pore is 1.10 mm away from the anterior extremity at the level of the anterior end of the oesophagus and with a well developed genital bulb.

Eggs are oval in shape, operculate and measure 0.123 mm x 0.062 mm in size.

OLVERIA INDICA THAPAR AND SINHA, 1945

(PLATE No. VIII)

The fluke is flat, elongate and measures on an average 5.096 mm in length and 2.273 mm in maximum breadth. It is widest at the middle and gradually tapers towards the anterior end. The posterior extremity is more or less rounded. Numerous cuticular papillae are present in the region of mouth and genital sucker. The cuticle is inturned both at the mouth and the genital opening and the cuticular papillae present in these regions are in the form of small denticles. They are also continued along the entire length of the muscular portion of the oesophagus.

The mouth opening is placed terminally and is surrounded by the oral sucker which is 0.203 mm in diameter. There are two pouches, one on each side of the oral sucker at its posterolateral aspect. They are fused with the oral sucker and each one measures 0.656 mm in length. The ventral sucker which is bordered by a ridge is at the posterior end of the body and measures 1.066 mm x 0.705 mm in size and is oval in shape.

The mouth leads into an elongated recurved 'J' shaped oesophagus which has two parts: an anterior long muscular part which can again be divided into an elongated straight bar and the curve of the oesophagus and a posterior non-muscular part which connects the former with the intestinal bifurcation. The length of the muscular part of oesophagus is 2.822 mm and the non-muscular part 0.470 mm making a total of 3.292 mm. The

caecal bifurcation is at about 1.599 mm from the anterior end of the body. The two intestinal caeca are long and with four bends on each limb terminate blindly near the ovary, in front of the ventral sucker.

There are two testes situated slightly diagonally tandem one behind the other in the posterior half of the body, in front of the ovary. They are more or less rounded with slightly lobed irregular margins. The anterior testis measures 0.439 mm x 0.360 mm and the posterior 0.470 mm x 0.401 mm in size. Distance of the anterior testis from the anterior end of the fluke is 3.026 mm and the distance of the posterior testis from the anterior testis is 0.172 mm.

The vasa deferentia from the two testes unite together a little in front of the anterior testis and forms the vesicula seminalis, which leads into the cirrus. The cirrus is enclosed within a thin walled cirrus sac and opens into the genital pore beside the opening of the metraterm.

Ovary, located slightly left to the median line at the level of the hind border of the posterior testis, is spherical in shape and 0.188 mm in diameter. The course of the uterus is winding and near its terminal part becomes slightly muscular forming the metraterm. The vitellaria are well developed and consist of several large follicles. They are situated laterally on either side of the body, extending from a little posterior to the genital sucker to a little in front of the acetabulum.

The genital pore is situated at a distance of 1.697 mm from the anterior end of the body and is surrounded by a well developed genital sucker.

OLVERIA BOSI TANDON, 1951

(PLATE No. IX)

The worm is more or less conical and flattened and measures 7.131 mm in length and 2.744 mm in breadth. The posterior end is more or less rounded. Cuticular papillae are present in the region of mouth, genital sucker and also the acetabulum. The cuticle is inturned at the mouth and the genital sucker and is also continued as a lining of the oral sucker and the muscular portion of the oesophagus.

The mouth and the oral sucker are terminal. There are two pouches on either side arising from the dorso-lateral sides of the oral sucker and are fused with it. The acetabulum located at the posterior end of the body is oblong in shape and measures 0.862 mm x 1.097 mm. The mouth leads into an elongated 'J' shaped oesophagus which consists of an anterior long muscular portion forming only the elongated bar of the letter 'J' and the posterior non-muscular portion forming the curve of the letter 'J' and connecting the oesophagus with the intestinal bifurcation. The muscular portion of the oesophagus measures 1.724 mm and non-muscular portion 0.862 mm in length.

The caeca are long, coiled tubes arising at a distance of 2.195 mm from the anterior end of the body. Each one forms three loops during its course before terminating blindly just in front of the acetabulum. The caeca are always curved inwards at their posterior blind extremities lying very closely one behind the other.

The testes which are roughly spherical with lobed margin are placed one behind the other in the posterior half of the body. The anterior testis lies at a distance of 3.499 mm from the anterior end of the body and measures 0.901 mm in length and 1.097 mm in breadth, while the posterior one 0.893 mm in length and 1.066 mm in breadth.

The ovary is oval in shape lying near the terminal loops of the intestinal caeca and posterior to the testes, measures 0.219 mm x 0.266 mm in size. It lies at a distance of 1.097 mm from the posterior end at the midline of the body. The uterus arises from the ootype, runs anteriorly in the mid line to form the metraterm and opens into the genital pore. The vitelline glands are follicular, placed laterally on either side of the body, extending between the genital sucker and ventral sucker.

The genital pore, which is situated in the pre-bifurcal zone is surrounded by the genital sucker, which is located at a distance of 1.960 mm from the anterior end.

Eggs are oval in shape, operculate and measure 0.109 mm x 0.062 mm in size.

CEYLONOCOTYLE SCOLIOCOELIUM (FISCHOEDER, 1901) NAGMARK, 1937

(PLATE No.X)

The body is elongate, oval, slightly curved ventrally, bluntly pointed at the anterior end and rounded at the posterior end. The anterior end presents several rows of cuticular papillae. While the dorsal border is convex the ventral border is almost straight. The body measures 6.58 mm x 2.27 mm in size, the ratio between the length and the breadth of the body is 1:2.9.

The oral sucker is spherical, measures 0.70 mm x 0.52 mm and its ratio to the body length is 1:9.3. The oesophagus measures 0.71 mm in length. The caeca are almost equal in length, each with five to six bends and terminate at the level of the ovary.

The testes are large, spherical, tandem and slightly lobed. The anterior testis measures 1.29 mm x 1.38 mm and the posterior 1.25 mm x 1.30 mm in size.

The ovary is oval to almost spherical in shape, lies between the posterior testis and the acetabulum, either to right or left side in the dorsal aspect of the body and measures 0.31 mm x 0.47 mm in size. The vitelline glands are in nine to fifteen clusters, extend from the level of oesophagus to the level of anterior border of the acetabulum. The ootype is clear and surrounded by compact Mehlis gland cells. The uterus

arises from the ootype, runs anteriorly medial and dorsal to the testis and opens into the genital pore.

The acetabulum is sub-terminal with the opening ventrally directed. It measures 0.94 mm in diameter. The ratio between the diameter of acetabulum and the body length is 1:7.00.

The genital pore is located behind the intestinal bifurcation. The genital papillae vary in shape according to their degree of extension (Fig. 2). Pars musculosa is muscular, and the seminal vesicle is well developed and highly convoluted.

Eggs are almost oval in shape, operculate and measure 0.125 mm x 0.070 mm in size.

CERCOCOTYLE BRACHYCEPHALUS TANDON, 1955

(PLATE No. XI)

The body is conical in shape with a convex dorsal and concave ventral surface. The anterior extremity tapers while the posterior extremity is more or less rounded. The body is pink in colour while fresh and the anterior region is covered with several chitinous papillae. Five or six rows of small cuticular spines are found just beneath the mouth opening. The distance between the adjacent rows of spines is 0.283 mm (average).

The body measures 7.683 mm in length and 3.057 mm in breadth. The oral sucker measures 0.94 mm x 0.862 mm in size. The oesophagus is tube like, elongated measuring 2.195 mm in length. It bifurcates into two thick conspicuous intestinal caeca which terminate near the anterior margin of the acetabulum. The intestinal caeca are without any coiling or twisting and uniform in shape and size.

The two testes which are tandem, with few lobes, lie in the middle of the body. They are comparatively larger in size with regard to the body size of the fluke. The anterior testis measures 1.411 mm in length and 1.801 mm in breadth and the posterior 1.499 mm in length and 1.615 mm in breadth. The common genital opening situated anterior to the intestinal bifurcation is surrounded by a muscular ring.

The ovary is oval in shape, post testicular and measures

0.376 mm x 0.501 mm in size. Vitellaria are well developed, consisting of elongated follicular masses in 12-14 groups in each side. The vitellaria on both sides, extend from the level of intestinal bifurcation to the middle of the acetabulum. Transverse diameter of the acetabulum is 1.097 mm.

The eggs are oval in shape and measure 0.125 mm x 0.670 mm in size.

CEYLONOCOTYLE NARAYANI GUPTA AND GUPTA, 1972

(PLATE No. XII)

The worms are conical in shape, dorsal border slightly convex and ventral border concave. It measures 6.66 mm x 2.47 mm. The dorsoventral diameter is 2.11 mm.

The acetabulum measures 0.94 mm in diameter and its ratio to the length of the body is 1:7.3. Pharynx measures 0.627 mm x 0.501 mm in size and the ratio of its length to that of the body is 1:10.6.

The oesophagus is a very small tube 0.568 mm in length and its ratio to the length of the body is 1:10.12. There is no oesophageal bulb or sphincter. The intestinal caeca are wavy without much winding, reaching upto the acetabular zone.

The testes are almost tandem. They are lobed with irregular border. The anterior testis measures 0.940 mm in length and 0.972 mm in breadth. The posterior testis measures 0.840 mm in length and 0.912 mm in breadth. Pars muscularis is well developed and coiled.

Ovary is oval in shape, situated in between the posterior testis and the acetabulum. It measures 0.258 mm x 0.203 mm in size. Vitellaria are scattered in groups along the intestinal caeca.

The genital pore lies posterior to the intestinal bifurcation. Genital atrium is well developed.

Eggs are oval in shape with operculum at the narrow end and measure 0.109 mm x 0.062 mm in size.

CEYLONOCOTYLE KASHIARKI MUKHERJEE, 1963

(PLATE No. XIII)

The body of the living specimen is conical in shape and slightly curved ventrally. The flattened specimens measure 4.93 x 2.07 mm in size. The maximum breadth is at the level of the middle of the posterior testis. The anterior portion of the body is provided with papillae while the rest of the body is smooth.

The acetabulum is sub-terminal, measures 0.05 mm in diameter, and is directed ventrally. Its ratio to the length of the body is 1:5.02. The pharynx measures 0.67 mm in length and 0.51 mm in breadth. The ratio between the length of the pharynx and the body length is 1:7.35. The oesophagus measures 0.41 mm in length and is provided with a well developed oesophageal bulb. The intestinal caeca are slightly wavy at the posterior end and terminate at the level of the middle of the acetabulum.

The testes are lobed, situated obliquely tandem in front of the acetabulum and triangular in shape. The anterior testis measures 0.78 mm in length and 0.94 mm in breadth while the posterior testis 0.63 mm in length and 0.86 mm in breadth.

The ovary is rounded in shape, situated at the level of the middle of the acetabulum and measures 0.31 mm x 0.27 mm in size. The genital pore is located at a little below the intestinal bifurcation. Vitellaria are composed of small

follicles, situated mainly on lateral aspects of the cæca. The vitellaria extend from the level of intestinal bifurcation and terminate at the middle level of the acetabulum.

Eggs measure 0.125 mm x 0.071 mm in size, operculate at the narrow attenuated end and oval in shape.

GASTROTHYLAX CRUMENIFER (CREPLIN, 1847) POIRIER, 1883

(PLATE No. XIV)

Body is nearly cylindrical, banana shaped, curved ventrally, widened at the posterior end and having a slight constriction at the preacetabular region. The length of a mature specimen is on an average is 14.42 mm and the breadth 6.28 mm.

The ventral pouch is very large, which opens anteriorly and extend over the whole ventral surface upto the region of the ventral sucker.

The oral sucker measures 0.94 mm x 0.78 mm. The oesophagus is 0.87 mm in length. The caeca are long, wavy and reach upto the anterior border of the testes. The acetabulum is terminal and measures 1.88 mm x 2.51 mm, the maximum diameter found being 3.00 mm. The acetabular index is 1:4.8.

The two testes are oval, lobed, symmetrical and placed side by side in the same transverse plane between the intestinal caeca and the acetabulum. They measure 2.04 mm x 2.59 mm and 2.43 mm x 2.19 mm respectively in size. Pars musculosa and pars prostatica are well developed.

The ovary is situated in between the two testes, just anterior to the anterior margin of the acetabulum. It is oval in shape and measures 0.73 mm x 0.58 mm in size. The uterus which is a small tube, crosses from left to right in the middle

of the body. Vitellaria composed of small follicles extend from the intestinal bifurcation upto the anterior margin of the testes mainly in the preacetabular zone in the ventral and lateral fields of the body.

The genital pore is surrounded by a small genital bulb and opens into the ventral pouch, 1.12 mm from the anterior end. Genital atrium is fairly well developed.

Eggs are almost oval with an operculum at the narrow end and measure 0.109 mm x 0.062 mm in size.

CALICOPHORON CALICOPHORUM (FISCHOEDER, 1901) NASMARK, 1937

(PLATE No. XV)

The body is conical and slightly curved ventrally. While the dorsal border is evenly curved the ventral border is unevenly curved. The anterior portion in majority of the specimens are straight. The cuticle bears prominent papillae on the anterior third on the ventral aspect and slightly less extensive dorsally. The body measures 15.44 mm x 7.13 mm in size.

The acetabulum is terminal and measures 3.84 mm in diameter. The acetabular index is 1:4.02. The oral sucker measures 2.17 mm x 1.96 mm. The ratio of the length of oral sucker to the body length is 1:7.3. The oesophagus measures 1.41 mm in length. The intestinal caeca have seven bends with the terminal part directed ventrally.

The testes are diagonal in young adults, apparently tandem in full grown one's, more or less triangular and deeply lobed. The anterior testis measures 1.80 mm x 1.72 mm, while the posterior one 1.72 mm x 1.64 mm in size. The pars musculosa is highly developed forming several loops and about six to seven times as long as the pars prostatica. Seminal vesicle is well developed and highly convoluted.

Ovary is post testicular, oval to spherical in shape and measures 0.94 mm x 1.176 mm in size. Vitellaria extend from

the oesophageal region to almost the posterior end of the body. The genital pore is 3.517 mm from the anterior end and is located along with the genital atrium. The genital pillar which bears genital papillae on the tip is surrounded by a cup shaped cavity on the body wall called genital calyx.

Eggs are almost oval in shape, operculate and measure 0.141 mm x 0.062 mm in size.

CALICOPHORON CAULIORCHIS (STILES AND GOLDBERGER, 1910) HAWARK, 1937

(PLATE No. XVI)

Body is conical, elongated and curved ventral. While the dorsal border is evenly curved, the ventral border is unevenly curved. The cuticle bears a few papillae around the oral aperture. The body measures 10.19 mm x 5.33 mm in size.

The acetabulum is subterminal and measures 2.74 mm in diameter. The acetabular index is 1:3.71. The oral sucker measures 1.26 mm x 0.94 mm and its ratio to the body length is 1:0.08. The oesophagus measures 0.94 mm in length, caeca present five to six bends in each limb with the terminal part directed dorsally.

The two testes are symmetrical, one on either side on the median line, hemispherical, irregular in outline, cauliflower like and deeply lobed. The right testis measures 1.81 mm x 1.64 mm while the left one 1.64 mm x 1.78 mm. The seminal vesicle is tubular and thin.

The ovary is slightly posterior to the testes, oval and measures 0.53 mm x 0.61 mm in size. The vitellaria extend from behind the oesophageal region to mid acetabular zone.

The uterus is simple tube like and thin, originates from the ootype and runs centrally in the median field to open into the genital pore.

The Genital pore is placed at a distance of 2.50 mm from

the anterior end and post bifurcal. The genital bulb is located at the bottom of a deep genital pit.

Eggs are oval in shape, operculate and measure 0.125 mm x 0.062 mm in size.

GIGANTOCOTYLE EXPLANATUM (CREPLIN, 1847) NAHMARK, 1937

(PLATE No.XVII)

The body is conical in shape. The posterior half of the body is evenly curved while the anterior half sharply curved. Cuticle bears a few tubercles. Length of the body is 13.64 mm and the breadth 6.35 mm. Dorsoventral measurement of the body is 2.1 mm.

The mouth is surrounded by an oral sucker which is 1.019 mm in length and 0.944 mm in breadth. The mouth leads into a pharynx measuring 0.784 mm x 0.978 mm. The ratio between the length of the pharynx and the body length is 1:17.00.

The oesophagus is slightly curved and measures 0.705 mm in length. The intestinal caeca has four shallow bends and terminate in front of the acetabulum. The terminal parts of the caeca are directed dorsally.

A pair of testes situated obliquely tandem are shallowly lobed and compact. The anterior testis measures 1.88 mm x 3.96 mm, while the posterior one 1.57 mm x 3.76 mm.

Ovary is compact, oval and situated at the posterior end on right side, measures 0.52 mm x 0.78 mm. The seminal vesicle is highly developed, tightly coiled, occupying a large space below the genital pore. The vitelline follicles are large, mainly distributed on the lateral sides and extend from near the oesophagus upto the anterior region of the acetabulum.

The uterus runs anteriorly, medial and dorsal to the testes and is convoluted at the middle and the terminal end. The acetabulum measures 4.60 mm in diameter. The acetabular index is 1:2.700.

The genital pore is located posterior to the intestinal bifurcation, at a distance of 1.00 mm away from the anterior extremity.

Eggs are almost oval in shape and measure 0.134 mm x 0.086 mm in size.

DISCUSSION

DISCUSSION

During the present study, out of a total number of 1490 faecal samples from domestic ruminants examined specifically for amphistome eggs, reveals that 16.98% of the animals were infected. The rate of prevalence increased from the month of April onwards and declined drastically from December to March. This pattern of prevalence could be possibly due to the geo-climatic conditions of Kerala State. The climate of Kerala is described as maritime monsoon type with little seasonal rhythm. Only two seasons are prevailing here, namely Dry/Summer and monsoon (Samanathan, 1980). The monsoon season extends from May to November and dry/summer season from December to April. A close study of the month-war prevalence of amphistomes in domestic ruminants shows that the prevalence was higher in the months of monsoon season and lower in the months of dry/summer season. Fractionised scrutiny of the monsoon season reveals that there are two definite monsoons namely South West and North East, the former being the predominant one. Further, depending upon the temperature and humidity, the monsoon season of Kerala can be divided into cold-wet (June to August) and warm wet (May and September to November). While considering the prevalence seasonwise it was highest during the South West monsoon (June to August) with 30.08% followed by a prevalence of 20.37% in the North East monsoon (May and September to November). The data collected during the present investigation substantiate that there is a definite relationship of

amphistome infection with the seasons, being heavy during the monsoon seasons.

A perusal of the available literature reveals that only a few reports are available with regard to the seasonal prevalence of paramphistomes in domestic ruminants in India. Pande (1935) observed that 60% of the cattle of Kamrup district of Assam was infected with amphistomes and the infection started after the rains. Alwar (1949) remarked that the outbreak of amphistomiasis in ruminants was seasonal and appeared after the rainy season, from October to March. Katiyar and Varshney (1963) reported amphistomiasis in a village of U.P. and found that the outbreak occurred from the last week of September to January, following the rains. Gupta et al. (1985) examined faecal samples from sheep and goats in Haryana and observed a peak of infection between May and September which is the rainy season in that State. Sahai and Ansari (1985) found that the overall prevalence of amphistomes was highest during monsoon season (July to September). However, Moghe (1945) reported the results of a survey conducted in Central Provinces, Berar and Central India that amphistomiasis existed throughout the year, even in winter, infecting as many as 76% of animals. The results of the present study also indicate that amphistomiasis existed throughout the year with peak infection in the monsoon season.

This observation is in agreement with the reports of Pande (1935), Alwar (1949), Katiyar and Varshney (1963), Gupta et al. (1985) and Sahai and Ansari (1985).

The higher prevalence during the rainy season could be perhaps due to the availability of the water which is essential for the development of the eggs and also the intermediate hosts (Water snails).

Alwar (1949) observed that the percentage of infection depends upon the susceptibility, grazing habit, intensity of infection and vitality of the animal and the sheep had the maximum (90%) and cattle and buffaloes the minimum (50%).

During the present investigation a total number of 780 domestic ruminants which were slaughtered or died were also examined for amphistomes and found that 140 (17.95%) were infected. The maximum prevalence of amphistomes was in buffaloes (34.67%) and the minimum in sheep (4.17%).

A total of 17 species belonging to eight different genera were recovered from domestic ruminants and identified. Out of positive cases more than 30% were mixed infection (more than one species of amphistome in a single host). Host-wise prevalence reveals that cattle were having the highest percentage (62.64%) of mixed infection, followed by sheep (40%), goats (27.77%) and buffaloes (26.92%).

Gastrothylax crumenifer accounted for the highest incidence in cattle (62.64%) and Ceylonocotyle spiniocephalus and C. narayani (1.20%) the lowest.

In buffaloes the highest prevalence (57.69%) was found to be due to Gigantocotyle explanatum and the lowest (15.38%) due to Calicophoron sauliorchis.

The paramphistome associated with the highest prevalence in sheep was Cotylophoron cotylophorum (60.00%) and all others, viz., C. indicum, Fischoederius cobboldi, Olveria bosi, Ceylonocotyle nasmarki and Gastrothylax crumenifer, the lowest (20.00%).

Among the goats the highest prevalence of amphistome was found to be Cotylophoron cotylophorum (38.09%) and Paramphistomum cervi, C. chauhani and Ceylonocotyle spiniocephalus accounted for the lowest (9.56%).

Bhalerao (1935) reported Paramphistomum cervi from cattle, sheep and goats; P. explanatum from cattle and buffaloes; Cotylophoron cotylophorum from cattle and sheep; Gastrothylax crumenifer from cattle and buffaloes; Fischoederius cobboldi from cattle; P. elongatus from cattle and buffaloes; Carmerius gregarius from cattle and buffaloes from India.

Gupta (1943) observed that three species of Paramphistomum, viz., Paramphistomum cervi, P. crassum and P. explanatum existed in oxen and buffaloes and that P. cervi was most common and the other two species very rare.

Thapar and Sinha (1945) described the morphology of a new genus of amphistome Olveria indica from the rumen of a cow in Central Provinces.

Srivastava (1945) conducted a survey of helminth infections of sheep, goats, cattle and buffaloes of Punjab and Sindh and reported the widespread occurrence of Cotylophoron cotylophorum;

Paramphistomum cervi; P. explanatum and Gastrothylax crumenifer in these animals.

Moghe (1945) in a survey conducted on the incidence of helminthic infection in cattle in Central Province, Berar and in Central India found that 75% of cattle were infected with Cotylophoron cotylophorum and 54% to 80% with Gastrothylax crumenifer.

D'Souza (1948) while investigating the cases of fatal enteritis in cattle, sheep and buffaloes recovered Cotylophoron cotylophorum and Gastrothylax crumenifer from their digestive tract.

Alwar (1949), while reviewing amphistomiasis, remarked that Paramphistomum explanatum, Cotylophoron cotylophorum, Gastrothylax crumenifer, Fischoederius elongatus and F. cobboldi were the important amphistomes recorded from cattle, buffaloes, sheep and goats in Madras Province.

Varma (1957) reported the occurrence of Cotylophoron cotylophorum, Gastrothylax crumenifer, Calicophoron calicophorum and Gigantocotyle explanatum in cattle, buffaloes, sheep and goats in Bihar.

Yamaguti (1958) reported the occurrence of the following species of amphistomes in India: Paramphistomum (S) birmanus, P. (S) explanatum, Calicophoron caulorchis, C. crassum, C. papillosus (Host not mentioned), Cotylophoron cotylophorum from sheep, goats and buffaloes. C. elongatus from goats,

C. indicum from sheep, C. orientalis from sheep and goats, C. graham from cattle, sheep and goats; Olveria indica from cattle and buffaloes, O. bosi from buffaloes; Gastrothylax crumenifer from cattle, sheep and goats; Cavlocoetyle scoliocoelium from buffalo and Johnsonitrema bovum from cow.

Gupta (1958) recorded a new species of amphistome Cavlocoetyle dawesi from Bos indicus at Madras.

Mukherjee (1960c) reported the occurrence of Cavlocoetyle scoliocoelium an amphistome parasite of cattle, buffaloes, sheep and goats and Gigantocotyle explanatum an amphistome parasite of cattle, buffaloes and goats.

Thapar (1961) recorded Olveria indica, an amphistome parasite from the rumen of an Indian cattle.

Gupta (1963) claimed that Paramphistomum gracilitum was a common amphistome parasite of cattle, goats and buffaloes in Punjab.

Gupta (1966) reported occurrence of Calicophoron papillosum and C. caulicrchis in Indian buffaloes and cattle respectively.

Mukherjee (1966b) reported the occurrence of Fischoederius elongatus an amphistome parasite of cows and buffaloes.

Mukherjee (1966c) recorded the occurrence of Calicophoron calicophorum from sheep and buffaloes, Fischoederius elongatus from cattle, Hanaloenator malonias from sheep and cattle, and a new species Calicophoron orientalis from goats in India.

Gupta and Dutt (1967a&b) reported the occurrence of Fischoederius cobboldi, a pouched amphistome from cattle in India. They also recorded the occurrence of Gastrothylax crumenifer, a common pouched amphistome of ruminants in India.

Mukherjee (1968) reported the occurrence of Cotylophoron indicum, an amphistome parasite of ruminants in India.

Jain and Srivastava (1969) recorded Carmyerius acetabulum from Indian ruminants.

Gupta and Gupta (1971) recorded Cochinocotyle bovini a new genus new species from cattle at Ernakulam (Kerala).

Gupta and Gupta (1972a) recorded a new species Carmyerius nakayani from stomach of cattle at Ernakulam (Kerala).

Jayakumar (1979) identified Gastrothylax crumenifer and Paramphistomum epiclitum as the most common amphistome occurring in cattle in Karnataka.

Soulsby (1982) reported the occurrence of Paramphistomum cervi from cattle, buffaloes, sheep and goats; P. ceteri from cattle; Cotylophoron cotylophorum from cattle, sheep and goats; Calicophoron calicophorum from cattle and sheep; Carmyerius streptocoelium from cattle and sheep; C. acetabulum from cattle, sheep, goats and buffaloes; Gigantocotyle explanatum from buffaloes, less commonly from cattle, Gastrothylax crumenifer from sheep, cattle and buffaloes; Fischoederius elongatus from cattle and other bovines; F. cobboldi from cattle; Carmyerius spatiosus from cattle and C. gracilis from cattle and buffaloes.

Sahai (1935) reported the occurrence of Cotylophoron cotylophorum and Fischoederius elongatus from goats, Paramphistomum epiclitum and Ceylonocotyle cuneum from cattle and C. scoliocoelium, Paramphistomum cotoi and Gigantocotyle explanatum from buffaloes in Patna.

Tandon (1951) described a new amphistome Olveria bosi from rumen of buffaloes from Lucknow. He (1955a&b) also furnished a redescription of Paramphistomum cotoi Fukui, 1922, an Indian record of the species and discovered Paramphistomum spiniocephalus, a new species of amphistome from buffaloes in Lucknow.

Thapar (1956) reported the occurrence of Paramphistomum cotoi and P. cervi from Indian buffaloes.

Mukherjee and Srivastava (1960) reported Gigantocotyle explanatum, a trematode parasite of bile duct and gall bladder of buffaloes in India.

Mukherjee (1960b) reported the occurrence of Cotylophoron indicum in buffaloes, sheep and goats in India. He (1960c) also recorded Ceylonocotyle spiniocephalus an amphistome parasite of Indian buffaloes.

Mukherjee (1966a) reported the occurrence of Calicophoron sculleorchis from buffaloes in U.P.

Rama (1977) recorded Ceylonocotyle cuneum an amphistome parasite from buffaloes in Rajasthan.

Dutt (1978) described a new species Gastrothylax indicus from buffaloes in U.P. and M.P.

Shankar and Singh (1978) recorded Gigantocotyle explanatum a common amphistome occurring in buffaloes, goats and sheep in U.P.

Tripathy and Srivastava (1930a&b) recorded two new species of a new genus of amphistome Balamphistomum. B. labatum and B. dutti from buffaloes, sheep and goats from Allahabad.

Harshey (1934) reported the presence of Gastrothylax elongatus, G. cruvenifer, Cotylophoron cyatus, G. orientalis in goats and sheep from Allahabad.

Haji (1933) expressed the opinion that a disease of sheep and goats at Sindh was caused by the immature Paramphistomum cervi.

Mudaliar (1944) reported immature form of Cotylophoron cotylophorum as the cause of fatal enteritis in goats in India.

Mudaliar (1945) recovered certain immature amphistomes from goats which were tentatively identified as Cotylophoron cotylophorum.

Mukherjee (1960a) recorded Ceylonocotyle scoliocoelium an amphistome parasite of sheep and goats in U.P. and Bengal.

Mukherjee and Sharma Deorani (1962) reported occurrence of Gastrothylax cruvenifer, Ceylonocotyle scoliocoelium, Olveria indica and O. bosi in sheep in U.P.

Katiyar and Varshney (1963) reported Gastrothylax crumenifer, Cotylophoron cotylophorum, Paramphistomum cervi, P. microbothrium and Fischoederius elongatus from sheep and goats in U.P.

Mukherjee (1963) reported occurrence of two new species of amphistomes Cervicaprotyle nagpurki and C. akrishni from sheep and goats in U.P.

Nath (1971) reported Gastrothylax crumenifer and Cotylophoron cotylophorum from goats and sheep in U.P.

Bali (1972) reported the occurrence of Calicophoron calicophorum in sheep in Jammu and Kashmir.

Bali and Fotedar (1972a&b) reported the occurrence of Cervicaprotyle explanatum from sheep and recorded a new species Paramphistomum akrishni an amphistome parasite of sheep from Jammu and Kashmir.

Gupta and Gupta (1972b) recorded a new species Cotylophoron bhalerai from sheep at Ernakulam (Kerala).

Bali and Fotedar (1974) recorded Olveria bhalerai a new species of amphistome from sheep at Kashmir.

Chellape and Gopalakrishnan (1977) encountered Fischoederius elongatus, Gastrothylax crumenifer and Cervicaprotyle species in sheep and Cotylophoron species in sheep and goats.

Gupta and Gupta (1977) recorded Cotylophoron indicum and Calicophoron calicophorum from sheep in Chandigarh.

Gupta et al. (1985) recovered Cotylophoron cotylophorum, C. indicum, Carmyerius scoliocoelium, Fischoederius elongatus, Paramphistomum cervi and Gastrothylax crumenifer from sheep and goats in Haryana.

During the present investigation 11 species of amphistomes recovered from cattle are: Paramphistomum epiclitum, P. cervi, Cotylophoron cotylophorum, Fischoederius elongatus, F. cobboldi, Olveria indica, Carmyerius scoliocoelium, C. spinicephalus, C. narayani, Gastrothylax crumenifer and Calicophoron calicophorum. Out of these, two species viz., Olveria indica and Carmyerius narayani were occurring only in cattle.

A perusal of the available literature shows that the records of amphistomes reported from India include Paramphistomum epiclitum by Gupta (1963) and Sahai (1985), P. cervi by Bhalerao (1935), Gupta (1943), Srivastava (1945) and Soulsby (1982); P. explanatum by Bhalerao (1935), Gupta (1943), Srivastava (1945) and Alwar (1949); P. crumenum by Gupta (1943); P. ceylonicum by Soulsby (1982); Cotylophoron cotylophorum by Bhalerao (1935), Srivastava (1945), Moghe (1945), D'Souza (1948), Alwar (1949), Varma (1957) and Soulsby (1982); C. indicum by Mukherjee (1968); Fischoederius elongatus by Bhalerao (1935), Alwar (1949), Mukherjee (1966b) and Soulsby (1982); F. cobboldi by Bhalerao (1935), Alwar (1949), Gupta and Dutt (1967a) and Soulsby (1982); Olveria indica by Thapar and Sinha (1945) and Thapar (1961); Carmyerius scoliocoelium by Mukherjee (1960c), Jain and

Srivastava (1969); Soulsby (1982); C. dawesi by Gupta (1958); C. narayani by Gupta and Gupta (1972a); C. streptocoelium by Soulsby (1982); C. cucumis by Sahai (1985); Gastrothylax crumenifer by Bhalerao (1935), Srivastava (1945), Hoche (1945), D'Souza (1948), Alwar (1949), Varma (1957), Yamaguti (1958), Gupta and Dutt (1967b), Jayakumar (1979) and Soulsby (1982); Calicophoron calicophorum by Varma (1957) and Soulsby (1982); C. cauliorchis by Gupta (1966); Gigantocotyle explanatum by Mukherjee (1960c), and Soulsby (1982); Cameronia fecundum by Bhalerao (1935) and Soulsby (1982); C. spatiosum by Soulsby (1982); Cochinocotyle bovini by Gupta and Gupta (1971); Johnsonitrema magnum by Yamaguti (1958) and Himalocaster paloniae by Mukherjee (1966).

It appears that cattle is a new host record for Ceylonocotyle scoliocoelium in India. The two species of amphistomes namely Cochinocotyle bovini and Ceylonocotyle narayani were reported from cattle by Gupta and Gupta in 1971 and 1972 respectively from Ernakulam of this State. Ceylonocotyle narayani could be recovered during the present investigation but not Cochinocotyle bovini.

During the present studies the species of Paramphistomes collected from buffaloes were Fischoederius elongatus, F. cobboldi, Gastrothylax crumenifer, Calicophoron cauliorchis and Gigantocotyle explanatum. It was noted that G. explanatum and C. cauliorchis occur only in buffaloes.

The records of amphistomes from buffaloes in India include Explanatum by Bhalerao (1935), Alwar (1949) and Soulsby (1982); E. cobboldi by Alwar (1949); Olveria indica by Yamaguti (1958); O. bosi by Tandon (1951) and Yamaguti (1958); Cotylocoelia spiniscyphalus Mukherjee (1960c); C. acetabulum by Yamaguti (1958) and Mukherjee (1960c) and Bahai (1985); C. cucumis by Verma (1977); Gastrothylax crumenifer by Bhalerao (1935), Srivastava (1945), D'Souza (1948), Alwar (1949), Gupta and Dutt (1967b) and Soulsby (1982); G. indicus by Dutt (1978); Paramphistomum gotoi by Verma (1957) and Mukherjee (1960c); P. cauliorchis by Mukherjee (1960a) and P. papillosum by Gupta (1966); Gigantocotyle explanatum by Verma (1957), Mukherjee (1960c), Mukherjee and Srivastava (1960), Shankar and King (1978); Soulsby (1982) and Bahai (1985); Paramphistomum epiclitum by Gupta (1963); P. explanatum by Bhalerao (1935), Gupta (1943), Srivastava (1945) and Alwar (1949); P. gorvi by Gupta (1943), Srivastava (1945), Thapar (1956) and Soulsby (1982); P. spiniscyphalus by Tandon (1955b); P. cruscum by Gupta (1943); P. gotoi by Tandon (1955a), Thapar (1956) and Bahai (1985); Gastrocirrus crocerius by Bhalerao (1935) and Soulsby (1982); Cotylophoron cotylophorum by Srivastava (1945), D'Souza (1948), Alwar (1949), Verma (1957) and Yamaguti (1958); C. indicum by Mukherjee (1960b) and (1963); Paramphistomum lobatum by Tripathy and Srivastava (1963a) and P. duttai by Tripathy and Srivastava (1963b).

The amphistomes recovered from buffaloes during the course

of present investigation were all reported previously from India.

The recorded species at present from sheep included Cotylophoron cotylophorum, C. indicum, Fischoederius cobboldi, Olveria bosi, Carmyerioides nagpurkari and Gastrothylax crumenifer.

From India the amphistomes reported included Gastrothylax gigantus by Harshey (1934); G. crumenifer by Harshey (1934); Srivastava (1945), D'Souza (1948), Alwar (1949), Yamaguti (1958), Mukherjee and Sharma Deorani (1962), Katiyar and Varshney (1963), Soulsby (1982) and Gupta et al. (1985); Cotylophoron cotylophorum by Bhalerao (1935), Srivastava (1945), D'Souza (1948), Alwar (1949), Yamaguti (1958), Katiyar and Varshney (1963), Nath (1971), Soulsby (1982) and Gupta et al. (1985); C. ovatum by Harshey (1934), Yamaguti (1958); C. orientalis by Harshey (1934) and Yamaguti (1958); C. indicum by Yamaguti (1958), Mukherjee (1960b) and (1968), Gupta and Gupta (1977), Gupta et al. (1985); C. chauhani by Gupta and Gupta (1972b); Paramphistomum cervi by Naji (1935), Bhalerao (1935), Srivastava (1945), Katiyar and Varshney (1963), Gupta et al. (1985); P. explanatum by Srivastava (1945), Alwar (1949) and Katiyar and Varshney (1963); P. skrjabini by Bali and Fotedar (1972b); Calicophoron calicophorum by Mukherjee (1966c), Bali (1972), Gupta and Gupta (1977) and Soulsby (1982); Fischoederius gigantus by Alwar (1949), Katiyar and Varshney (1963), Chellapa and Gopalakrishnan (1977), Gupta et al. (1985); F. cobboldi by Alwar (1949), Carmyerioides nagpurkari by Mukherjee (1963); C. skrjabini by Mukherjee (1963);

C. *skrjabinocalium* by Soulsby (1982); C. *scoliocoelium* by Mukherjee (1960a&c), Mukherjee and Sharma Deorani (1962), Bali and Fotedar (1972a), Soulsby (1982), Gupta *et al.* (1985); *Olveria bhandari* by Bali and Fotedar (1974); C. *indica* by Mukherjee and Sharma Deorani (1962); C. *ivani* by Mukherjee and Sharma Deorani (1962); *Himalocaster palonica* by Mukherjee (1966); *Gigantocotyle orelongatum* by Shankar and Singh (1978); *Paramphistomum lobatum* by Tripathy and Srivastava (1980a) and *P. duttai* by Tripathy and Srivastava (1980b).

All the species recovered from sheep at present were those reported by others in India.

From the goats the species of amphistomes recovered were *Paramphistomum epiclitum*, *P. cervi*, *Cotylophoron cotylophorum*, *C. indicum*, *C. shaubani*, *Fischoederius elongatus*, *F. cobboldi*, *Ceylonocotyle scoliocoelium*, *C. spiniscrobiculus*, *Gastrothylax crumenifer* and *Calicophoron calicophorum*. Among these species only *Cotylophoron shaubani* was found only in goats.

The species of amphistomes reported from India are *Gastrothylax crumenifer* by Harshey (1934), Srivastava (1945), Alwar (1949), Varma (1957), Yamaguti (1958), Katiyar and Varshney (1963), Gupta and Dutt (1967b) and Nath (1971); *C. elongatus* by Harshey (1934); *Ceylonocotyle papanai* by Mukherjee (1963); *C. scoliocoelium* by Mukherjee (1960a&c), Gupta *et al.* (1985); *C. skrjabini* by Mukherjee (1963); *Cotylophoron cotylum* by Harshey (1934), Yamaguti (1958); *C. indicum*

by Mukherjee (1960b) and (1968) and Gupta et al. (1985); C. gigantum by Yamaguti (1958); C. orientalis by Harshey (1934), Yamaguti (1958); C. ostylorhorum by Srivastava (1945), Mudaliar (1945), Varma (1957), Yamaguti (1958), Katiyar and Varshney (1963), Nath (1971), Soulsby (1982), Sahai (1985) and Gupta et al. (1985); Gigantocotyle anulatum by Mukherjee (1960c); Shankar and Singh (1978); Paramphistomum epiclitum by Gupta (1963); P. cervi by Bhalerao (1935), Naji (1935), Srivastava (1945), Katiyar and Varshney (1963) and Soulsby (1982); P. anulatum by Srivastava (1945), Alvar (1949) and Katiyar and Varshney (1963); Fischoederius gigantus by Katiyar and Varshney (1963), Sahai (1985); F. cobboldi by Alvar (1949); Calicophoron calicophorum by Varma (1957), Gupta and Gupta (1977); C. orientalis by Mukherjee (1966c); Paramphistomum ichnatum by Tripathy and Srivastava (1980a) and P. dutti by Tripathy and Srivastava (1980b).

Ostylorhorum chauhani and Cotylocotyle spinicephalus are not seen recorded from goats in India and hence these two species could be considered as new host records.

SPECIES RECOVERED FROM CATTLE, BUFFALOES, SHEEP AND GOATS

PARAMPHISTOMUM FISCHOEDER, 1901

The genus Paramphistomum was first established by Fischoeder in 1901. Later, Stiles and Goldberger (1910) proposed four sub-genera under the genus Paramphistomum, namely Paramphistomum (Paramphistomum), P. (Orthocoelium), P. (Cauliorchis) and P. (Sub-genus uncertain). Fukui (1929) split up the genus into three sub-genera Paramphistomum (Paramphistomum), P. (Gastrothylax) and P. (explanatum) and also reduced the genus Cotylophoron Stiles and Goldberger, 1910 to a sub-genus under it. Naplestone (1932) synonymized several species described under the genus Paramphistomum, recognising only a few. But Travassos (1934) recognised only two sub-genera, namely P. (Paramphistomum) and P. (Cauliorchis). Nasmark in 1937 divided the genus Paramphistomum into eight genera, viz., Paramphistomum Fischoeder (1901), Gigantocotyle, Calicophoron, Ceylonocotyle, Homalocotyle, Gastrothylax and Macrocharynx and excluded the genus Cotylophoron. The last seven genera were new and erected by him.

The genus Paramphistomum includes a group of flukes whose internal anatomy closely resembles the earliest described form, Paramphistomum cervi (Zeder, 1790). Nasmark (1937) added to this genus two new and nine already known forms: P. cervi (Zeder, 1790), P. bothriophoron (Braun, 1892), P. gracile (Fischoeder, 1901), P. epiclitum (Fischoeder, 1904), P. microbothrium (Fischoeder, 1901), P. liorchis (Fischoeder,

1901), P. papillicornum (Stiles and Goldberger, 1910), P. ichikawai (Fukui, 1922), P. cotoi (Fukui, 1922), P. ciavuia (Nasmark, 1937) and P. leydeni (Nasmark, 1937). Dinnik, 1954 described a new species, P. sukari from the reticulum of Bos taurus in Kenya.

During the present investigation, two different species of the genus Paramphistomum were encountered in domestic ruminants under study. The measurements and the morphological features of the specimens collected came very close to the key and specific diagnosis of Paramphistomum epiclitum and P. cervi furnished by Dutt (1960). Hence they are identified as such.

I. Paramphistomum epiclitum (Fischoeder, 1904)
Stiles and Goldberger, 1910

Host: i. Capra hircus (goats)
ii. Bos indicus (cattle)

Location : Rumen

Locality : Kerala

II. Paramphistomum cervi (Zeder, 1790) Fischoeder, 1901

Host : i. Bos indicus (cattle)
ii. Capra hircus (goat)

Location : Rumen

Locality : Kerala

COTYLOPHORON STILES AND GOLDBERGER, 1910

The genus Cotylophoron was proposed by Stiles and Goldberger (1910) and they placed it under the sub-family Paramphistominae Fischoeder, 1901 of the family Paramphistomidae Fischoeder, 1901. Naplestone (1913) and Naemark (1937) followed the classification proposed by Stiles and Goldberger. Fukui (1929) reduced Cotylophoron to a sub-genus under the genus Paramphistomum Fischoeder, 1901. Skrjabin (1949) removed the sub-family Paramphistominae and placed the genus directly under the family Paramphistomatidae Fischoeder, 1901. Yamaguti (1958) placed Cotylophoron under the tribe Paramphistomini, which was newly created by him. Soulsby (1982) described Cotylophoron under the family Paramphistomatidae Fischoeder, 1901.

Naplestone (1923) expressed the opinion that Cotylophoron indicum and C. cotylophorum are identical and put the former species as synonym to the latter. This view was also shared by Fukui (1929), Harshey (1934), Travassos (1934), Bhalerao (1935) and Chatterjee (1938). But Bennett (1936), Naemark (1937), Skrjabin (1949) and Price and McIntosh (1953) regarded these two species as distinct. Moreover, Price and McIntosh transferred C. indicum from the genus Cotylophoron to Paramphistomum and proposed a new name P. bhamri. However, Mukherjee and Chauhan (1965) and Dutt (1980) described this species under the genus Cotylophoron.

During the course of the present studies, three different types of materials belonging to the genus Cotylophoron were encountered. The measurements and the morphology of the first type of materials fully agree with the key and description of Mukherjee and Chauhan (1965) for Cotylophoron cotylophorum Stiles and Goldberger (1910). Hence it is identified as such.

Host: i) Bos indicus (cattle)
ii) Capra hircus (goat)
iii) Ovis aries (sheep)

Location : Rumen

Locality : Kerala

The second material closely agree with the description of Mukherjee and Chauhan (1965), Dutt (1980) for Cotylophoron indicum. Hence the present material is refer able as Cotylophoron indicum (Stiles and Goldberger, 1910) Nasmark, 1937.

Host: i) Ovis aries (sheep)
ii) Capra hircus (goat)

Location : Rumen

Locality : Kerala

The third material which was collected from goats only, closely resembles the description given by Gupta and Gupta (1972) and Dutt (1980) for Cotylophoron chauhani. Hence, this material is identified as Cotylophoron chauhani Gupta and Gupta (1972).

Host: i) Capra hircus (goat)

Location : Rumen

Locality : Kerala

FISCHOEDERIUS (POIRIER, 1883) STILES AND GOLDBERGER, 1910

The genus Fischoederius was erected by Stiles and Goldberger, 1910 for five species, elongatus, cobboldi, Fischoederi, Siamensis and Cevlonensis, of which only the first two are of undoubted validity.

During the present investigation two different types of specimens belonging to the genus Fischoederius were encountered. The first one was comparable with the key and description given by Dutt (1980) for Fischoederius cobboldi. Hence this was specifically identified as Fischoederius cobboldi (Poirier, 1883) Stiles and Goldberger, 1910.

Hosts : i) Bos indicus (cattle)
ii) Bos bubalis (buffalo)
iii) Capra hircus (goat)
iv) Ovis aries (sheep)

Location : Rumen

Locality : Kerala

The second specimen was in agreement with the account proposed by Dutt (1980) for the species Fischoederius elongatus. Hence this was identified as Fischoederius elongatus (Poirier, 1883) Stiles and Goldberger, 1910.

Hosts : i) Bos indicus (cattle)
ii) Bos bubalis (buffalo)
iii) Capra hircus (goat)

Location : Rumen

Locality : Kerala

OLVERIA THAPAR AND SINHA, 1945

The genus Olveria was erected by Thapar and Sinha in 1945 and they placed it under the sub-family Gladorchiinae of the family Paramphistomidae.

In the present investigation two types of materials belonging to the genus Olveria were encountered. The first material was found to be in full agreement with the key proposed by Mukherjee and Chauhan (1965) for O. bosi in almost all major characters. Hence the material was identified as Olveria bosi (Tandon, 1955).

Host : Ovis aries (sheep)

Location : Rumen

Locality : Kerala

The second type of material under study showed close resemblence with Olveria indica (Thapar and Sinha, 1945) in almost all morphological features proposed by Mukherjee and Chauhan (1965) except the size of the testes. Mukherjee and Chauhan (1965) have reported the size of testis as 1.2 mm x 0.9 mm and 1.33 mm x 1.14 mm, but in the present material it is found 0.439 mm x 0.360 mm and 0.470 mm x 0.401 mm. This difference in size of the testes could be due to the specimens under study were immature. Hence this was identified as such.

Host : Bos indicus (cattle)

Location : Rumen

Locality : Kerala

CEYLONOCOTYLE NASMARK, 1937

Nasmark (1937) placed the genus Ceylonocotyle under the sub-family Paramphistominae Fischoeder, 1901 along with other genera. Skrjabin (1949) also adopted the classification proposed by Nasmark. Price and McIntosh (1953) maintained that the sub-genus Orthocoelium Stiles and Goldberger as a valid one and suggested that this sub-genus has the same nomenclature status as a genus, and that Orthocoelium has priority over Ceylonocotyle. They also suggested a new sub-family Orthocoeliinae. Yamaguti (1958) placed the genus Ceylonocotyle under a new tribe Ceylonocotylini.

The genus Ceylonocotyle comprises of nine species, viz., C. dicranocoelium (Fischoeder, 1901) Nasmark, 1937; C. orthocoelium (Fischoeder, 1901) Nasmark, 1937; C. streptocoelium (Fischoeder, 1901) Nasmark, 1937; C. scoliocoelium (Fischoeder, 1904) Nasmark, 1937; C. davesi Gupta, 1958; C. petrovi Davidova, 1961; C. nasmarki Mukherjee, 1963; C. nafavani Gupta, 1969 and C. cuneum (Bhalerao, 1937) Nama, 1977.

The present investigation yielded four different types of materials referable to genus Ceylonocotyle. The first three specimens were identified following the key and descriptions furnished by Mukherjee and Chauhan (1965) and they are:

1. Ceylonocotyle scoliocoelium (Fischoeder, 1904) Nasmark, 1937

   Hosts : i) Bos bubalis (buffalo)
   ii) Bos indicus (cattle)
   Location: Rumen and reticulum
   Locality: Kerala

2. Cevlonocotyle quinicephalus (Tandon, 1955)
Mukherjee, 1960

Hosts : Bos indicus (cattle)

Capra hircus (goat)

Location : Rumen and reticulum

Locality : Kerala

2. Cevlonocotyle nagmarki (Mukherjee, 1963)
Yamaguti, 1971

Host : Ovis aries (sheep)

Location : Rumen and reticulum

Locality : Kerala

The fourth material was identified as Cevlonocotyle narayani Gupta and Gupta, 1972 based on the key proposed by Dutt (1990).

Host : Capra hircus (goat)

Location : Rumen and reticulum

Locality : Kerala

GASTROTHYLAX (CREPLIN, 1847) POIRIER, 1883

The genus Gastrothylax was erected by Poirier in 1883. There are several species of amphistomes included in this genus.

In the present investigation only one species belonging to this genus was encountered and when compared with the key proposed by Tandon (1957) for the species under the genus Gastrothylax, the present material came close to G. crumenifer (Creplin, 1847) Poirier, 1883 in almost all the characters and hence the material under study is identified as Gastrothylax crumenifer (Creplin, 1847) Poirier, 1883.

Hosts : i) Bos bubalis (buffalo)
ii) Bos indicus (cattle)
iii) Capra hircus (goat)
iv) Ovis aries (sheep)

Location : Rumen

Locality : Kerala

CALICOPHORON (FISCHOEDER, 1901) NASMARK, 1937

The genus Calicophoron was considered synonymous with the genus Paramphistomum, by Naplestone (1923), Fukui (1929), Stunkard (1929), Travassos (1934) and Dawes (1936). But Nasmark in 1937 established the genus Calicophoron and this view was also shared by Skrjabin (1949) and Tandon (1957), Yamaguti (1958), Mukherjee and Chauhan (1965) and Dutt (1980).

During the present investigation two types of flukes belonging to the genus Calicophoron were recovered. Following the key proposed by Mukherjee and Chauhan (1965) for the genus Calicophoron, the first material resembles Calicophoron calicophorum (Fischoeder, 1901) Nasmark, 1937 and hence the material is identified as such.

Hosts : i) Bos indicus (cattle)
ii) Capra hircus (goat)

Location : Rumen

Locality : Kerala

The second material was identified as Calicophoron sauliorchis (Stiles and Goldberger, 1910) Nasmark, 1937 following the key proposed by Mukherjee and Chauhan (1965) for the genus Calicophoron.

Host : Bos bubalis (buffalo)

Location : Rumen

Locality : Kerala

GIGANTOCOTYLE (CREPLIN, 1847) NASMARK, 1937

The genus Gigantocotyle was created by Nasmark in 1937. Skrjabin (1949) accepted it as a valid genus. Gupta (1951) and Yamaguti (1958) considered it as a synonym to Paramphistomum Fischoeder, 1901. But Mukherjee and Chauhan (1965) and Dutt (1980) retained the genus Gigantocotyle.

In the present investigation only one type of material belonging to the genus Gigantocotyle was recovered. Based on the key and description proposed by Dutt (1980), the material was identified as Gigantocotyle explanatum (Creplin, 1847) Nasmark, 1937.

Host : Bos bubalis (buffalo)

Location : Bile duct

Locality : Kerala

SUMMARY

SUMMARY

An investigation into the prevalence of amphistomes in domestic ruminants (cattle, buffaloes, goats and sheep) in Kerala State was undertaken during the year 1985-86.

A total number of 1490 faecal samples collected from these ruminants from different parts of Kerala State were examined adapting sedimentation technique in order to detect the infection with paramphistomes. In addition to this, viscera of 780 slaughtered/dead ruminants belonging to the above categories were also subjected to thorough examination for the presence of amphistomes. The species collected were suitably prepared, studied, identified and described.

The data collected during the investigation revealed that the infection was higher in rainy seasons, that too during south west monsoon with an overall prevalence of 38.00%.

A total of seventeen species that belong to eight different genera were recovered and identified during this study. The highest prevalence of 62.64% was due to Gastrothylax crumenifer in cattle, followed by Fischoederius cobboldi (47.25%), Calicophoron calicophorum (34.07%), Ceylonocotyle scoliocoelium (29.67%), Fischoederius elongatus (19.78%), Cotylophoron cotylophorum (18.68%), Paramphistomum cervi (7.69%), P. epiclitum (4.40%), Olveria indica (2.20%), Ceylonocotyle spiniocephalus (1.20%) and C. narayani (1.20%). The highest prevalence of 57.69% of Gigantocotyle explanatum was noticed in buffaloes.

followed by Gastrothylax crumenifer (34.62%), F. cobboldi (23.08%), F. gigantatus (19.23%), C. gaudierrhiza (15.38%). Highest prevalence of 38.89% was due to C. cotylocherum in goats followed by C. scoliocoelium (33.33%), F. gigantatus (27.78%), G. crumenifer (27.78%), C. indicum (16.67%), F. cobboldi (16.67%), F. epiclitum (11.11%), C. calicocherum (11.11%), C. cervi (5.56%), C. chauhani (5.56%) and C. spini-cephalum (5.56%). The highest prevalence of 60% in sheep was due to C. cotylocherum followed by C. indicum (20.00%), F. cobboldi (20.00%), G. bosi (20.00%), C. nasmarki (20.00%) and G. crumenifer (20.00%).

Majority of the infection were of mixed origin, 62.63% in cattle, 40.00% in sheep, 27.78% in goats and 26.92% in buffaloes.

Based on the above findings the conclusions arrived at are:

1. Though the infection with Paramphistomes in domestic ruminants (cattle, buffaloes, goats and sheep) exists throughout the year, the highest prevalence occurs during rainy season and the lowest in Dry/Summer season.

2. The extent of infection is almost the same in cattle and buffaloes and comparatively lower in sheep and goats under the existing climatic condition of Kerala State.

3. The common species encountered in cattle are: Gastrothylax crumenifer, Fischoederius cobboldi, F.gigantatus, Carmicercylia

acoliocoelium in buffaloes, *Gigantocotyle explanatum*, *Gastrothylax crumenifer*, *Fischoederius cobboldi* and *F. elongatus* in goats *Cotylophoron cotylophorum*, *Carmoncotyle acoliocoelium*, *Gastrothylax crumenifer*, *Fischoederius elongatus* and in sheep *Cotylophoron cotylophorum*, *Olveria hani*, *Carmoncotyle nasmarki* and *Gastrothylax crumenifer*.

4. Majority of amphistome infections in domestic ruminants are of mixed species.

5. *Carmoncotyle spiniporchata* from cattle and goats and *Cotylophoron chauhani* from goats appear to be the first host records from India.

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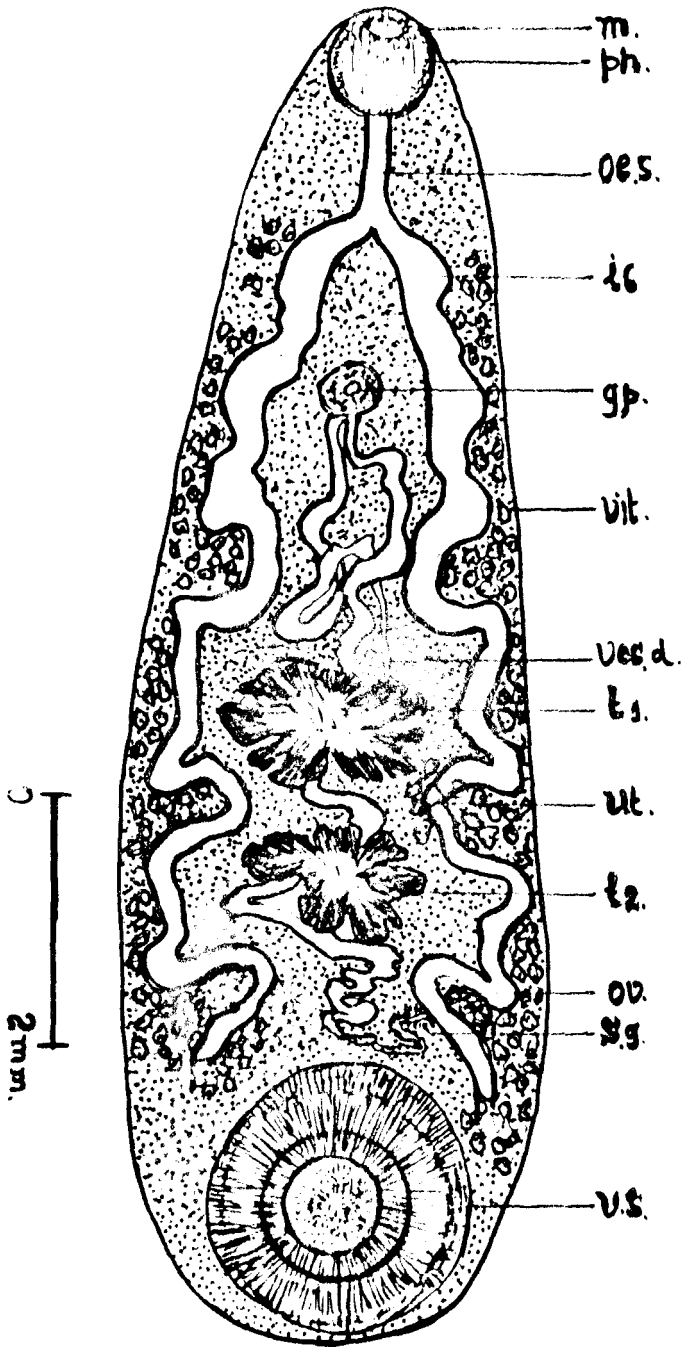
PLATES

Plate I. *Paramphistomum epiclitum*
(Camera lucida drawing)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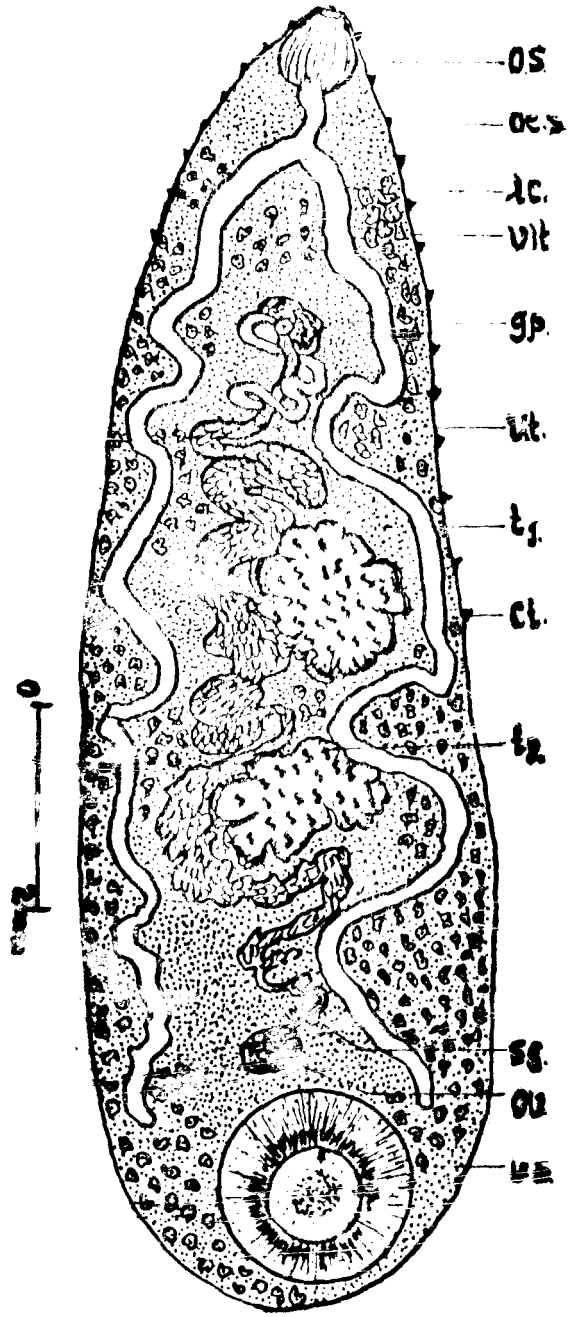
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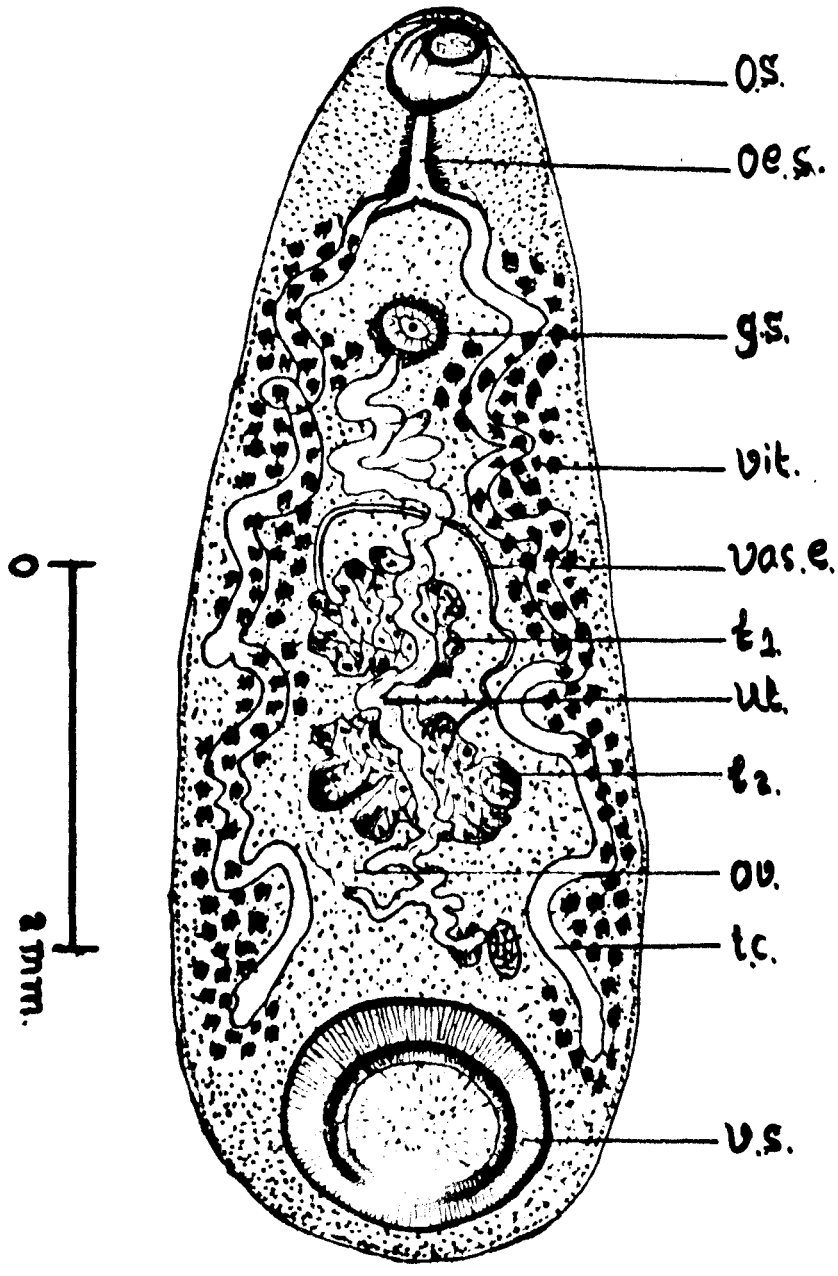
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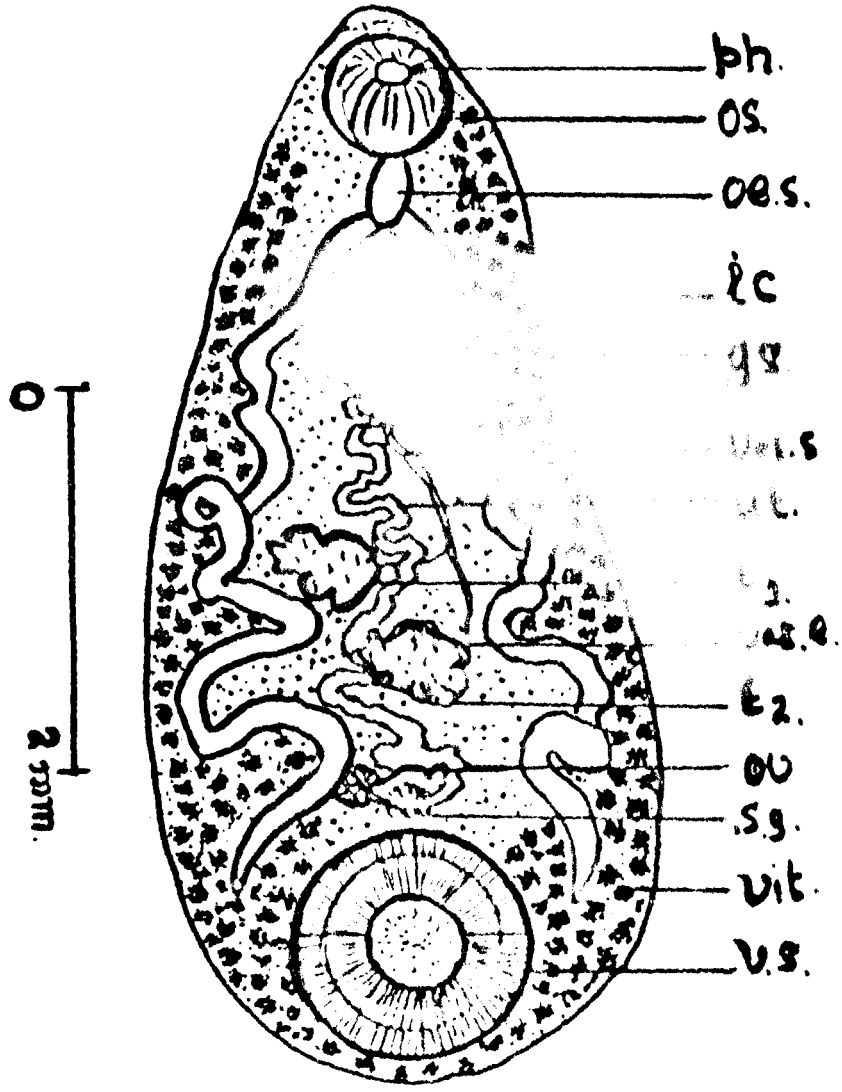
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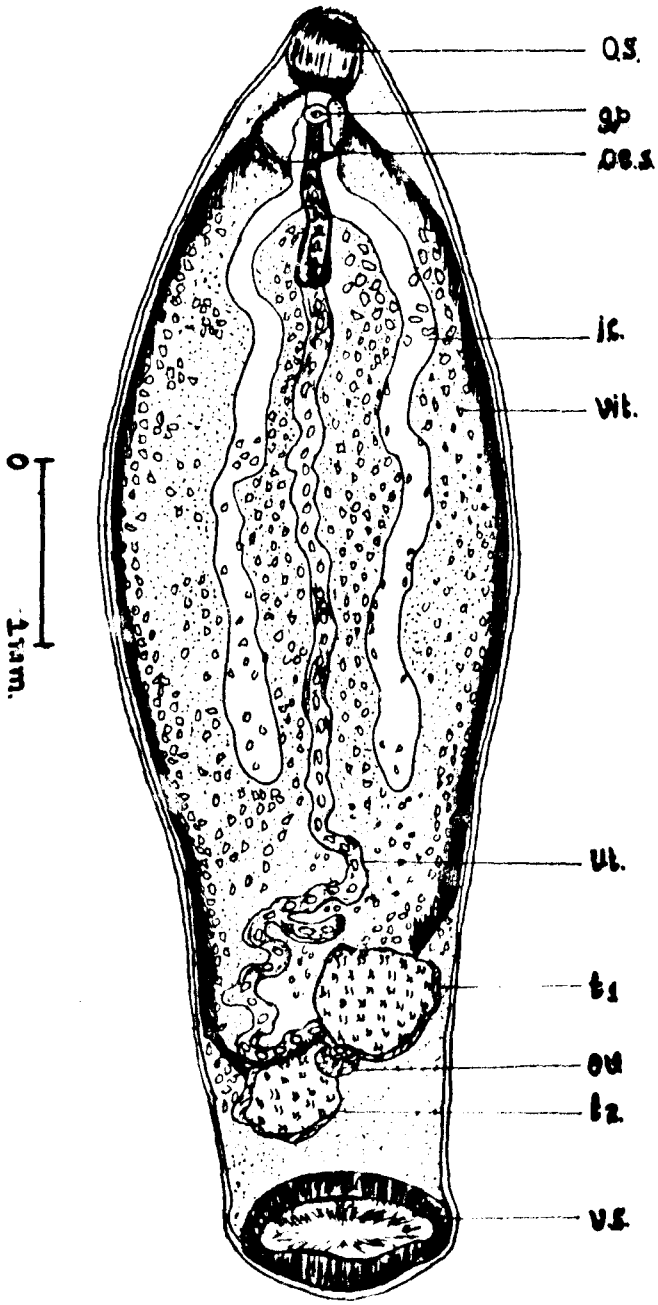
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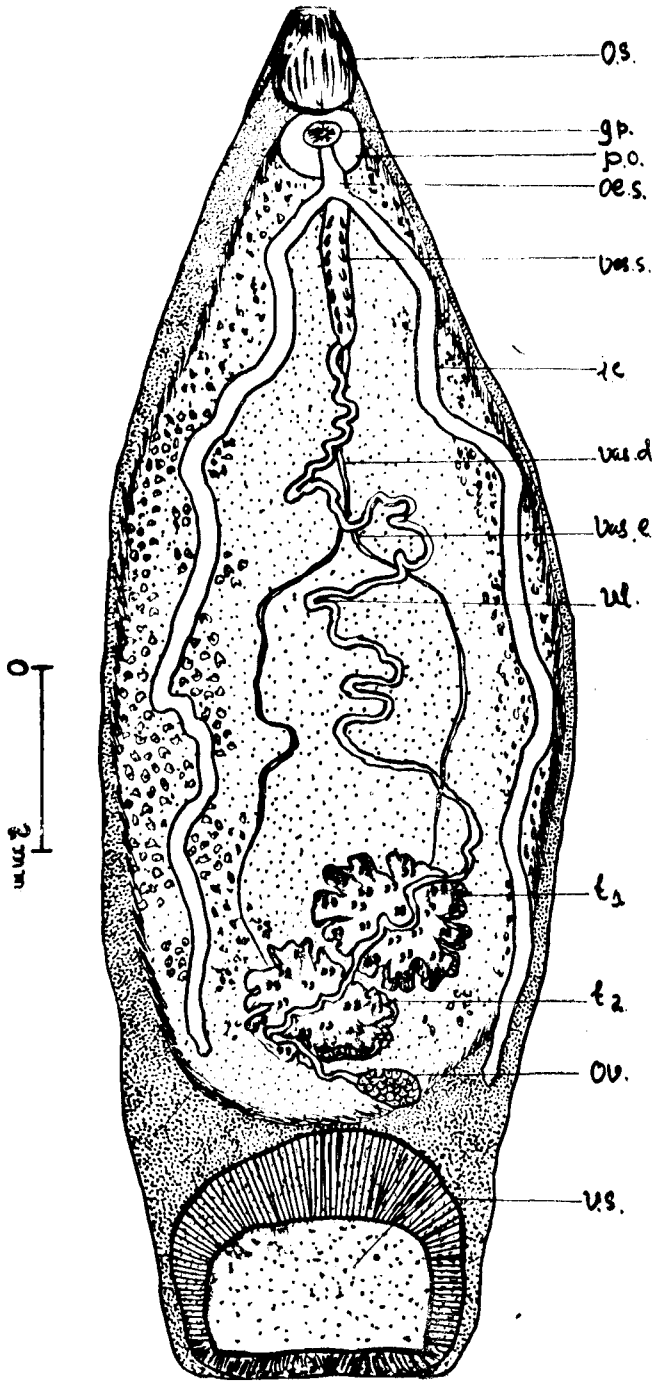
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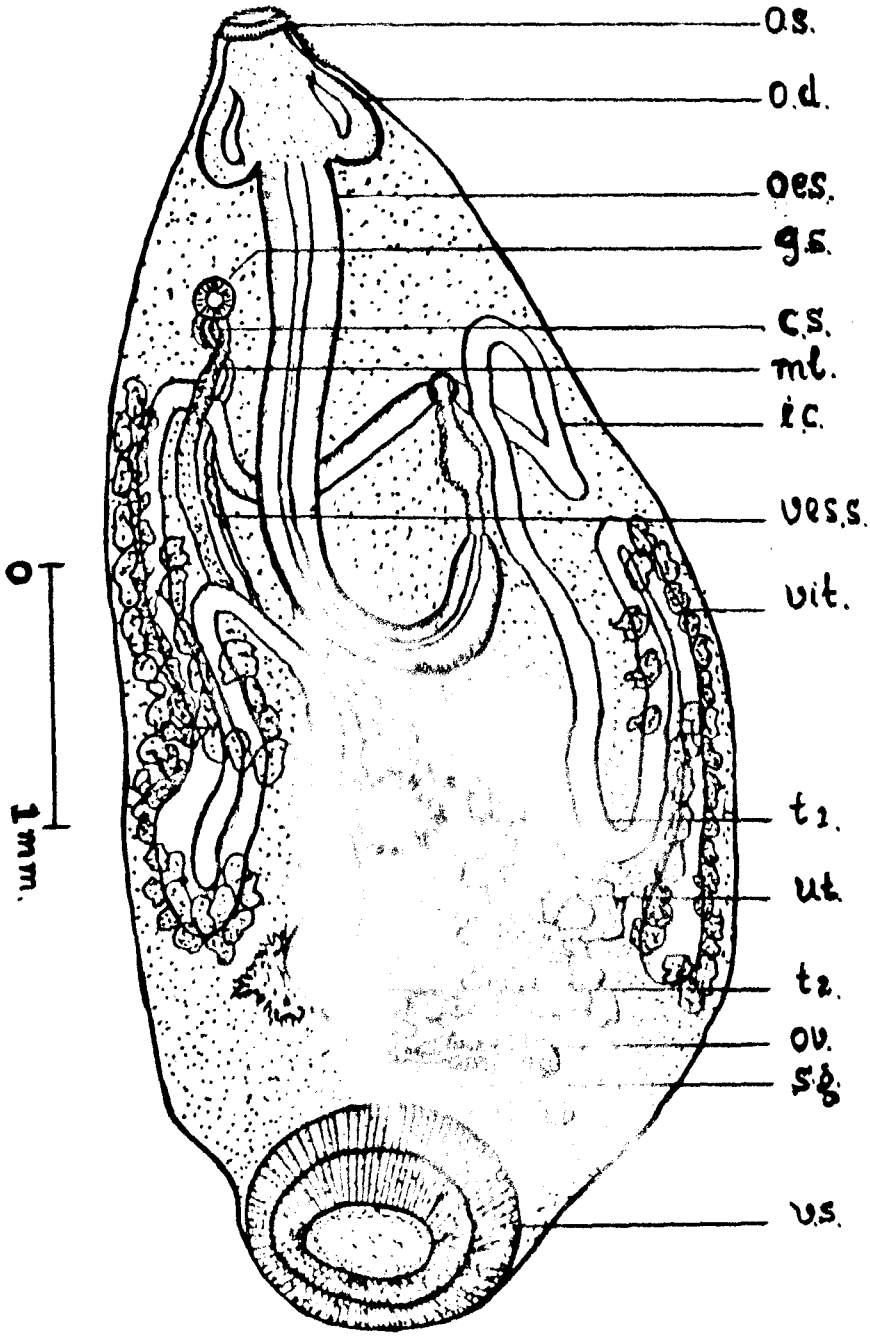
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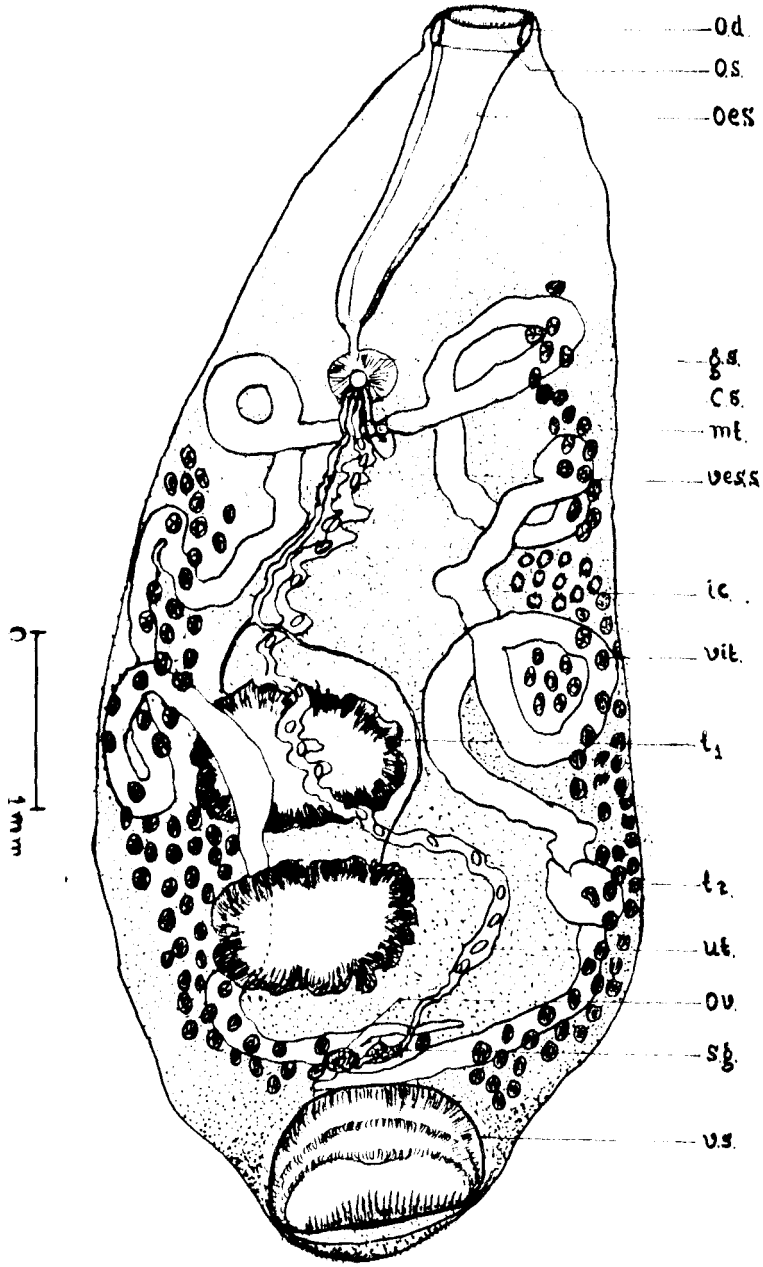
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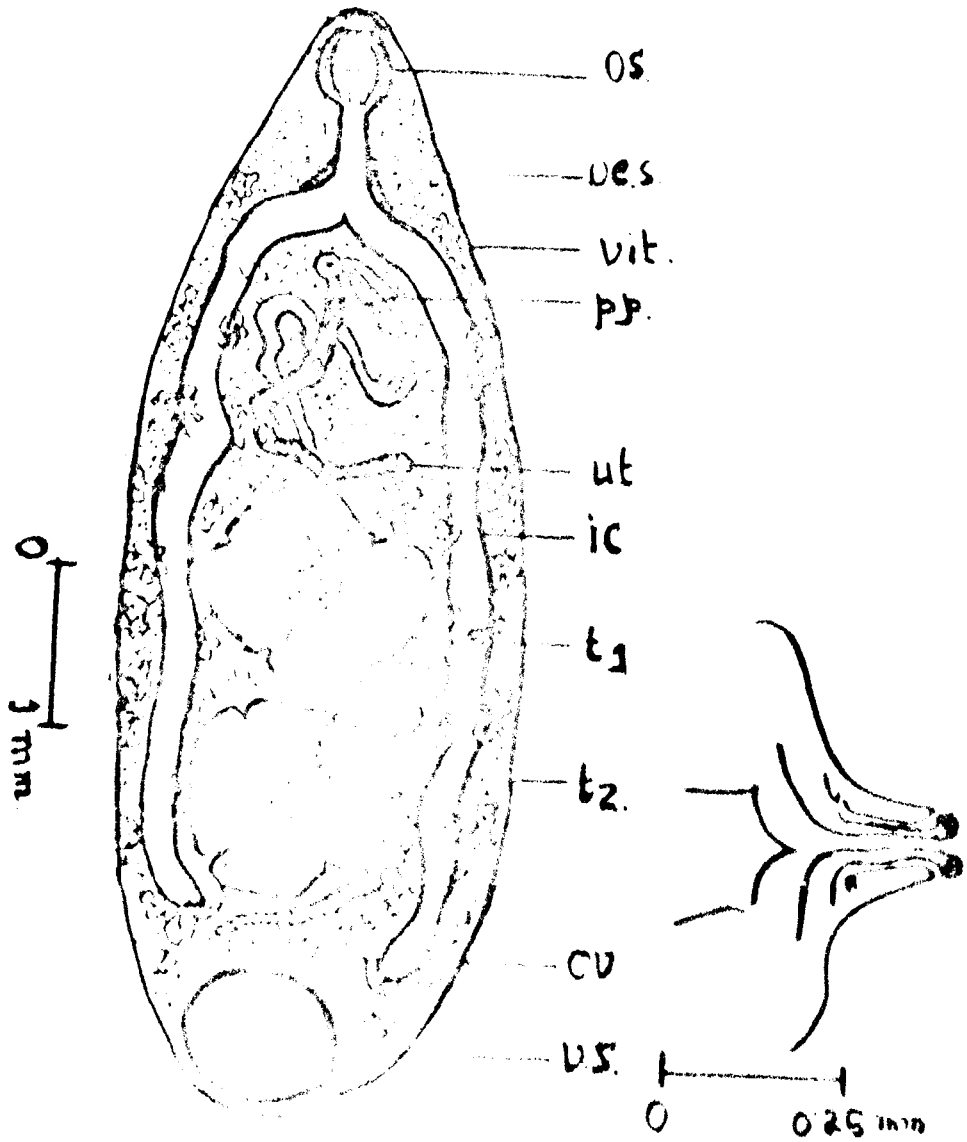
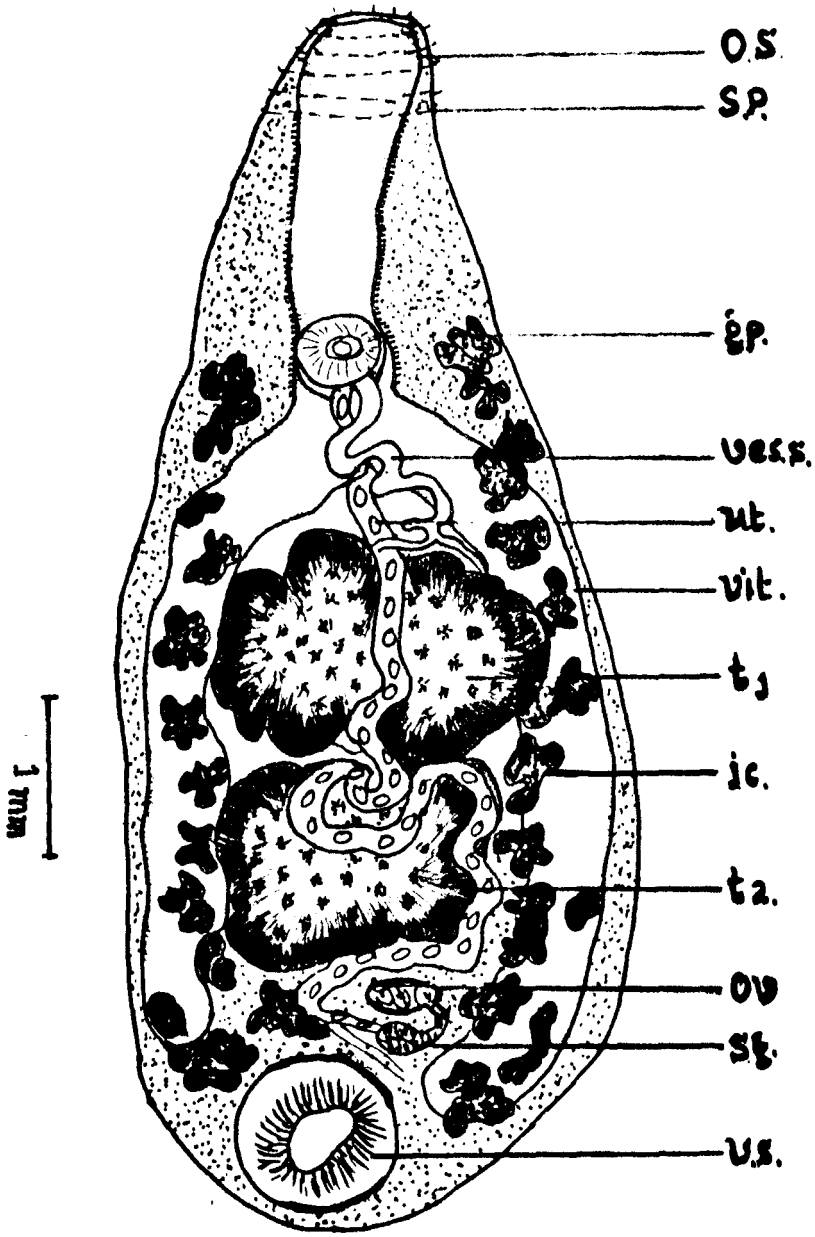


Fig. 1

Fig. 2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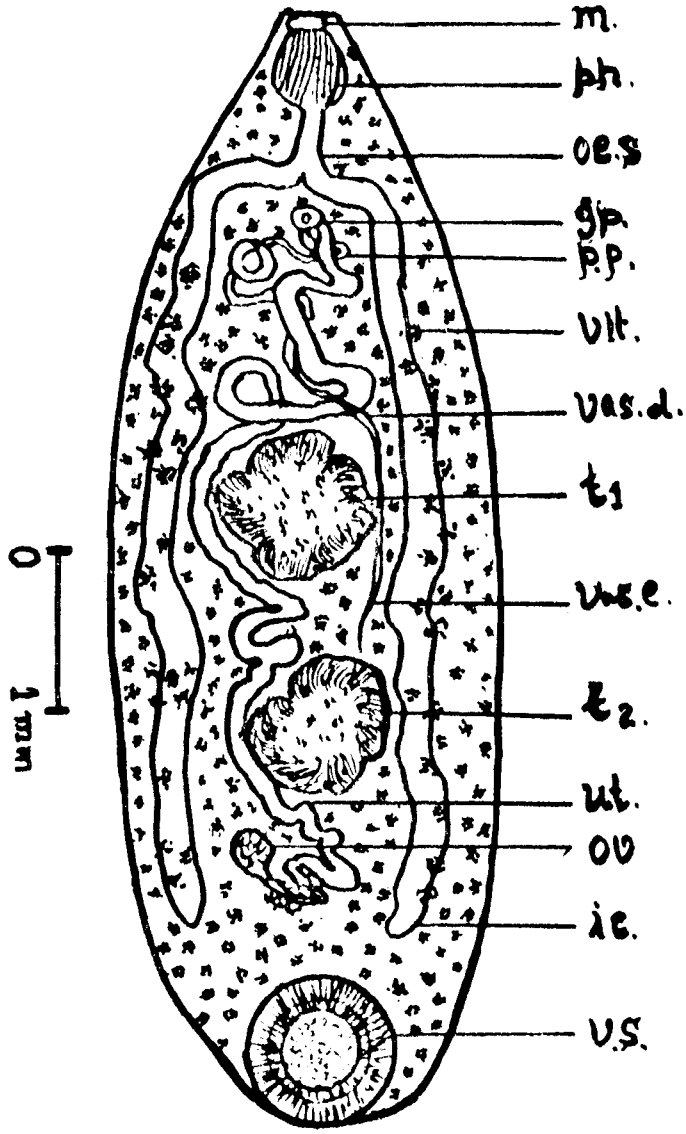
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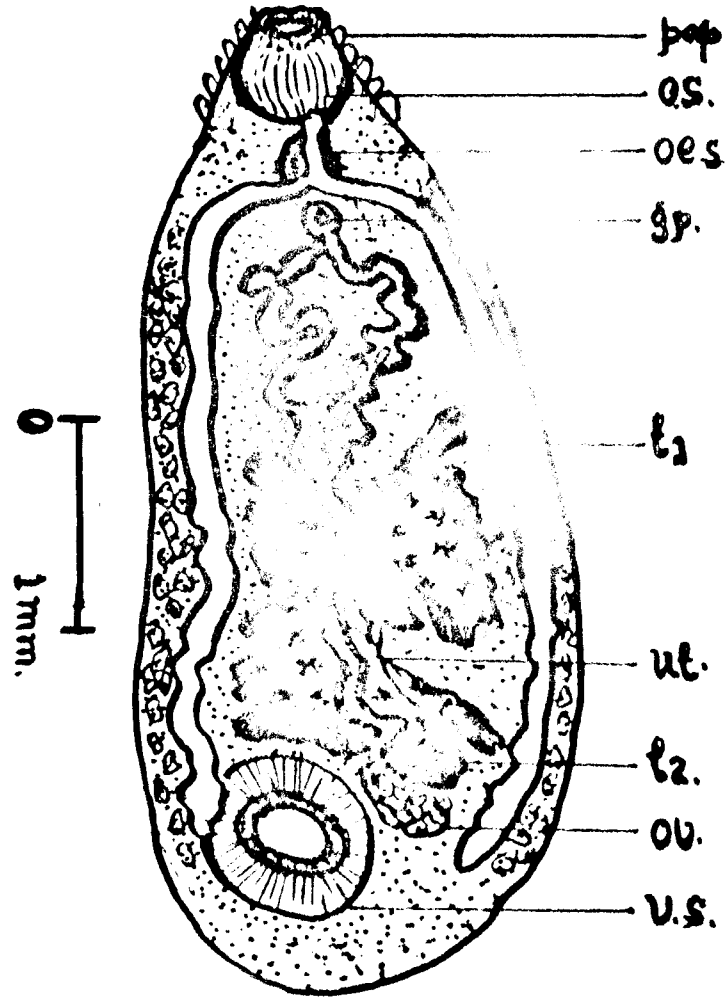
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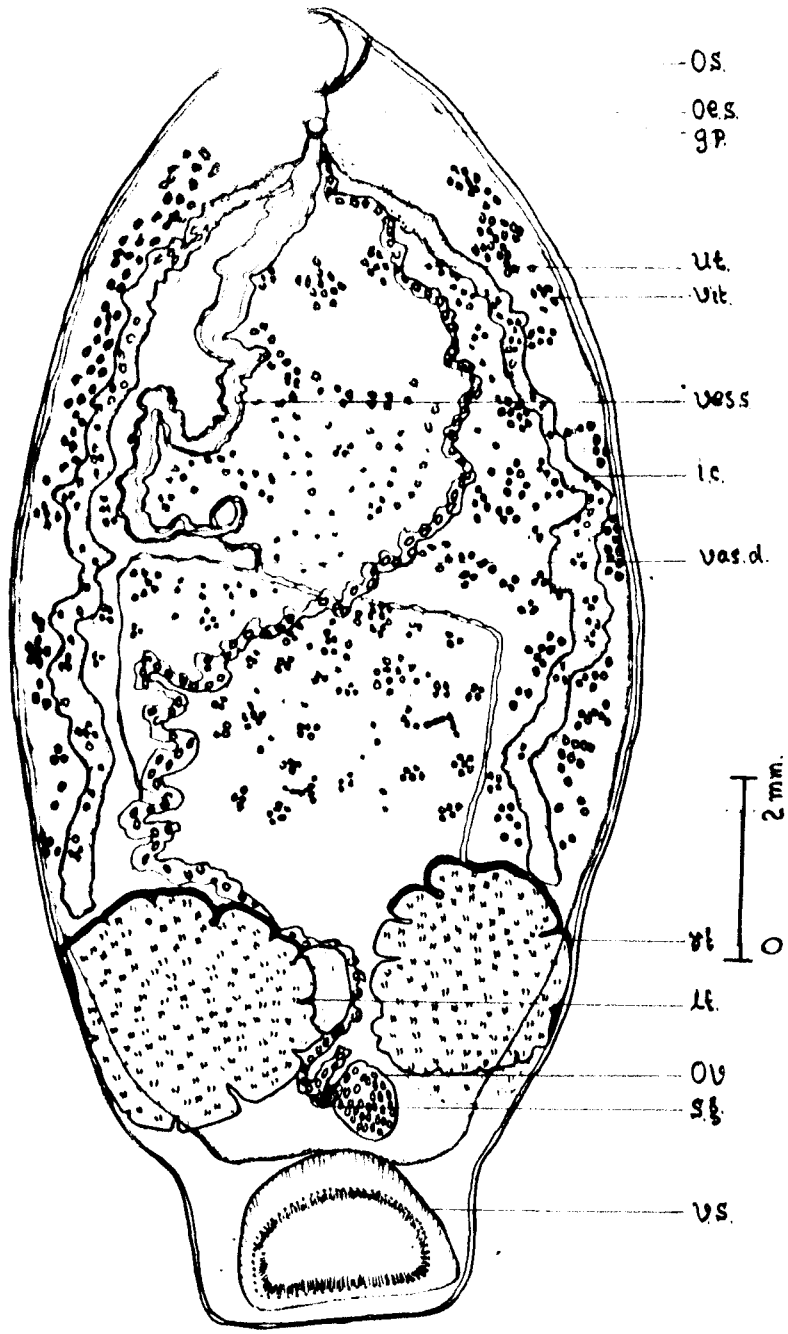
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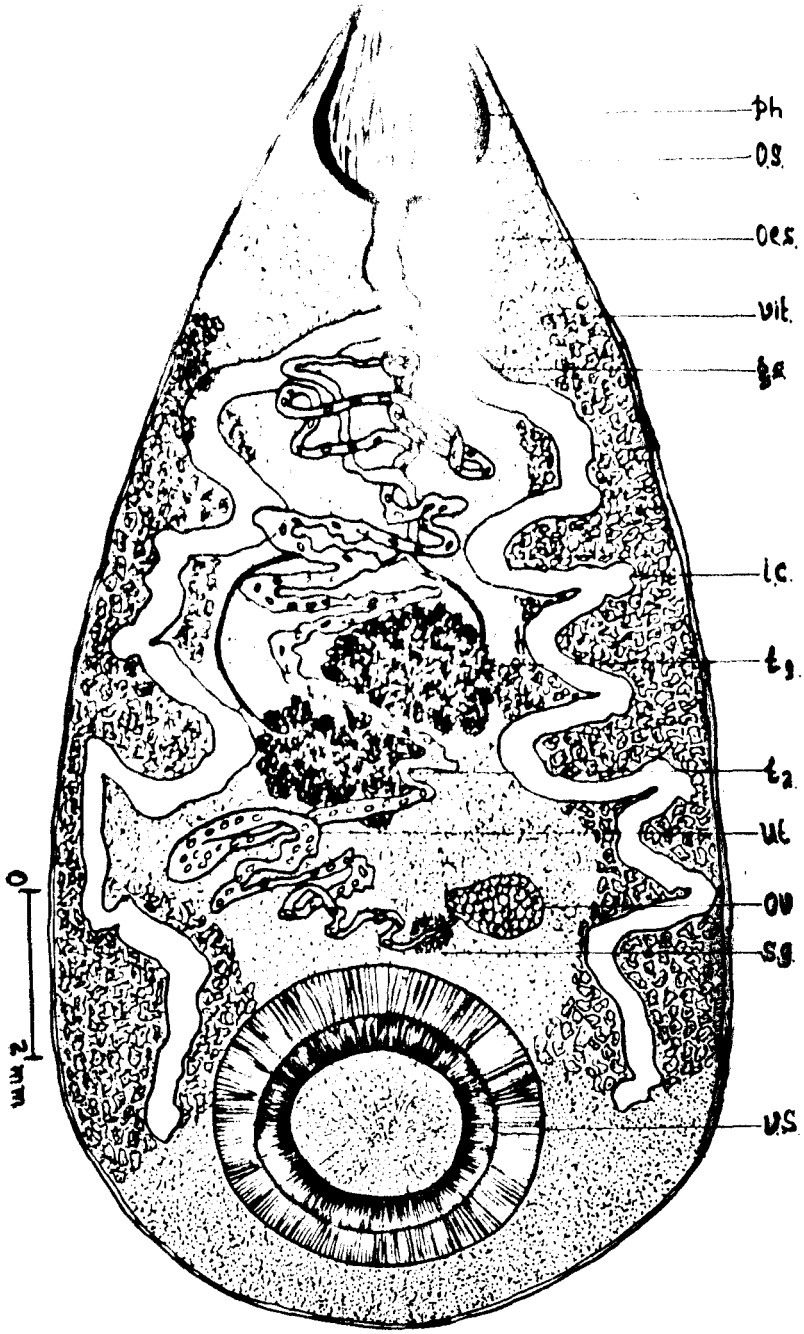
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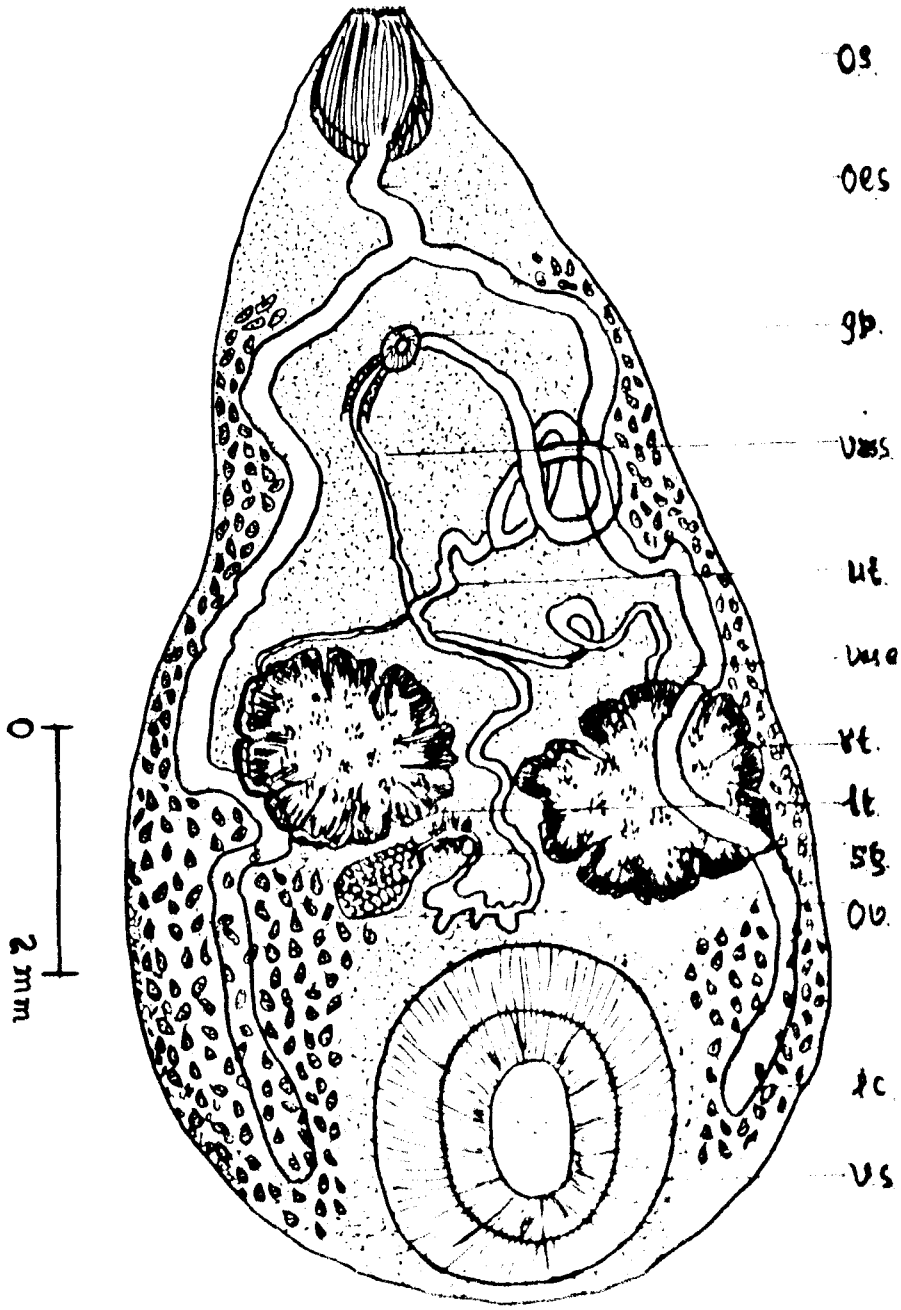
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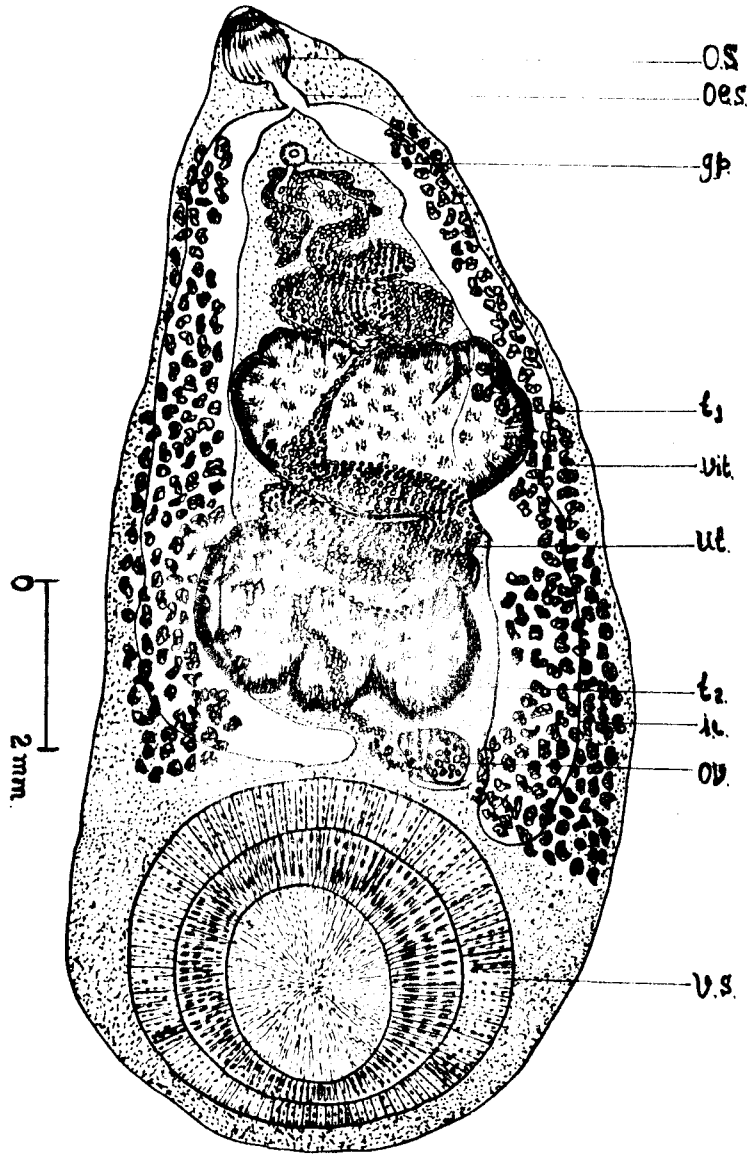
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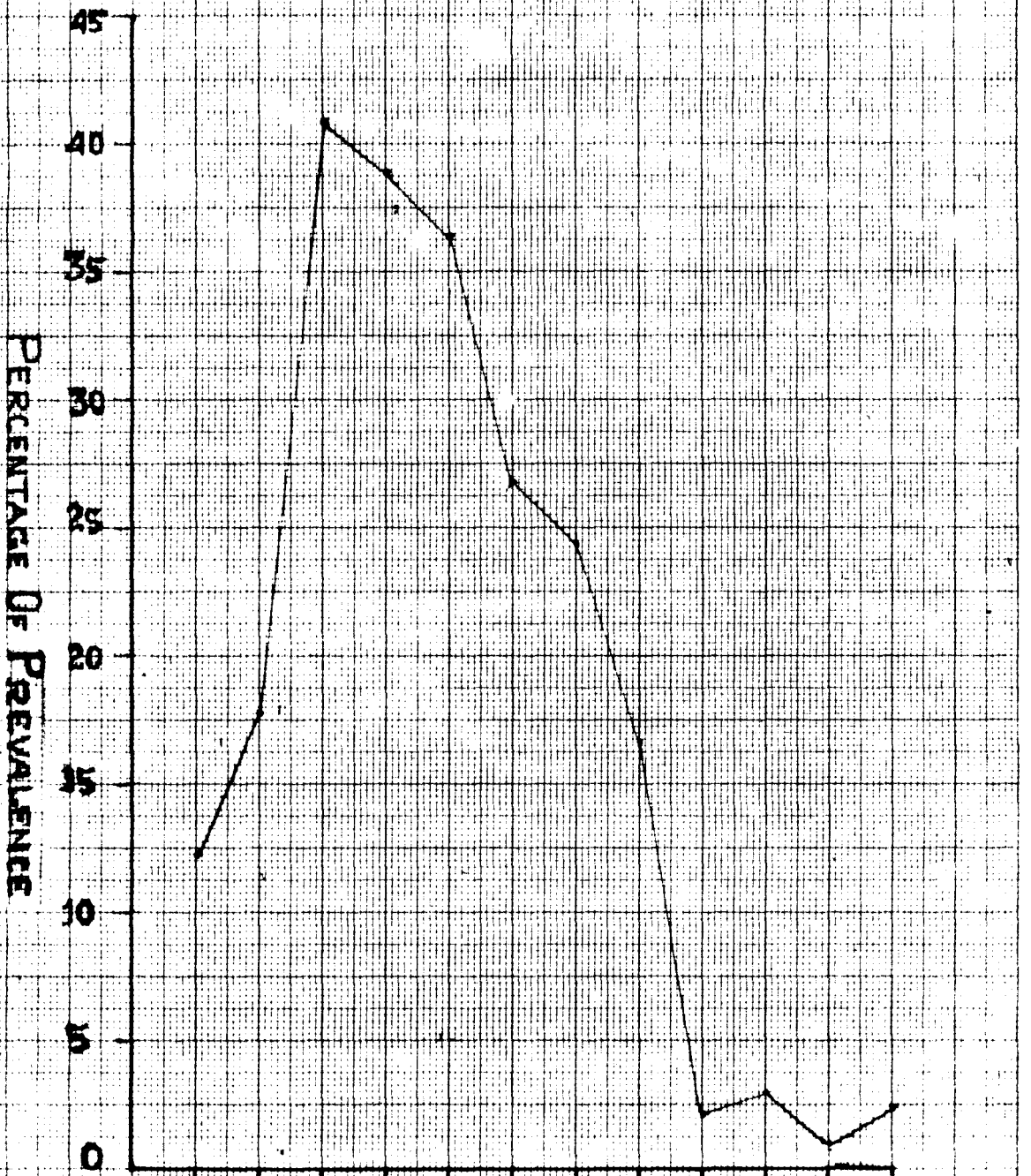

MONTH-WAR PREVALENCE OF AMPHISTOMES IN RUMINANTS

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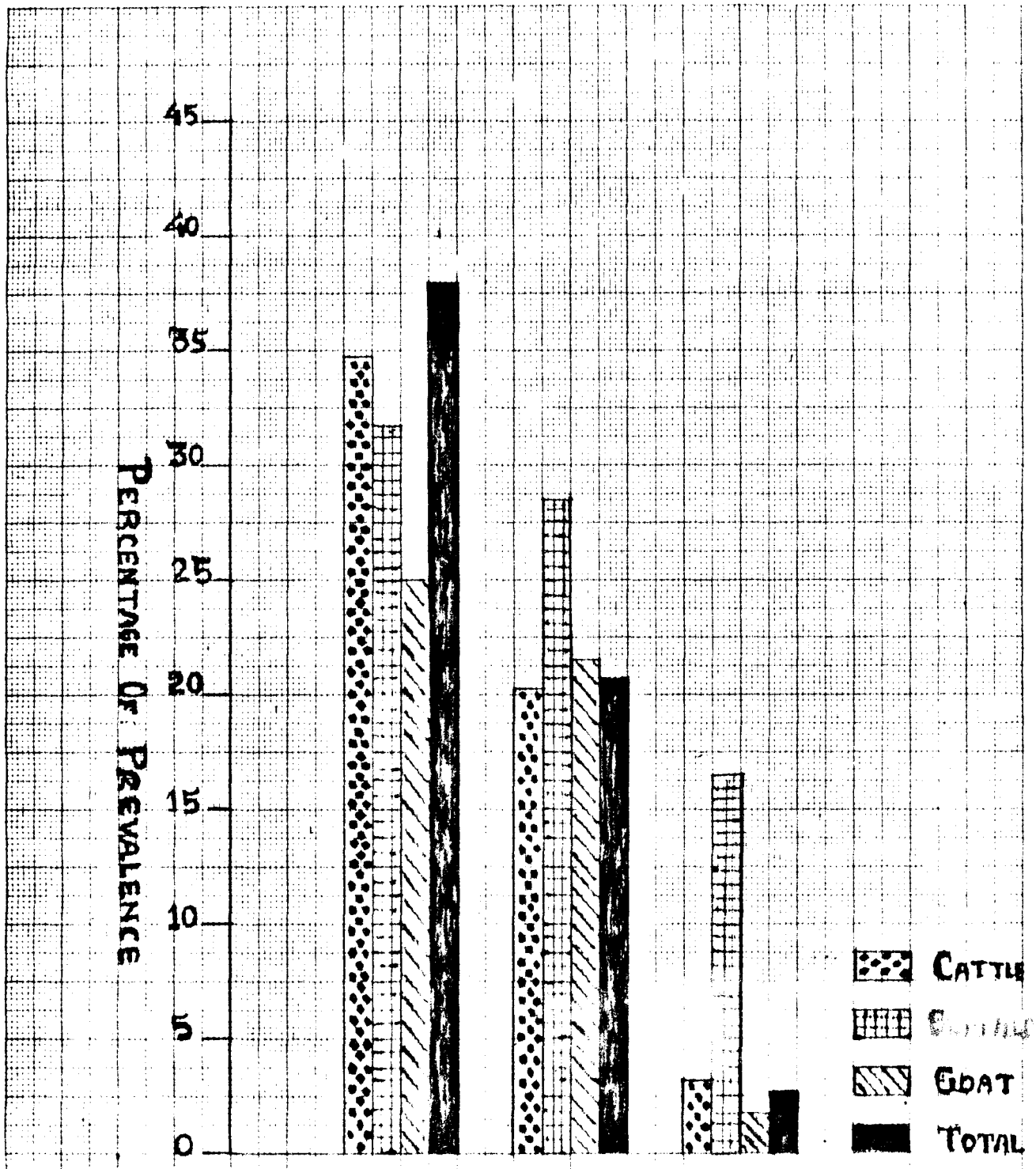

SOUTH-WEST NORTH-EAST SUMMER MONSOON

SEASON-WISE PREVALENCE OF AMPHISTOMES IN DOMESTIC RUMINANTS

TREMATODES OF PARAMPHISTOMATIDAE INFECTING DOMESTIC RUMINANTS

By

TARUN SHANKAR NATH

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirement for the degree

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Mannuthy - Trichur

1987

ABSTRACT

The thesis embodied the results of an investigation on the prevalence of amphistome infection and their specific identity in different domestic ruminants (cattle, buffaloes, sheep and goats) of Kerala State.

A total of 1490 faecal samples from domestic ruminants were collected from different places of Kerala State during a period from April 1985 to March 1986. These samples were examined by sedimentation technique to detect infection with amphistomes and their prevalence. Viscera of 780 slaughtered/ dead ruminants from different parts of Kerala were examined in addition and the available amphistomes were collected for the study and specific identification. The flukes were studied alive, flattened and stained and in certain cases by microtomy sections.

Result of the study indicated that the prevalence of infection was far more in cattle and buffaloes than in sheep and goats. The rate of prevalence in cattle, buffaloes and goats was 20.16%, 28.57% and 3.22% respectively.

In slaughtered/dead animals the prevalence was 33.09%, 34.67%, 4.17% and 5.31% respectively in cattle, buffaloes, sheep and goats. The highest prevalence was recorded during the rainy season and lowest in dry/summer season. Prevalence during South West monsoon was 38.08% and 20.73% during North East monsoon. The seasonal prevalence hardly varied between

cattle and buffaloes but it was consistently low in sheep and goats. Most of the prevalence in all animals were of mixed origin.

A total number of 17 species belonging to eight genera of amphistomes were identified. Ceylonocotyle spinicephalus (Tandon, 1955) was recorded from new hosts i.e., cattle and goats, Cotylophoron chauhani from goats, in addition to the already reported hosts, buffaloes and sheep respectively.

The following conclusions are drawn on the basis of the results of this study:

Amphistomes are most prevalent in cattle and buffaloes.

Though the infection with amphistomes exists throughout the year, it is definitely more in monsoon seasons.

Ceylonocotyle spinicephalus (Tandon, 1955) occurs in cattle and goats and Cotylophoron chauhani (Gupta and Gupta, 1972) in goats also.