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Binder 168, Paramphistomatidae from Mammals P-Z [Trematoda Taxon Notebooks]

Harold W. Manter Laboratory of Parasitology

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Paramphistomoides n. g.

Generic diagnosis. — Paramphistominae, Ceylonocotylini: Body elongate, elliptical, curved ventrally, without ventral pouch. Acetabulum ventroterminal, simple, not very large; acetabular index approximately 1 : 1.6. Oral sucker without diverticula. Esophagus moderately long, without bulbous swelling. Ceca long, somewhat sinuous, terminating in front of acetabulum. Testes more or less lobed, tandem, in midbody. Seminal vesicle coiled in front of anterior testis; pars muscosa and prostatica present. Ductus hermaphroditicus small, opening on genital papilla projecting into genital atrium. Genital pore postbifurcal. Ovary rounded, slightly submedian, posttesticular. Laurer's canal opening just in front of excretory pore. Uterus winding forward dorsal to testes; eggs large. Vitelline follicles small, extending from level of oral sucker to anterior end of acetabulum, continuous dorsally in front of acetabulum. Excretory vesicle pre-acetabular, opening just behind opening of Laurer's canal. Intestinal parasites of ungulates.

DIGenea OF MAMMALS

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Genotype: *P. maplestonei* (Bhalerao, 1937), n. comb. (Pl. 82, Fig. 1001), syn. *Paramphistomum* m. B., in *Hyelaphus porcinus*; Calcutta.

This new genus differs from *Paramphistomum* chiefly in the Laurer's canal not crossing the excretory canal.

Paramphistomum maplestoni Bhalerao, 1937

Length: 4.05-4.6 mm.

Thickness: 1.1-1.2 mm.

Oral Sucker: 0.456-0.57 X 0.4-0.43 mm.

Posterior Sucker: 0.67 mm. in diameter.

Esophagus: 0.2-0.22 mm. long

Intestinal ceca terminate about 0.22 mm. in front of the posterior sucker.

Genital Pore: 0.22 mm. posterior to intestinal fork.

Testes: Lobed, tandem; anterior pre-equatorial, posterior post-equatorial.

Ovary: Immediately posterior to hinder testis, slightly to the left of the middle line.

Laurer's Canal: Opens in front of excretory canal.

Vitellaria: Extend from the middle of the oral sucker to the anterior border of posterior sucker; extra-cecal, cecal and inter-cecal. Anteriorly to genital pore and posteriorly to ovary, vitelline follicles of either side meet centrally on the dorsal aspect.

Eggs: Measure 0.115-0.119 X 0.05-0.052 mm.

Host: Hyelaphus porcinus

Location: Small and large intestine

Locality: Calcutta Zoo, Calcutta, India



PARAPHI-
STOMOIDES

LOOSE LEAF ORGANIZER

SCHEDULE

OD TIME								
COURSE ON. STRUCTOR								
COURSE IE. STRUCTOR								
COURSE ED. STRUCTOR								
COURSE HU. STRUCTOR								
COURSE RL STRUCTOR								
COURSE AT. STRUCTOR								

NAME _____

ADDRESS _____

SCHOOL _____

TELEPHONE _____

KEY TO THE GENUS *PARAMPHISTOMUM*

The following key was composed to provide a simple, rapid means of identifying the various species of genus *Paramphistomum* Fischöder, 1901, in accordance with Näsmark's classification. Näsmark (1937) originally included 11 species in the genus. In bringing the present key up to date, several new species have been added. Only species whose diagnosis is based on Näsmark's classification system, were included. Thus, *P. maplestoni*, *P. cuonum*, *P. magnum*, *P. spinicephalus* and other suggested new species of questionable validity, are disregarded. It should be mentioned that Skrjabin's (1949) comprehensive work on paramphistomes was found of great benefit in composing the present key. The reader is once more referred to Näsmark (1937) for explanation of nomenclature.

- 1 (2) Testes distinctly diagonal... .. *P. skrjabini* Popowa, 1937*
 2 (1) Testes tandem or almost tandem... .. 3
 3 (4) Dorsal exterior circular muscle units in the acetabulum not differentiated into two distinct groups... .. *P. sukari* Dinnik, 1954.
 4 (3) Dorsal exterior circular muscle units in the acetabulum differentiated into two distinct groups... .. 5
 5 (18) Pharynx of "Paramphistomum" type (No pharyngeal bulb; no primary pharyngeal sacs; middle circular muscle layer absent)... .. 6

* I. V. Davidova (1958) questions the validity of *P. skrjabini* and considers it identical with *Calicophoron calicophorum*.

- 6 (9) Sphincter papillae in the genital atrium absent... .. 7
 7 (8) Radial musculature in the genital atrium absent... .. *P. gracile* Fischöder, 1901
 8 (7) Radial musculature in the genital atrium present... .. *P. epistilium* Fischöder, 1901
 9 (6) Sphincter papillae in the genital atrium present... .. 10
 10(11,12,17) Genital sphincter present... .. 11
 11(10,12,17) Genital sphincter very strong... .. *P. clavula* Näsmark, 1937
 12(10,11,17) Genital sphincter small and inconspicuous... .. 13
 13 (16) Ventral atrium small (poorly developed)... .. 14
 14 (15) Dorsal exterior circular 2 muscle units in the acetabulum are 25 in number and regularly spaced... .. *P. microbothrium* Fischöder, 1901
 15 (13) Ventral atrium very large... .. *P. bathriophoron* (M. Braun, 1892) Fischöder, 1901
 16(10,11,12) Genital sphincter absent... .. *P. ichikawai* Fukui, 1952
 17 (5) Pharynx of "Liorchis" type (No pharyngeal bulb; no primary pharyngeal sacs; middle circular muscle layer present)... .. 21
 18 (23) Sphincter papillae in the genital atrium absent... .. 25
 19 (20) Radial musculature in the genital atrium present... .. *P. leydeni* Näsmark, 1937; *P. scotiae* Willmott, 1950*
 20 (19) Radial musculature in the genital atrium absent... .. 21
 21 (22) In acetabulum: 19 dorsal exterior 1 circular units; 31 dorsal interior circular units; 49 ventral interior circular units... .. *P. gatoi* Fukui, 1952
 22 (21) In acetabulum: 14 dorsal exterior 1 circular units; 41 dorsal interior circular units; 40 ventral interior circular units... .. *P. cervi* (Zeder 179)
 23 (18) Sphincter papillae in the genital atrium present... .. 25
 24 (25) Sphincter papillae in the genital atrium poorly developed; circular and radial musculature absent... .. *P. liorchis* Fischöder, 1901
 25 (24) Sphincter papillae in the genital atrium well-developed; circular and radial musculature present... .. *P. hiberniae* Willmott, 1950*

Family PARAMPHISTOMATIDAE FISCHÖDER, 1901.

The moment seems opportune to mention that NÄSMARK (1937) has revised the systematics of this family on an entirely new basis — an idea possibly derived from FUKUI's (1929) work on Japanese amphistomes — and involves a study of the structure of the pharynx, the genital atrium and the posterior sucker, as seen in median sagittal sections. In fact the basis is one of histology rather than morphology. The conclusions reached by NÄSMARK from his study led him to erect several new genera and many new species. The value of this revision may be assessed in a statement made by NÄSMARK himself in his introduction (p. 309): "In most instances there are no more than one sectioned specimen per species as a basis for the investigation". There is no doubt that the revision includes some helpful suggestions towards a better understanding of the problems associated with the systematics of the paramphistomes, but the multiplicity of genera and species in the revision is the natural outcome of a restricted examination, in which no consideration could possibly have been given to morphological and histological variation in well-established species. An example of this is given below in a discussion on the type of genital atrium found in *Paramphistomum microbothrium*. Thus, the present writer feels that NÄSMARK's conceptions of genera and species within the *Paramphistomatidae* should be treated with reserve.

Family PARAMPHISTOMIDAE FISCHÖDER, 1901.

Family diagnosis: Digena with thick fleshy body, conical or cylindrical in shape. Body without spines, papillae may or may not be present. Ventral pouch present or absent. Acetabulum ventral terminal or subterminal, with or without posterior diverticles. Oesophagus short or long, may be straight or winding, with or without oesophageal bulb. Caeca simple straight or undulating, short or long. Testes one or two, lobed or unlobed, placed tandem, obliquely tandem or side by side. Cirrus pouch present or absent. Genital pore located ventrally in anterior part of body, pre, post or at bifurcal zone. Genital pore with or without genital sucker. Ovary posttesticular. Excretory vesicle posterior. Eggs with operculum.

Type genus: *Paramphistomum* Fischöeder, 1901.

Key to subfamilies from fish

1. Acetabulum very large, occupying whole breadth of expanded posterior part of body. Nicollodiscinae.
- Acetabulum small or wider than posterior end of body proper. 2.
2. Acetabulum small, oral diverticula small and not prominent. 3.
- Acetabulum wider than posterior end of body proper, oral diverticula large and prominent. 4.
3. Oesophageal bulb present or absent, vitellaria restricted to posterior portion of caeca in testiculo-ovarian zone. Cleptodiscinae.
- Oesophageal bulb present vitellaria lateral extending whole or almost whole length of caeca or restricted only to posterior part of caeca. Dadaytrematinae.
4. Acetabulum large wider than posterior end of body proper, oesophageal bulb present, genital pore behind oral sucker. Helostomatinae.

Mukherjee and
Chauhan, 1965

Family : PARAMPHISTOMIDAE Fischöder, 1901.

Key to subfamilies

1. Body divided into two portions.....Gastrodiscinae.
Body not divided into two portions.....2.
2. Ventral pouch present.....3.
Ventral pouch absent.....4.
3. Genital pore opening into ventral pouch.....Gastrothylacinae.
Genital pore opening on dorsal surface.....Johnsoniinae.
4. Oral diverticula absent.....Paramphistominae.
Oral diverticula present.....5.
5. Cirrus pouch present.....Cladorchinae.
Cirrus pouch absent.....Pseudodiscinae.

Subfamily : PARAMPHISTOMINAE Fischöder, 1901.

Subfamily diagnosis : Body conical. Ventral pouch absent. Acetabulum usually ventroterminal. Oral diverticula absent. Oesophagus long or short with or without oesophageal bulb. Caeca long or short. Testes tandem, diagonal or symmetrical. Cirrus pouch absent. Genital pore with or without genital sucker. Ovary median or submedian, usually posttesticular. Vitellaria usually on lateral fields.

Key to genera

1. Genital sucker strongly developed.....*Cotylophoron*.
Genital sucker absent.....2.
2. Acetabulum of modest dimension.....3.
Acetabular part dominating.....4.
3. Oesophagus usually without bulb. Pars musculosa not very strongly developed. Diameter of acetabulum in relation to length of body 1 : 4.55 (1 : 3.6-1 : 7.6). Laurer's canal crossing excretory vesicle.....*Paramphistomon*.

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Oesophagus may or may not be provided with bulb. Pars musculosa very strongly developed. Diameter of acetabulum in relation to length of body 1 : 6.48 (1 : 6.0-1 : 7.2). Laurer's canal not crossing excretory vesicle.....*Ceylonocotyle*.

4. Genital papilla surrounded by discoid muscular calyx. Pars prostatica and pars musculosa strongly developed. Wreath like folded wall around aperture of acetabulum, diameter of acetabulum in relation to length of body 1 : 3.17 (1 : 3.0-1 : 3.4).....*Calicophoron*.
Genital calyx, pars prostatica, pars musculosa absent. Wreath like folded wall around aperture of acetabulum absent, diameter of acetabulum in relation to length of body 1:2.22 (1:1.50-1:2.60).....*Gigantocotyle*.

Mukherjee & Chaudhan, 1965

Family diagnosis. — Digenea with thick body; ventral pouch present or absent. Cuticle may be papillated but not spined. Acetabulum terminal or subterminal, occasionally almost ventral. Oral sucker terminal, exceptionally subterminal, with or without posterior diverticles. Esophagus may or may not be provided with muscular bulb posteriorly. Ceca simple or more or less sinuous, terminating usually at or near posterior end of body, occasionally a considerable distance away from it. Testes usually in middle third of body, double, exceptionally single. Vesicula seminalis usually present. Pars muscosa may be differentiated. Cirrus pouch or hermaphroditic pouch present or absent. Genital pore

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SYSTEMA HELMINTHUM

anterior, midventral, middorsal,¹⁾ with or without genital sucker. Ovary usually posttesticular. Laurer's canal present, exceptionally absent (?). Vitellaria acinous or follicular, lateral. Uterine coils mostly intercecal; eggs without filament. Excretory vesicle posterior, exceptionally equatorial, intertesticular, saccular or tubular, with posterodorsal or dorsal aperture. Lymph system present. Parasites of vertebrates.

Type genus: *Paramphistomum* Fischöder, 1901.

Key to subfamilies of Paramphistomidae from mammals

1. Body usually flattened, divided into anterior and posterior portions; ventral pouch absent Gastrodiscinae
- Body usually conical, more or less elongate, not divided into portions 2
2. Ventral pouch absent 3
- Ventral pouch present
 - a) Genital pore opening into ventral pouch Gastrothylacinae
 - b) Genital pore opening on dorsal surface Johnsonitrematinae
3. Excretory vesicle equatorial, intertesticular Solenorchinae
- Excretory vesicle posterior, posttesticular 4
4. Body with paired caudal appendages; hermaphroditic pouch present Brumptiinae
- Body without paired caudal appendages; hermaphroditic pouch absent 5
5. Cirrus pouch present; paired oral diverticula present 6
- Cirrus pouch absent 7
6. Testes chiefly postovarian Balanorchinae
- Testes preovarian Cladorchiinae
7. Acetabulum provided with a caudal overhanging lip which terminates on either side in a small horn-like projection Zygocotylinae
- Acetabulum without such appendage 8
8. Oral diverticula double Pseudodiscinae
- Oral diverticula single Stephanopharynginae
- Oral diverticula absent Paramphistominae

PARAMPHISTOMIDAE Fischöder, 1901

Family diagnosis. — See p. 951.

It is very doubtful that *Paramphistomum argentinum* Cordero et Vogelsang, 1940, from an Argentine chelonian (probably *Hydraspis* sp.) should be referred to *Paramphistomum* Fischöder, 1901.

Key to subfamilies of Paramphistomidae from reptiles

1. Acetabulum with a projection on each side posteriorly Zygocotylinae
- Acetabulum without such projections 2
2. Body conical; acetabulum very large, commonly with a central protuberance in form of a papilla or sucker; testes usually single, exceptionally double; lymph system with one pair or two of longitudinal stems Diplodiscinae
- Body conical; acetabulum large, constricted on each side near posterior end, its ventral opening somewhat

trifoliate; testes single; hermaphroditic pouch present
..... Dermatemytrematinae
Body elongate oval, fusiform, subcylindrical; acetabulum
not very large, without central protuberance; testes
always double; lymph system usually with three pairs of
longitudinal stems Schizamphistominae

The moment seems opportune to remark on the taxonomic value of the crossing of Laurer's canal and the "neck" of the excretory vesicle. In a differential table of the species of the genus *Paramphistomum*, Fischodor (1903) separates three species from four others, because they possess no such crossing. Näsmark (1907) decided to place greater taxonomic importance on this feature and segregated those forms without the crossing from *Paramphistomum* and erected a new genus, *Ceylonocotyle*, for their reception. Price and McIntosh (1953) considered the feature to be of even greater diagnostic import and proposed the subfamily Orthocoeliinae, after relegating *Ceylonocotyle* to the synonymy of *Orthocoelium* Stiles and Goldberger, 1910. This subfamily has been accepted by Yamaguti (1971) in his recent uncritical classification of the Trematoda, despite the fact that the doubtful value of this feature has been known since 1929, when Stunkard stated that in *Cotylophoron cotylophorum* and in *Paramphistomum microbothrium* (= *cervi* of Stunkard) Laurer's canal and the excretory canal may not cross one another, and this observation is substantiated by the present writer's own examination of both species. Moreover, the several available descriptions of *Paramphistomum gotoi* (syn. *Ceylonocotyle gigantopharynx* Schad et al, 1964) indicate that both conditions may also be found in this species. In the writer's experience the relationship of Laurer's canal with the excretory canal is not constant, because the openings of the two canals are not situated in the same longitudinal plane, and are often situated more or less on the same transverse level. It is, therefore, not unusual to find one pore or other to lie a little more anteriorly, and on this depends whether or not Laurer's canal seemingly crosses the "neck" of the excretory vesicle. The evidence so far available suggests that the positional relationship between Laurer's canal and the excretory vesicle has only limited systematic value in the classification of the paramphistomes, and then merely as a specific feature on the basis of frequency. It is certainly not a character of generic or of subfamily significance.

From Prudhoe, 1975

SUBFAMILY PARAMPHISTOMATINAE FISCHOEDER, 1901

Amphistomes are common and conspicuous parasites in the stomach of herbivorous mammals. They are difficult to study partly because the body is thick, and good toto-mounts are difficult if not impossible to make. Nevertheless a number of monographic reviews of the family have been attempted. NASMARK's (1937) detailed study revised all earlier classifications and has been generally accepted as the modern foundation for the taxonomy of mammalian amphistomes. While some genera can be recognized without much trouble, the identification of most species requires the study of serial sagittal sections which reveal, in particular, details of the genital sucker and atrium, and the muscles of the acetabulum and pharynx. BAER (1950) believed the ratio of the pharynx and acetabulum to body length should not be stressed because of varying contraction of the body, and DOLLFUS (1950, p. 97) expressed similar views. Eggs of amphistomes are thin-shelled and more variable in size than in most groups of trematodes. In spite of the large amount of work done on the amphistomes, differentiation of some species is still difficult.

Forty-eight species of amphistomes have been reported from African mammals; 21 of them from the hippopotamus; 15 from cattle. Most of the records from cattle are from East Africa (Sudan, Egypt, Kenya, etc.). STUNKARD (1929) reported "*Paramphistomum cervi*" from antelopes of the Congo, but NASMARK concluded that his material was actually *P. clavula* NASMARK, 1937. STUNKARD also reported *Paramphistomum explanatum* (CREPLIN, 1847) [= *Gigantocotyle explanatum* (CREPLIN, 1847)] and *Cotylophoron cotylophorum* from Congo cattle. NASMARK believed *P. explanatum* to be limited to India and that STUNKARD's identification was incorrect. *Calicophoron calicophorum* (FISCHOEDER, 1901) is also known from cattle of the Congo. Thus NASMARK recognized three species of amphistomes from cattle in the Congo.

FROM WINTER + PATCHARD (1964)

Paramphistomum Fischoeder, 1901

Syn. *Gigantocotyle* Näsmark, 1937

Generic diagnosis. — Paramphistominae, Paramphistomini: Body

conical to pyriform, nearly round in cross section, without ventral pouch. Acetabulum ventroterminal or practically ventral; acetabular index 1:3.6-7.6 (subg. *Explanatum*), 1:1.5-2.0 (subg. *Paramphistomum*). Oral sucker without diverticula. Esophagus without posterior bulb. Ceca long, sinuous, reaching to acetabular zone. Testes rounded or lobate; tandem or somewhat diagonal, seminal vesicle convoluted; pars musculo-sa present; cirrus pouch absent. Genital pore may be more or less muscular but not forming genital sucker. Ovary posttesticular, in posterior third of body; uterus winding forward in median field dorsal to testes. Laurer's canal crossing excretory vesicle. Vitellaria extending in lateral fields between two suckers. Lymph system with one pair of longitudinal trunks. Parasitic in stomach, intestine or bile ducts of mammals.

Genotype: *P. (Paramphistomum) cervi* (Zeder, 1790) (Pl. 90, Fig. 1087) in stomach of domestic and wild ruminants (type host: "Hirsch"); Africa, Asia, North America and Europe.

Cercaria pigmentata Sonsino, 1892, develops in *Physa alexandrina*, *P. micropleura*, *Bullinus contortus*, *B. forskali*, etc., encysts freely — Looss (1896); *Planorbis compressus japonicus* — Takahashi (1927, 28, 32)¹⁾; *Bullinus contortus* — Brumpt (1936); *Planorbis planorbis* — Szidat (1936); in *Bullinus truncatus* — Balozet and Callot (1938), *Bullinus syngenes*, *B. alluaudi* — Dinnik (1951).

Other species:

Subgenus *Paramphistomum* (Fischoeder, 1901) (type: *cervi*).

P. (P.) bothriophoron (Braun, 1892), in *Bos indicus*; Madagascar.

P. (P.) clavula (labelled in Looss collection, designated n. sp. in Näsmark, 1937), syn. *P. cervi* of Stunkard, 1929, in "Sudan cattle", *Adenota leucotis*, *A. cob alurae*, *Cobus defassa*, *Redunca bohor*; Africa.

P. (P.) epiclitum Fischoeder, 1904, syn. of *P. cervi* — Maplestone, (1923), Fukui (1929), Stunkard (1929), Sprehn (1932), Travassos (1934), regarded by Näsmark (1937) as distinct, in *Bubalus bubalus*; Saigon, Lahore.

P. (P.) gotoi Fukui, 1922, in *Bos taurus*; Japan.

Cercaria develops in *Planorbis compressus japonicus*, encysts on surface of aquatic vegetation within 3-4 hours after emergence — Takahashi (1927). Redescription — Tandon (1955).

P. (P.) gracile Fischoeder, 1901 syn. of *P. cervi* — Maplestone, 1923, in *Bubalus bubalis*, *Boselaphus tragocamelus*, *Bos taurus indicus*; Ceylon.

P. (P.) hibernae Willmott, 1950, in *Bos taurus*; Ireland, Scotland.

¹⁾ It seems certain that he had before him *P. gotoi* and not *P. cervi*.

Netherlands. For development and morphology see Willmott (1952). *Planorbis leucostoma* as natural intermediate host in Channel Isl. — Willmott and Peter (1955).

P. (P.) ichikawai Fukui, 1922, in *Bos taurus*; Japan. Formosa, Manchuria, Australia.

Cercaria develops in *Segnitilia alphenae*; mature adults obtained in sheep 49-51 days after cysts had been fed, about 3 months are required to complete life cycle — Durie (1953).

P. (P.) leydeni Näsmark, 1937, in *Bos taurus*; Ritsema. Also in cattle of Königsberg Zoological Garden.

P. (P.) liorchis Fischoeder, 1901, syn. *Amphistomum conicum* Rud. partim, in *Mazama simplicicornis*, *M. americana*, *M. nana nambi*, *Blastocerus bezoarticus*, *B. dichotomus*, *Odocoileus mexicanus*; Brazil; Surinam.

P. (P.) microbothrium Fischeoeder, 1901, *Amphistomum conicum* Rud., in parte, syn. of *P. cervi* — Stunkard (1929), in *Gazella dorcas*, *Bos taurus*, *Bubalus bubalis*; Africa, Europe.

Whole life cycle worked out experimentally from miracidia through sporocysts, rediae and cercariae in *Bullinus alluaudi* to metacercaria on vegetation, and finally to egg producing maturity in cattle — Dinnik J. A. and Dinnik, N. N. (1954).

P. (P.) microbothrioides Price et McIntosh, 1944, pro *Cotylophoron cotylophorum* of Krull, 1932, in cattle, sheep; U.S.A. Biological studies on miracidia and intermediate host (*Stagnicola cubensis*) — Prince (1954).

P. (P.) papilligerum Stiles et Goldberger, 1919, syn. of *P. cervi* — Maplestone, 1923, in *Rucervus eldi*; locality unknown.

P. (P.) scotiae Willmott, 1950, in *Bos taurus*; Scotland, Ireland.

P. (P.) skrjabini Popowa, 1937, in cattle and buffaloes; Russia.

P. (P.) sukari Dinnik, 1954, in cattle; Kenya. *Biomphalaria pfeifferi* determined experimentally as an intermediate snail host.

Subgenus *Explanatum* Fukui, 1929 (type: *explanatum*).

P. (E.) anisocotylea (Faust, 1920), in *Bubalus bubalis* and *Bos taurus*; Manila.

P. (E.) bathycotyle (Fischeoeder, 1901), syn. *Paramphistomum cervi* of Maplestone (1923), Stunkard (1929), Fukui (1929), Sprehn (1932), Travassos (1934), Dawes (1936), in *Bubalus bubalis* and *Bos taurus indicus*; Indochina, Ceylon. For gametogenesis and early development see Willmott (1950).

P. (E.) birmanse (Railliet, 1924), syn. *P. explanatum* of Dawes, 1936, in *Bos taurus*; Burma, India.

P. (E.) dulpicitestorum (Näsmark, 1937), syn. *Gigantocotyle d. N.*, *Hippopotamus amphibius*; Africa.

P. (E.) explanatum (Crepl., 1847) (type of subgenus *Explanatum*) (Pl. 92, Fig. 1115), in *Bos taurus indicus* and *Bubalus bubalis*; Africa, Ceylon, Celebes, Indochina, Burma, India, Philippines, Australia.

P. (E.) formosanum (Fukui, 1929), syn. of *P. explanatum* — Dawes, 1936, in *Bos taurus*; Formosa.

P. (E.) fraternum (Stiles et Goldberger, 1910), syn. of *P. explanatum* — Maplestone (1923), in *Bubalus bubalis*; Indochina.

P. (E.) gigantocotyle (Brandes, 1896), syn. of *P. explanatum* — Dawes, 1936, in *Hippopotamus amphibius*; Africa.

P. (E.) siamense (Stiles et Goldberger, 1910), syn. *P. explanatum* of Maplestone (1923), Stunkard (1929), Fukui (1929), Sprehn (1932), Travassos (1934), in *Bos taurus indicus*; Siam.

P. (E.) symmeri (Näsmark, 1937), syn. *Gigantocotyle s. N.*, in cattle; Sudan.

Paramphistomidae
Paramphistominae

PARAMPHISTOMUM Fischöder, 1901

Body tends to conical form, with convex dorsum and concave venter, rather attenuate cephalad, rather blunt caudad; ventral pouch absent. Acetabulum terminal, tilts ventrad, small to very large. Genital sucker absent, pore ventromedian, pretesticular. Excretory vesicle at least partly in acetabular zone. Oral sucker without evagination; esophagus with or without muscular thickening; ceca long, nearly straight to wavy, end postequatorial, posttesticular, usually in acetabular zone.

Testes two, usually intercecal, small to large, finely lobulate to coarsely lobulate, exceptionally nearly smooth, fields coincide to separate, zones coincide to separate; cirrus pouch absent.

Ovary and Mehlis' gland usually ~~posttesticular~~ posttesticular, never pretesticular; Laurer's canal may cross excretory vesicle; uterus runs dorsally of testes, under arch of vasa efferentia, then ventrally of vas deferens.

Type: P. cervi (Schränk, 1790)

Others: P. explanatum (Creplin, 1847) Fischöder, 1904

From Stunkard

Genus : *Paramphistomum* Fischöder, 1901.

Generic diagnosis : Body conical to pyriform, with convex dorsum and concave venter. Ventral pouch absent. Acetabulum ventral, usually terminal, acetabular index 1 : 3.6-7.6. Oral sucker without diverticula oesophageal bulb usually absent. Caeca long, reaching to acetabular region. Testes round or lobate, tandem or diagonally tandem, fields coincide to separate, pars muscosa present, not very strongly developed. Genital sucker absent, at times genital pore may be more or less muscular. Ovary posttesticular, uterus winding. Vitellaria lateral, extending between two suckers. Laurer's canal crossing excretory vesicle.

Type species : *P. cervi* (Zeder, 1790) Fischöder, 1901.

The genus *Paramphistomum* created by Fischöder, 1901, was included under the subfamily Paramphistominae Fischöder, 1901. This view was shared by Stiles and Goldberger, 1910, Maplestone, 1923, Stunkard, 1925, Travassos, 1934, Näsmark, 1937 and Skrjabin, 1949. However, Fukui, 1929 reduced it to the generic status and placed it under the genus *Paramphistomum* Fischöder, 1901. He also created a new tribe Paramphistomini to accommodate this genus. Yamaguti, 1958 also supported the view expressed by Fukui. However, he put it under his new tribe Paramphistomini.

Key to species. ~~OF MAMMALS~~ - INDIA

- Anterior region without tubules or spines. Papillae surrounding mouth occasionally present..... *P. cervi*
- Oral sucker lined anteriorly with closely bundled tubules, each tipped with a very minute spines..... *P. gonoi*

MUKHERJEE AND CHAUHAN, 1965

Genus : *Gigantocotyle* Näsmark, 1937.

Generic diagnosis : Body conical to pyriform. Acetabulum ventro-terminal, large, acetabular index 1:1.50-2.60, wreath-like folded wall around acetabular aperture usually absent. Oral sucker without diverticula. Oesophagus without posterior bulb. Caeca long, sinuous, reaching up to acetabular region. Testes round or lobed, tandem or diagonally tandem. Ovary posttesticular. Laurer's canal crossing excretory vesicle. Vitellaria extending in lateral fields between two suckers.

Type species : *G. explanatum* (Creplin, 1847) Näsmark, 1937.

This genus was created by Näsmark in 1937. Skrjabin, 1949 accepted it as a valid genus. Gupta, 1951 and Yamaguti, 1958 consider it as synonymus to *Paramphistomum* Fischöder, 1901. Yamaguti also accepts Fukui's, 1929 subgenus *Explanatum* as valid.

Mukherjee and Chauhan, 1965

Paramphistomum bathycotyle Fiscoeder, 1901

Gupta, N.K. 1951 Res. Bull. East Panjab Univ.,
No. 15, pp. 33-38.

'ON THE MORPHOLOGY OF *PARAMPHISTOMUM BATHYCOTYLE*
FISCHÖEDER (1901) A COMMON AMPHISTOME IN THE BILE
DUCTS OF INDIAN BOVINES.'

By N. K. GUPTA, M.Sc.

(Lecturer in Zoology, Government College, Hoshiarpur)

INTRODUCTION

Paramphistomum bathycotyle was another worm which I collected from Indian bovines in 1941 at Lahore. This worm is very common in the bile ducts of these animals. Due to their heavy infestation, they generally block the bile duct and the flow of bile is hindered.

This worm is generally confused with *P. explanatum* Creplin (1847) because the latter has got the same habitat. It is also mistaken for *P. cervi* Zeder (1790) for having antero-posteriorly placed testes.

The preliminary description of the worm was given by Fischöeder in 1901 who also recorded it for the first time. In 1923, Maplestone, on the basis of the position of testes synonymised it with *P. cervi*. Later workers, prominent amongst whom were Fukui (1929), Stunkard (1929), Sprehn (1932), Travassos (1934) and Ben Dawes (1936), concurred with Maplestone's view.

Nasmark (1937) revised the family Paramphistomidae and split up the genus *Paramphistomum* into many genera. He proposed the genus *Gigantocotyle* for *P. bathycotyle* Fischöeder (1901), *P. explanatum* Creplin (1847), *P. gigantocotyle* Brandes (1896), *Gigantocotyle symmeri* Nasmark (1937), *P. formosanum* Fukui (1929), *G. duplicitestorum* Nasmark (1937), *P. anisocotylea* Faust (1920), *P. birniense* Railliet (1924), *P. siamense* Stiles and Goldberger (1910) and *P. fraternum* Stiles and Goldberger (1910).

Considering *P. bathycotyle*, he points out that its identity with *P. cervi* is absolutely erroneous because of differences in habitat and in the anatomical structures of the Pharynx (Oral sucker), the acetabulum and the genital atrium.

Ben Dawes (1946), in his book 'The Trematoda', has retained the genus *paramphistomum* and treated *P. bathycotyle* as synonym of *P. cervi*. From his book it appears that he does not recognise the scheme of classification put forth by Nasmark, 1937.

In view of the diversity of opinion about the validity of this species, its morphology is described here. My observations are based on the freshly collected material of which the whole mounts were prepared and serial sections were cut.

I have great pleasure in expressing my indebtedness to Prof. Dewan Anand Kumar, M.A. (Cantab.), Vice-Chancellor of the Panjab (I) University under whose guidance the work was carried out. I am also grateful to Dr. H. D. Srivastava, D.Sc., Helminthologist, Indian Veterinary Research

Institute, for his valuable suggestions in the preparation of this paper and to Dr. Vishwa Nath, Ph.D. (Cantab.), P.E.S. (I) for accepting it for publication in this bulletin.

Detailed life cycle by Jain (1978)



Shape and size: elongated, like a cone, 6-14.48 mm. in length and 4.48-4.84 mm. in maximum breadth. Cuticle: thin. Oral sucker: globular; ratio between its length and that of the body of the worm 1:12.6-1:12.7 in fully relaxed and 1:9.3-1:10.3 in unrelaxed specimens. Acetabulum: ratio between its diameter and the length of the body 1:3.2-1:3.6 in fully relaxed and 1:1.8-1:2.1 in unrelaxed specimens. Gut: oesophagus 0.68-0.80 mm. in length. Intestinal caeca almost straight (not spiral). Reproductive systems: testes in tandem, one behind the other. Ovary somewhat spherical situated behind the posterior testis. Vitellaria on the lateral sides extending from the level of the oral sucker to the acetabulum. Laurer's canal crosses the excretory vesicle, opening dorsally behind the excretory pore. Genital pore close to the oesophagus in front of intestinal bifurcation. Eggs: 0.12x0.08 mm.

The Morphology

Paramphistomum bathycotyle is found in the bile duct of Indian bovines. Live worm is of light brown colour, reddish at the extremities. It is elongated, conical in shape, and tapering postero-anteriorly to a blunt oral extremity. Fixed specimens may be straight (Plate I, fig. 1) or slightly bent dorso-ventrally. They measure 6-14.48 mm. in length and 4.48-4.84 mm. in maximum breadth. The dorso-ventral side in unflattened specimens measures 2.64-2.8 mm. across the testicular region and 3.6 mm. across the acetabular region. The body surface is generally smooth without any wrinkle or groove. The oral aperture is situated terminally at the anterior end and the genital aperture in the anterior one third on the ventral side of the body (Plate I, fig. 1). The oral sucker is globular in shape and measures 0.64-1.12x0.6-1 mm. The ratio between its length and that of the body is 1:12.6-1:12.7 in fully relaxed and 1:9.3-1:10.3 in unrelaxed specimens. The latter specimens were cut sagittally and transversely. The acetabulum is placed at the posterior end of the body and measures 4.0-4.6 mm. in diameter in relaxed and 3.32 mm. in dorso-ventral direction in unrelaxed specimens. The acetabular aperture is either sub-terminal or ventral in position. It measures 0.83-1.86x2.40-2.88 mm. The ratio between the diameter of the acetabulum and the length of the body is 1:3.2-1:3.6 in flattened specimens (Plate I, fig. 2) and ratio between the dorso-ventral diameter of the acetabulum and the length of the body in unflattened specimens is 1:1.8-1:2.1 (Plate I, fig. 4). Nasmark gives 1:2.22 the mean ratio for the genus, and this ratio is not applicable to the fully relaxed specimens. Even in unrelaxed specimens Nasmark himself shows that this character varies from 1:1.50-1:2.60. Such a variable character should not be retained for generic diagnosis.

The cuticle of the integument is very smooth and thin (Plate II, fig. 10). It is without any striation. The subcuticular region is, however, striated.

Near to the cuticle of its lumen there are bands of interior circular muscle fibres and then a wide layer of interior longitudinal muscle fibres. Oblique muscles interlacing the interior longitudinal muscles as in *P. (Caulothoris) crassum*, are absent in this species. At about an equal distance from the cuticle and the limiting membrane there is a row of bands of middle circular muscle fibres, the distal bands of which gradually approach the oral and aboral poles of the oral sucker. On the lateral sides, there are a few bands of anterior lateral circular and basal circular muscle fibres (Plate II, fig. 9). Just below the limiting membrane there are a few bands of exterior longitudinal muscle fibres. The radial muscles connecting the cuticle with the limiting membrane are feebly developed. The subcuticular cells are placed dorsal to the bands of middle circular muscles.

In the acetabulum (Plate II, fig. 12), underneath the cuticle there are prominent bands of circular muscles and on their dorsal side a few bands of longitudinal muscles. The bands of circular muscle fibres on the lateral sides have been counted. They are fifty-four on the dorsal exterior, forty-one on the dorsal interior, twenty-three on the ventral exterior and fifty-four on the ventral interior sides of the acetabulum. These bands were not counted by Nasmark, 1937, probably due to the badly fixed material he had at his disposal. The radial muscle fibres are present in bands alternating with the bands of the circular muscles. There are also present

Parampistomum bathycotyle (p.2) (over)

The mouth is in the centre of the oral sucker (Plate I, figs. 2 and 3). When the specimen is left unstretched or unrelaxed the oral sucker is retracted inside with the result the body surface forms a short anal in front of it. This anal in front of the mouth also forms two papillae like projections which are due to the inward growth of the body surface (Plate I, fig. 4). The oesophagus is a tubular structure measuring 0.68-0.80 mm. in length and 0.2 mm. in thickness. Behind the genital pore, the oesophagus bifurcates into two intestinal caeca, each of which then runs along the lateral wall of the body ending blindly in front of the acetabulum. Both the intestines and caeca 12-15 might show slight curvature during their course (fig. 5). They are not in a spiral as in *P. (C.) cerri*. The cells of the intestinal wall are grouped in such a way that they form comb-like structures projecting into the lumen (Plate I, fig. 7).

The excretory system is situated in the posterior region of the body dorsal to the testes extending backward up to the acetabular region. It is a bag-like structure dilated posteriorly and tapering anteriorly to form the excretory canal which opens in the mid-dorsal line in the testicular region (Plate I, fig. 4).

In genital system, the paired testes are placed antero-posteriorly in the middle region in between the two intestinal caeca. They are slightly lobulated (Plate I, fig. 2). The anterior testis measures 2.48-3.2 x 2.40-2.80 mm. and posterior testis 2.0-2.56 x 2.40-3.08 mm. in size. A vas deferens arises from the anterior side of each testis. The vas deferens is very prominent as compared to *P. (C.) cerri* and passes through a which the metraterm and opens into the ductus hermaphroditicus (Plate II, fig. 8).

The ovary is single and somewhat spherical lying behind the posterior testis. It measures 0.48-0.56 x 0.48-0.52 mm. The Laurer's canal runs on the left lateral side of the excretory vesicle and opens dorsally posterior to the excretory pore (Plate II, fig. 11). The Mehlis' gland-complex is globular in shape and measures 0.46 x 0.46 mm. (Plate I, fig. 7). The vitelline glands, on both sides, extend from the level of the base of the oral sucker (Plate I, figs. 5 and 6) or from the oesophagus to the acetabulum. They consist of distinct follicles overlapping one another and also the intestinal caeca at some places (Plate I, fig. 2). The two main vitelline ducts, one from each vitellaria open in the yolk reservoir (Plate II, fig. 11) which in its turn opens by a short duct into the ootype. The uterus emerges from the lateral side of the Mehlis' gland-complex and proceeds anteriorly along the left border of the posterior testis then changes its course and becomes dorsal to the anterior testis. Further it runs beneath the vas deferens and finally opens through a metraterm into the small and delicate chamber, the ductus hermaphroditicus (Plate I, fig. 4 and Plate II, fig. 8). It has a wide lumen containing a large number of eggs. The ductus hermaphroditicus opens out on the genital papilla which is strengthened by small sphincter muscle fibres. The eggs measure 0.12 x 0.08 mm. in size.

Name of the organ.	Measurements as given by Nasmark, 1937.	Measurements according to writer's observations.
Length of the worm ..	10.8 mm. (11-15 mm.)	6-14.48 mm.
Breadth ..	More than 2/5 of the length of the body.	4.48-4.84 mm.
Dorso-ventral dimension.	4.32 mm.	2.64-2.8 mm. across the posterior testicular region and 3.6 mm. across the acetabular region.
Ratio between the length of the oral sucker and the length of the body.	1 : 10.0 (1 : 12.2-1 : 15.0).	1 : 12.6-1 : 12.7 in fully relaxed and 1 : 9.3-1 : 10.3 in unrelaxed specimens.
Diameter of the acetabulum.	4.64 mm. (4.4-6 mm.).	4.0-4.6 mm. in relaxed and 3.32 mm. in dorso-ventral direction in unrelaxed specimens.
Ratio between the diameter of the acetabulum and the length of the body.	1 : 2.32 (1 : 2.5).	1 : 3.2-1 : 3.6 in flattened specimens 1 : 1.8-1 : 2.1 in unflattened specimens.
Oesophagus ..	1.0 mm. (1.0-1.05 mm.) in length.	0.68-0.80 mm. in length 0.2 mm. in thickness.
Testes ..	2.0 mm. (1.0-1.3 mm.) in length.	Anterior testis 2.48-3.2 x 2.40-2.80 mm. Posterior testis 2.0-2.56 x 2.40 x 3.08 mm.
	1.5 mm. (1.5-1.8 mm.) D.V. Direction	



REMARKS

From the morphology, it is quite evident that *P. bathycotyle* is not a synonym of *P. cerri* Zeder (1790) but a valid species. With regard to the acceptance of the new genus as proposed by Nasmark, 1937, there are certain objections. His system of classification,

Egg .. 0.12 x 0.08 mm.
.. 0.14 x 0.078 mm.



M. Giebel 1892

PARAMPHISTOMUM CERVİ (ZED.)

1, 2, 4 FROM BOS TAURUS

3 FROM CERVUS ELAPHUS

FROM: FISCHMEYER, 1903

Vers. v. G.

1. *Paramphistomum cervi* (Zeder, 1790)

(Рис. 1)

Хозяева: лось, изюбр, косуля, домашний северный олень, крупный рогатый скот, овцы.

Экстенсивность и интенсивность инвазии: 100%; в десятках тысяч экземпляров у диких животных и северного оленя; у домашних животных в сотнях, реже в тысячах экз.

Молодые трематоды в большом количестве (182—1500 экз.) регистрировались в печени, легких, в тонком отделе кишечника, в брюшной полости у всех вскрытых лосей, изюбров и косуль при одновременном наличии взрослых паразитов в рубце. У домашних животных молодые паразиты в этих органах обнаруживались редко и в единичных экземплярах.

Следует отметить весьма широкую вариабильность *P. cervi* по размерам, расположению органов, форме семенников. Возможно, что есть несколько подвидов этого вида или сильно выраженная возрастная изменчивость. Паразиты при жизни имеют розовато-красную окраску.

FROM KADENATZ II (1963)

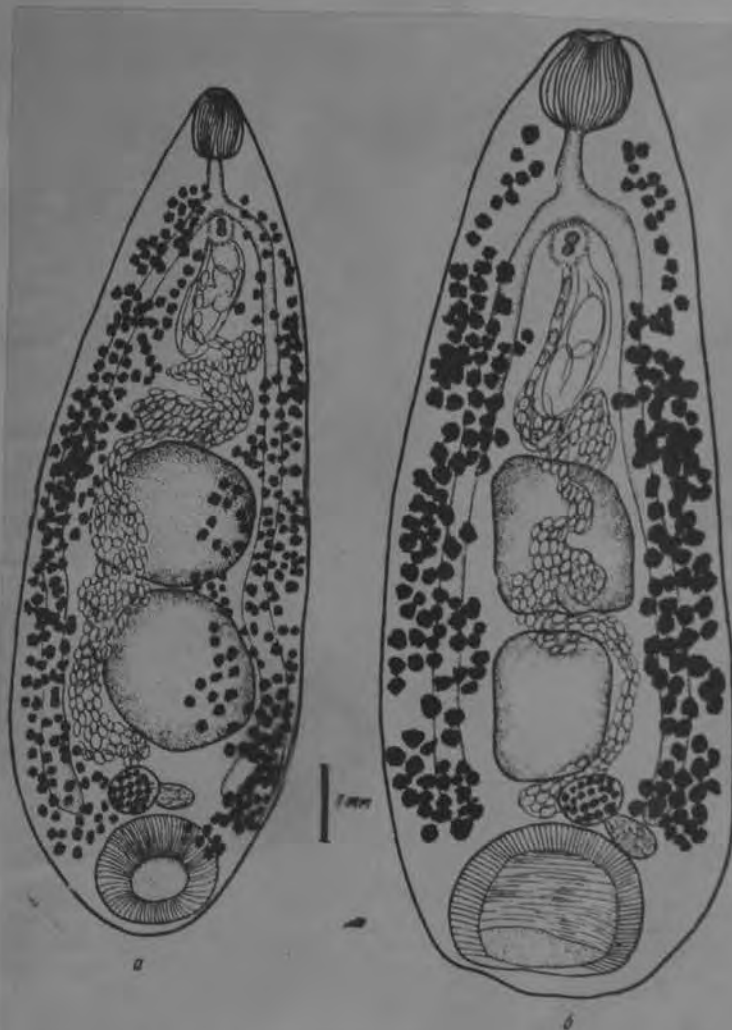


Рис. 1. *Paramphistomum cervi*. Вентрально
а — от крупного рогатого скота; б — от лося

Paramphistomum cervi (Zeder, 1790) Fischöder, 1901.

Syn : *P. papilligerum* Stiles & Goldberger, 1910.

P. indicum Stiles & Goldberger, 1910.

Specific diagnosis : Body conical in shape, measures 6-12 x 2-4 mm. Dorsal line evenly curved. Acetabulum ventroterminal or subterminal, measures 2.0

mm. (1-2.5 mm.) in diameter, in relation to length of body 1:4.4 (1:4.8-6.0). Papillae surrounding mouth may be present or absent. Pharynx 0.84 mm. (0.8-1.2 mm.) in length, in relation to length of body 1:10.5 (1:7.5-10.0). Oesophagus 0.77 mm. (0.8-1.2 mm.) long, without posterior bulb. Intestinal caeca reaching to acetabular zone. Genital pore just below intestinal bifurcation. Testes lobed somewhat obliquely tandem, measuring about 1.6 mm. (1.0-2.0 mm.) in length. Ovary posttesticular. Vitelline glands extending from intestinal fork to hinder border of acetabulum. Eggs measure 0.148 x 0.077 mm. (0.145-0.156 x 0.075-0.082 mm.).

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Host : Sheep, Goat, Cattle.

Location : Rumen and Bile duct.

Distribution : Widely distributed.



Paramphistomum cervi (Zeder, 1790)
Fischöder, 1901. (After Stunkard, 1929)

Paramphistomum clavula NASMARK, 1937. — Synonym: *Paramphistomum cervi* (SCHRANK) of STUNKARD, 1929, in part (fig. 26-27).

Host: *Adenota vardoni* LIVINGST.; «puku kob» antelope (Coll. nos 32.365, 32.971/84 and 32.390), new host record.

Discussion: This species was named by NASMARK for some of LOOSS's specimens from Sudan cattle and antelopes. Hosts include six kinds of antelope. STUNKARD's «*P. cervi*» were from *Adenota cob alurac*, *Cobus*



Fig. 26. — *Paramphistomum clavula* NASMARK, 1937, from *Adenota vardoni*; sagittal section through region of genital atrium showing absence of genital papilla. — 27. *P. clavula*; sagittal section through region of genital atrium showing presence of genital papilla.

depressa, and *Redunca «bohor»* in the Congo. Looss had labeled his specimens «*P. clavula*» but never published the name himself.

Our specimens are evidently *Paramphistomum*, but we are somewhat uncertain if the species is *P. clavula*. In some respects our material is more like *P. microbothrium*, particularly in body proportions as given by NASMARK. Perhaps two or more species are represented in the Congo collection. *Cotylophoron okapi* also occurred in the same host. Most of the specimens measured are more elongate than *P. clavula*, but long specimens were selected to avoid *C. okapi*. Measurements of four specimens are: length 9 to 11; width 2.75 to 5; acetabulum 2.33 to 2.47 in diameter, ratio to body length 1: 4.3 to 4.5; oral sucker length 0.95 to 1.045, ratio to body length 1: 9.5 to 10.8; oesophagus length 0.76, ratio to body length 1: 12 to 14.4; eggs 0.122 to 0.166 long by 0.064 to 0.068 wide. A contracted specimen, however, was 7.5 by 4.46 with acetabulum to body length ratio of 1: 3.07 and a very short oesophagus.

Of five specimens sectioned, four showed a *clavula*-type genital atrium (fig. 26) without trace of a genital papilla but with the outer sphincter muscles only moderately developed. The other specimen (fig. 27) showed a genital papilla with terminal male opening and a separate metraterm opening on the posterior side of the papilla. This condition differs from that in *P. microbothrium* in that the sex ducts do not unite to form a hermaphroditic duct. NASMARK found no papilla in ten sectioned specimens of *P. clavula*.

LENGY (1960) has recently studied *P. microbothrium* in Israel. He considered the American *P. microbothrioides* PRICE and MCINTOSH, 1944, to be a synonym. His specimens were less elongate than NASMARK's.

From MANTER AND PRITCHARD (1964)

2. *Paramphistomum explanatum* (Creplin) Fischæder.

(Fig. 15.)

Décrite pour la première fois par Creplin (1849), cette forme dont l'hôte-type est *Bos indicus* (dans les canaux biliaires et l'estomac), a été trouvée également chez *Ovis aries* (dans l'estomac) par T. Fukui et recueillie récemment dans l'estomac de *Hippotragus equinus* par M. le Dr A. Monard. *Angola*

Les exemplaires de la collection de la Mission scientifique suisse en Angola mesurent 8^{mm},5 à 9^{mm},5 de longueur et 4^{mm},5 de largeur. L'acetabulum, le plus souvent ovale (grand axe transversal, maximum observé 3^{mm},3 ; petit axe longitudinal, minimum observé 2^{mm},3) a un diamètre moyen de 2^{mm},7 à 3^{mm},1. Pour les exemplaires étudiés, le rapport du diamètre de l'acetabulum à la longueur du ver s'est trouvé constant et égal à 1 : 3,15. Maplestone (1923, p. 134) indique comme valeurs limites de ce rapport 1 : 1,9 et 1 : 3,6, ce qui donne comme moyenne 1 : 2,5. Le rapport calculé d'après les données de la description de Fischæder (1904) est de 1 : 2,4.

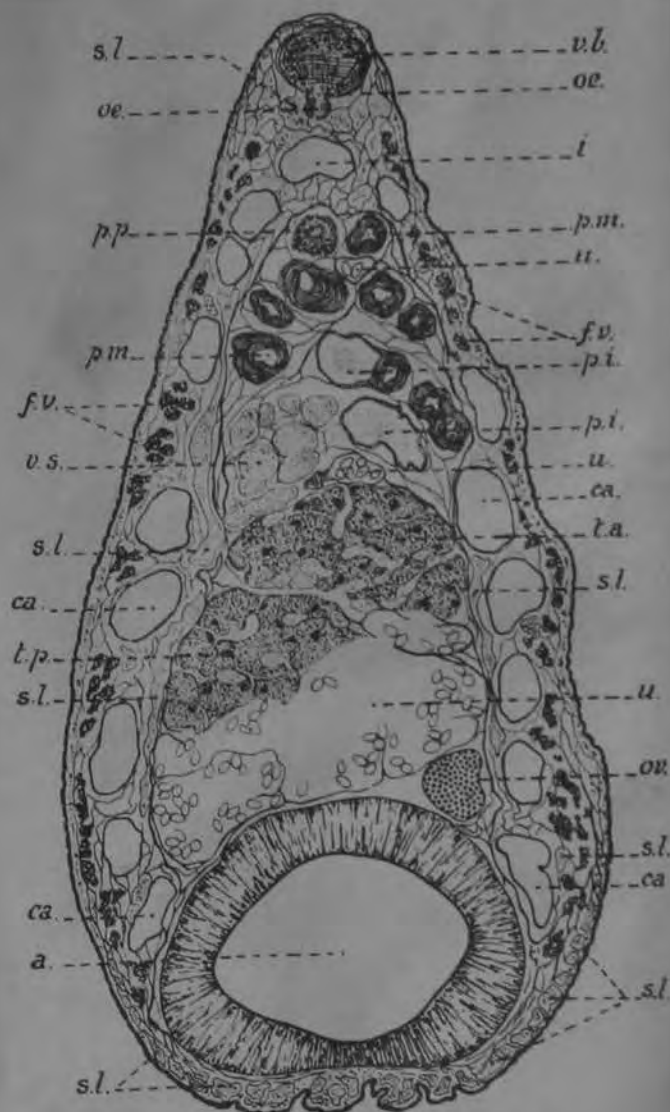


Fig. 15. *Paramphistomum explanatum* (Creplin) Fischæder.
Coupe horizontale.

La ventouse buccale, ovoïde, mesure $0^{mm},9$ à $1^{mm},0$ ($0^{mm},78$ à $0^{mm},81$). L'œsophage est très court; le diamètre des caeca varie de 270 à 480μ . La situation des deux testicules contigus, disposés l'un derrière l'autre, suivant un axe oblique, et leur forme lobée et massive constituent deux caractères spécifiques importants. Cette masse testiculaire a un diamètre transversal de 3 mm . L'examen des figures de Fischøder et de Maplestone révèle la variabilité topographique de ces organes suivant l'état de contraction ou d'extension de l'animal. Tandis que ces auteurs les représentent rapprochés de la surface ventrale (Fischøder) ou de la surface dorsale (Maplestone), mais toujours situés immédiatement au devant ou au voisinage de l'acetabulum, nous les avons observés exactement au milieu de la longueur du corps et séparés de la ventouse postérieure par l'utérus dilaté et bourré d'œufs. Ainsi donc, comme le remarque Maplestone, leur position est variable, mais la relation des deux organes ne l'est pas.

Le vas deferens occupe tout l'espace limité de chaque côté par les caeca et compris entre la masse testiculaire et la bifurcation de l'œsophage. A la vésicule séminale, latérale et pelotonnée, fait suite la pars intermedia dont les fibres musculaires sont encore peu développées, puis vient la pars muscosa proprement dite (diamètre $270-360 \mu$) caractérisée par le développement considérable de ses fibres circulaires (épaisseur de la musculature $90-100 \mu$) et la pars prostatica (diamètre $400-450 \mu$).

L'ovaire, massif, se trouve du même côté que le testicule antérieur et au niveau du bord antérieur de l'acetabulum, son diamètre varie de $600-690 \mu$.

Les œufs mesurent $115-135/67-80 \mu$ (Fischøder: $115-125/65-75 \mu$).

Les follicules vitellogènes forment de petits amas externes par rapport aux caeca et que l'on observe de l'acetabulum à la bifurcation de l'œsophage.

FROM DUBOIS, 1930

The elongated and conical flukes had a well developed oral sucker and a large acetabulum of postero-ventral position. Specimens measured 8 mm . in length and 3.8 mm . in maximum width. The oral sucker was 0.55 mm . in diameter and the acetabulum 3.4 mm . in diameter, the acetabular index was $1:6.5$ and the ratio with body length was $1:2.3$. The highly muscular acetabulum, with an oval to round opening, is composed of a less developed dorsal external layer constituting 26 units and a relatively more developed dorsal-internal of 34 units, while ventral interior was made up of 52 units. The radial musculature appeared evenly developed. An oesophageal bulb was absent, intestinal caeca extend upto the acetabulum. The mid-ventral genital pore leads into a shallow genital atrium/sinus which has a papillated character round the orifice. The pars prostatica was distinct but pars muscosa was absent. The follicular vitellaria extend along the lateral fields. The Laurer's canal crosses the excretory bladder which was entirely postero-dorsal in position.

In the immature forms, cut in sections, genitalia had not developed and these were in the jejunal and duodenal regions in inter-grading sizes and stages. In view of the musculature pattern of the acetabulum and the acetabular index which, however, was $1:4-5.1$. All these forms undoubtedly belong to this species. The above measurements and brief descriptions were in complete agreement with the account given by Singh (1958).

FROM PATNAIK (1964)

Loc. INDIA

Host: BUFFALO CALVES
UNDER 2 1/2 YRS. OLD.

Gigantocotyle explanatum (Creplin, 1847) Näsmark, 1937.

Syn : *Amphistomum explanatum* Creplin, 1847.

Paramphistomum explanatum Fischöder, 1904.

P. siamense Stiles & Goldberger, 1910.

P. fraternum Stiles & Goldberger, 1910.

P. birmense Railliet, 1924.

G. bathycotyle (Fischöder, 1904) Näsmark, 1937.

Specific diagnosis : Body conical in shape, measuring 8—16 x 5—7 mm. Large acetabulum with oval or elliptical opening, measuring 3.68-4.6 mm. in diameter. Oral sucker 0.95-1.04 mm. in length. Oesophagus 0.53-0.81 mm. long. Caeca wavy terminate to anterior margin of acetabulum. Testes slightly lobed, diagonally tandem, measuring about 1.2-1.5 mm. in length. Ovary situated posterior to posterior testis. Vitelline follicles small to large in size, extending from oesophageal bifurcation to anterior margin of acetabulum. Genital pore either at level of bifurcations of intestine or slightly below it. Eggs measure 0.123-0.149 x 0.073-0.084 mm.

Host : Cattle, Buffalo and Goat.

Location : Bile duct.

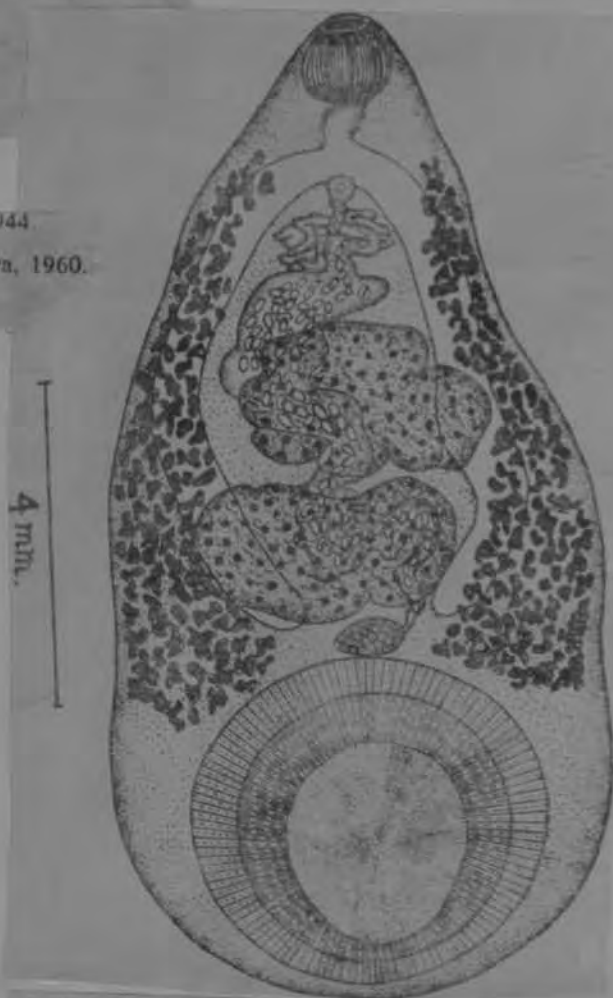
Distribution : Widely distributed.

FROM: MUKERJEE & CHHAUHAN 1965

Intermediate snail host :—*Indoplanorbis exustus*. Srivastava, 1944.

Gyraulus convexiusculus. Singh, 1958, Mukherjee and Srivastava, 1960.

Type of cercaria :—Pigmentata.



Gigantocotyle explanatum (Creplin, 1847)

Näsmark, 1937. (After Mukherjee, 1960).

Paramphistomum gotoi Fukui, 1922.

Specific diagnosis : Body elongate, club-shaped, measuring 9-13 x 3.3-3.7 mm.
Oral sucker oval, pot shaped, measuring 1.0-1.4 x 0.8-1.0 mm., lined anteriorly
with numerous columns up to 60 μ long by 20 μ broad, consisting of a number of
closely bundled tubules, each of which tipped with a very minute spine. Oesophagus

1965

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phagus 0.7-2.0 mm. long, with a fairly inconsiderable thickening of oesophageal musculature at inner part. Caeca undulating. Acetabulum 1.8-2.05 mm. in diameter. Testes irregularly and deeply lobed, tandem in position, situated in median field at middle third of body, measuring 0.75-1.25 x 0.45-0.65 mm. Ovary round measuring 0.42-0.65 x 0.47-0.65 mm., situated immediate behind posterior testis. Vitelline follicles extending in lateral peripheral fields from a little in front of genital pore to anterior part of acetabulum, leaving median field free. Eggs elliptical, thick-shelled, measuring 120-150 x 60-75 μ in whole mounts.

Host : *Bos bubalis*.

Location : Stomach.

Distribution : U.P.



Paramphistomum gotoi Fukui, 1922.

(After Yamaguti, 1959)

Paramphistomum microbothrium FISCHÖDER, 1901. ^{From Prudhoe, 1957}

(Fig. 7, a-c.)

Synonyms: *Paramphistomum cervi* (ZEDER, 1790) of MAPLESTONE, 1923 (in part); *Paramphistomum cervi* (SCHRANK, 1790) of STUNKARD, 1929; *Paramphistomum clavula* LOOSS, in NÄSMARK, 1936.

Hosts and localities:

Adenota vardoni. Mabwe, 585 m, 12.VIII.1947 (208 c); 28.VIII.1947 (226 c); 18.VIII.1947 (235 c).

Bubalus caffer. Mabwe, 585 m, 29.X.1948 (1714 c).

Hippotragus equinus. [Kafwe, 1,780-1,830 m, 18.IV.1947 (61 c, 63 c, 64 c)]; [riv. Kafwe (329 c)]; riv. Muve (330 c).

Kobus defassa crawshayi. Kaswabilenga, 680 m, 14.X.1947 (280 c).

Ourebia ourebi. Buye-Bala, 1,750 m, 26.III.1948 (678 c); Kalumengongo, 1,780-1,830 m, 16.I.1948.

Taurotragus oryx. Piste Mubale, 1,480-1,780 m, 21.XI.1947 (331 c).

Paramphistomum microbothrium appears to have been confused with *P. cervi* by MAPLESTONE (1923) and several subsequent writers. NÄSMARK (1936), however, has pointed out that the genital atrium in *P. microbothrium* possesses a sphincter, which is absent in *P. cervi*. Otherwise, the two forms bear a very close superficial resemblance to each other.

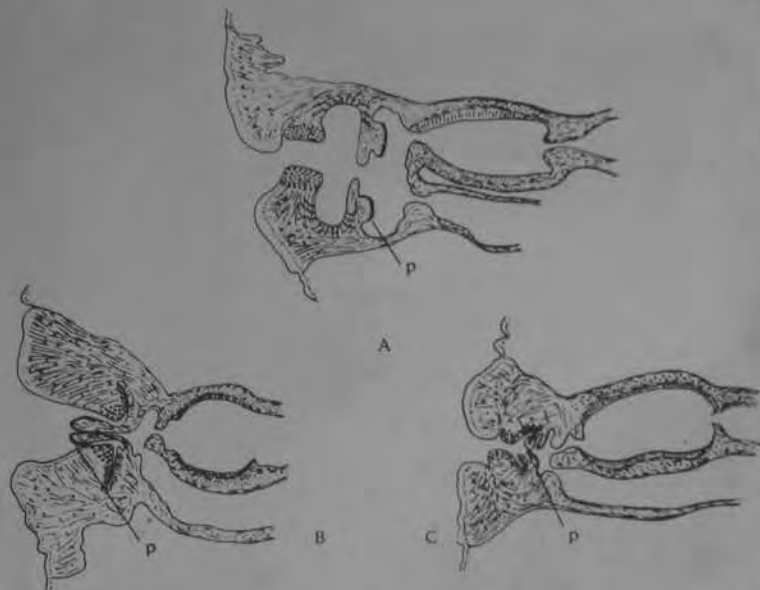


FIG. 7. — *Paramphistomum microbothrium* FISCHÖDER.

Copulatory apparatus (semi-diagrammatic).

A, * resting * condition of penis-papilla (p) (= * Clavula-type * of NÄSMARK); B, showing early activity of penis-papilla (p); C, active condition of penis-papilla (p) (= * Microbothrium-type * of NÄSMARK).



From FISCHÖDER, 1903
Host: *ANTILOPA DORCAS*

From an examination of numerous serial sections of the present material it has been possible to trace the mechanism of the copulatory apparatus in this species. The genital atrium is divided into a ventral and a dorsal chamber by a partition of tissue, in the centre of which lies an opening communicating one chamber with the other. Attached to the inner wall of the partition there is a ring of tissue heavily invested with a cuticular material [fig. 7 A (p)]. This ring of cuticularized tissue is able to transform itself into an elongate structure, capable of extending through the communicating aperture into the ventral chamber of the genital atrium (fig. 7 B). In the latter condition the cuticularized tissue shows the early formation of a penis-papilla. As this papilla extends to pass the sphincter, the dividing

partition of the atrium becomes the basal part of a genuine penis-papilla, which is cuticularized in its apical region. In the formation of a penis-papilla the present material shows all the graduations between the condition shown in figure 7 A and that shown in figure 7 C.

The relation here shown between the partitional wall in the genital atrium and a genuine penis-papilla invalidates NÄSMARK's conclusion on the distinctiveness of the "Clavula-type" (see fig. 7 A) and the "Microbothrium-type" (see fig. 7 C) of genital atria in the *Paramphistomatidae*. It now seems that the latter type is merely an active or functional condition of the former and that *Paramphistomum clavula* LOOSS, in NÄSMARK, 1936, is a synonym of *Paramphistomum microbothrium* FISCHÖDER, 1901.

A feature of *P. microbothrium* noticed in all of the numerous specimens examined in the present collection is the spaciousness of the lumen of the pars prostatica, which is well separated from that of the pars muscosa by a deep fold in the epithelial wall of the ejaculatory duct. This feature of the pars prostatica is well depicted by FISCHÖDER (1903, fig. 22) and provides a very practical means for identifying *P. microbothrium* from specimens bisected through the median sagittal plane and stained with a carmine stain.

By and large, the present material agrees in all respects with the adequate descriptions of *P. microbothrium* given by FISCHÖDER (1903) and by STUNKARD (1929) — the latter describing the form under the name of *Paramphistomum cervi* (SCHRANK, 1790).

Dinnik, 1954

Paramphistomum sukari n.sp.

Morphology of the species. The conical-shaped body of mature specimens from 6 to 10 mm. long and from 1.6 to 2.5 mm. wide, if measured dorsally at the level of the testes (Fig. 1).

The acetabulum is from 1.3 to 1.6 mm. in diameter. The ratio of the diameter of the acetabulum to the body length varies from 1:4 to 1:6. The dorsal and ventral halves of the external circular acetabulum musculature, as seen in median sections, are identical, and both are separated from the internal acetabulum by an obliquely running muscle band, although this band is not strongly developed. The radial muscle fibres of the acetabulum are moderately coarse and numerous. Table 1 shows the number of units in various circular muscle series of fifteen specimens of *P. sukari*: Host: cattle
Locality: Kenya

Table 1. The number of units in circular muscle series of *Paramphistomum sukari* n.sp.

Muscle series	Number of units														
	15	13	12	13	15	16	15	14	15	14	15	13	15	15	15
Dorsal exterior	15	13	12	13	15	16	15	14	15	14	15	13	15	15	15
Dorsal interior	36	31	31	34	33	32	31	35	33	34	31	32	34	34	34
Ventral interior	38	31	32	29	34	33	37	36	35	30	32	40	35	35	35
Ventral exterior	14	13	14	13	15	14	14	14	11	13	14	13	15	15	15

The pharynx is of the *Paramphistomum* type. The internal circular muscle layer consists of small closely packed units. The internal longitudinal layer occupies about one-third of the thickness of the pharynx and is indistinctly delimited externally. The external longitudinal layer is strong, narrow, and sharply limited internally. The external circular layer is well developed only in the posterior half of the pharynx, where its units consist of several somewhat separated muscle fibres. The radial layer consists of bundles of fibres running between the units of the external circular layer. The basal circular layer is composed of strong muscle units lying in two rows. The middle circular layer of muscle, posterior pharyngeal sphincter, and lip sphincter are lacking.

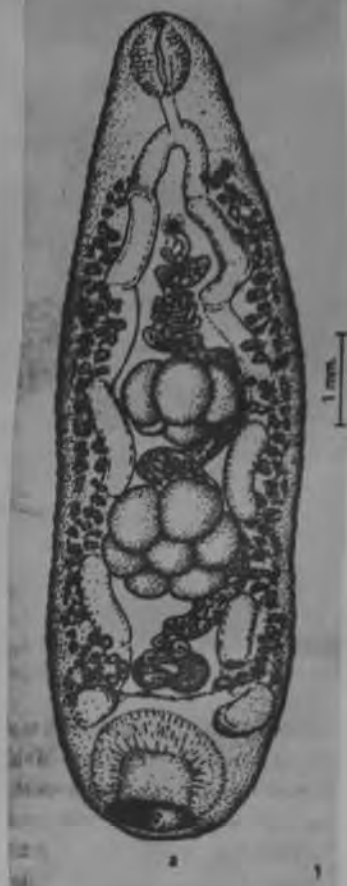
The pharynx is from 0.55 to 0.80 mm. long, which gives a ratio of from 1:10.42 to 1:12.5 in relation to the length of the body and from 1:2.0 to 1:2.7 in relation to the external diameter of the acetabulum.

The esophagus is from 0.55 to 0.70 mm. long and it is more or less curved ventrally towards its junction with the gut caeca. Each gut caecum has three main branches, the degree of which depends upon the state of contraction of the pharynx. Anterior to the acetabulum the terminal parts of the caeca turn towards the ventral surface and their blind ends are directed ventrally.

An excretory bladder lies dorsal to the acetabulum and extends anteriorly to the level of the posterior border of the hinder testis. A short duct runs from the bladder to the excretory pore, which opens in the mid-line of the body at about the level of posterior border of the hinder testis.

The testes are situated one behind the other. Both are lobed deeply, each having from five to eight lobes. In sagittal sections the testes appear as elongated dorso-ventrally and both are of approximately equal size, measured from 1.2 to 2.0 mm. dorso-ventrally and from 0.6 to 1.3 mm. antero-posteriorly.

The ovary is oval or spherical and lies between the posterior testis and the acetabulum, slightly ventral to the middle of the body (Fig. 2). Mehlis' gland lies close to the ovary, on the left or right side and usually slightly posterior to it. The gland is compact and more or less spherical. Measurements of the ovary are from 0.27 × 0.46 mm. to 0.56 × 0.73 mm. and those of Mehlis' gland from 0.25 × 0.35 mm. to 0.45 × 0.62 mm. A short oviduct connects the ovary with Mehlis' gland and outside this gland it is joined by Laurer's canal which runs dorsally from this point, crosses the excretory bladder and opens posterior to the excretory pore. The opening is located 0.25–0.65 mm. behind the excretory pore and somewhat to the side (Fig. 3).



Clusters of vitelline gland extend from the level of the junction of the gut caecum to the acetabulum.

The genital pore is situated 0.4–1.0 mm. posterior to the level of the gut junction and lies 1.3 mm. from the anterior end of the fluke.

The genital atrium is provided with a genital sphincter and sphincter papilla.

4) The genital sphincter is strongly developed and clearly delimited from the surrounding tissue. The radial musculature of the genital atrium is also well developed and its fibres are evenly curved. In most specimens examined the papilla was found partially or entirely extended, but in some specimens it was greatly retracted. The sphincter papillae is fairly strong and appears as a large area at the base of the papilla. Outside the wall of the genital atrium is a small ventral sucker which is invisible when the genital atrium is protruded (Fig. 5).

The pars prostatica is 0.3–0.4 mm. long. The pars muscosa is very long and strongly coiled. The width of the proximal part of the pars muscosa is from 0.2–0.3 mm. The closely coiled vesicula seminalis is situated posterior to the pars muscosa.

Eggs are 0.137–0.165 mm. × 0.071–0.092 mm.

Geographical distribution. Kenya, East Africa. The species has been found in the vicinity of Nairobi, Nanyuki, Nakuru, and in cattle from the Masai

Des. Lourus.

Des. Reticulum.

Maplestone (1937), who had ample sectioned material to study, came to the conclusion that the structure of the acetabulum, pharynx, and genital atrium may be used in the systematic study of paramphistomes. Using these criteria he has

confirmed the validity of many species which Maplestone (1923) regarded as synonyms of *P. cervi* (Zeder), described some new species and subdivided the genus *Paramphistomum* Fischöder, 1901 into eight genera.

Although in the acetabulum of the new species the dorsal and ventral halves of the external circular musculature are identical, the species cannot be placed in the genus *Calicophoron* Näsmark, 1937, since the distinctive features of the latter all include the genital atrium (which is of peculiar type) and the long and strongly developed pars prostatica.

The new species in its appearance and internal anatomy resembles *Paramphistomum microbothrium* Fischöder, 1901, and *P. clavula* Näsmark, 1937, more closely than any species of the other genera established by Näsmark (1937). The body is conical, the diameter of the acetabulum in relation to the length of the body varies between the values 1:4 and 1:6 (the corresponding value for *Calicophoron* are from 1:3 to 1:3.4), Laurer's canal crosses the excretory canal and its pore is located behind the excretory pore. The testes are lobed and lie directly one behind the other. Like the two *Paramphistomum* species mentioned, the new species has a genital atrium of modified *Microbothrium* type and the long and strongly developed pars muscosa, while the pars prostatica is short.



The original genus *Paramphistomum* retains a group of species which were included in the new genera created by Näsmark (1937). The characteristics common to these species, as given by Näsmark, are that they all have a body of oval shape, that their acetabulum which is of *Paramphistomum* type is posteriorly, and that their excretory canal crosses Laurer's canal and opens in front of its pore. According to this definition the new species should not be placed in the genus *Paramphistomum* since its acetabulum lacks the second part of the dorsal external circular muscle units which is characteristic of the *Paramphistomum* type. However, the genus *Paramphistomum* Fischöder, 1901, still contains morphologically two groups of species such as (1) *P. cervi* (Zeder), *P. granulosum* Fisch., and *P. liorchis* Fisch., which have a very short pars musculoa and a genital atrium without a genital sphincter; and (2) *P. microbothrium* Fisch. and *P. clavula* Näsmark, which possess a long strongly developed and coiled pars musculoa and a genital atrium with strongly developed genital sphincter. It is apparent that the new species belongs to the same group as *P. microbothrium* and *P. clavula*, and consequently it has to be placed in the genus *Paramphistomum*.

P. sukari n.sp. is easily distinguished from both *P. microbothrium* Fisch. and *P. clavula* Näsmark by its testes, which have only from five to eight lobes each and by the structure of the acetabulum, in which the second part of the dorsal external circular layer of muscle units is lacking.



Figs. 4, 5. *Paramphistomum sukari* n.sp.; genital atrium.

LOOSE LEAF ORGANIZER

SCHEDULE

PERIOD OR TIME								
COURSE MON. INSTRUCTOR								
COURSE TUE. INSTRUCTOR								
COURSE WED. INSTRUCTOR								
COURSE THU. INSTRUCTOR								
COURSE FRI. INSTRUCTOR *								
COURSE SAT. INSTRUCTOR								

NAME _____

ADDRESS _____

SCHOOL _____

TELEPHONE _____

• *Pfenderius* Stiles et Goldberger, 1910
Syn. *Tagumaea* Fukui, 1926

Generic diagnosis. — Paramphistomidae, Cladorchiinae, Cladorchiini:
Body conical to pyriform. Acetabulum terminal or subterminal, relatively large, with prominent margins; its shallow wide cavity provided with prominent papillae. Oral sucker with anterior sphincter and paired posterior evaginations. Esophagus without bulb. Ceca long, wavy, terminating in middle third of body. Cirrus pouch present. No genital sucker. Ovary posttesticular, anterior to excretory vesicle. Laurer's canal opening anterior to excretory pore. Uterus forming dorsoventral coils. Vitellaria extending along ceca from intestinal bifurcation to cecal ends, with sparsely scattered follicles. Excretory vesicle dorsal to acetabulum, pore in acetabular zone. Intestinal parasites of elephants.

Genotype: *P. papillatus* (Cobbold, 1882) Stiles et Goldberger, 1910 (Pl. 95, Fig. 1152), in *Elephas indicus*; India.

Other species: ' "

P. birmanicus Bhalerao, 1935, in elephant; Burma.

P. heterocaeca (Fukui, 1926) Bhalerao, 1935, syn. *Tagumaea* h. F., in *Elephas maximus*; India; Andaman Island. (Fukui's description is undoubtedly based on contracted material).

Genus : *Plenderius* Stiles and Goldberger, 1910.

Syn : *Tagumaea* Fukui, 1926.

Generic diagnosis : Body conical to pyriform. Acetabulum terminal or subterminal, relatively large, with prominent margins, cavity may be provided with papillae. Oral sucker with paired posterior evaginations. Oesophageal bulb absent.

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1965
Caeca long wavy, terminating in middle third of body. Cirrus pouch present. Genital sucker absent. Ovary posttesticular. Vitellaria extending along caeca from intestinal bifurcation to caecal ends, with sparsely scattered follicles.

Type species : *P. papillatus* (Cobbold, 1882) Stiles & Goldberger, 1910.

Key to species. of mammals — India

1. Acetabulum papillated. Caeca not divided into two parts. *P. papillatus*.

Acetabulum not papillated. Caeca divided into two parts anterior broad and posterior short portion or diverticulated internally. 2.

2. Caeca divided into anterior broad and posterior short portion *P. heterocaeca*.

Caeca diverticulated internally. *P. birmanicus*.

Pfenderius papillatus
(Cobbold, 1882) Stiles &
Goldgerger, 1910



Pfenderius papillatus (Cobbold, 1882) Stiles and Goldberger, 1910.

Syn : *Amphistoma papillatum* Cobbold, 1882.

Specific diagnosis : Body pearl tint or opaque olive green in colour, conical in shape, measuring 4.5-5.5 x 2.5-2.75 mm. Acetabulum terminal with projecting margin about 1.7 mm. in transverse diameter, aperture directed slightly ventrad, surface with prominent papillae. Mouth terminal at bluntly pointed cephalic extremity, with small papillae. Oral sucker with two lateral pouches. Oesophagus markedly curved dorsal. Caeca wavy reaching anterior border of acetabulum and then turning slightly forwards. Testes equatorial, fields separate, zones nearly coinciding, irregularly globular, measure 0.4 mm. Cirrus sac pyriform, measuring 0.44 x 0.32-0.34 mm. Ovary at 1/3 of body length from anterior end, posttesticular, intercaecal, preacetabular, nearly median. Vitellaria with sparsely scattered small follicles, external ventral, to some extent dorsal of caeca, extend in caecal zone from point of bifurcation to end of caeca. Genital pore in oesophageal zone, about 1/3 of body length from oral margin. Eggs measure 0.15 x 0.07 mm.

Text fig. 28. *Pfenderius papillatus* (Cobbold, 1882) Stiles & Goldberger 1910. (After Stiles and Goldberger, 1910)

JOURNAL ZOOLOGICAL SOCIETY OF INDIA, 17 (1 & 2), 1965

FROM : MUKHERJEE
ACHAUHAN 1965

Host : Elephant.

Location : Colon.

Distribution : Andamans.

Pfenderius birmanicus Bhalerao, 1935.

Specific diagnosis : Body oval in shape, measuring 2.3 x 2.12 mm., with anterior end attenuated, posterior hemispherical. Mouth subterminal, surrounded by papillae. Acetabulum strongly muscular, subterminal, measures 0.92-1.02 mm. in diameter. Oral sucker measures 0.39 x 0.465 mm., provided with well developed diverticula, one on each postero-lateral side, diverticula measure 0.2 x 2.4 mm. Oesophagus short, enlarges posteriorly into a large bulb. Oesophageal bulb measures 0.52 x 0.38 mm., surrounded by thick glands. Caeca commence at lateral aspects of oesophageal bulb, pass along posterolateral sides of body terminate laterally to acetabulum. Caeca diverticulated internally, diverticula being either simple or divided. Genital pore situated centrally at a distance of 0.48 mm. from anterior extremity. Testes situated anterolateral to acetabulum, lobed, measuring 0.28-0.33 x 0.31-0.46 mm. Cirrus sac spindleshaped, muscular, measures 0.5 x 0.3 mm. Ovary oval, situated centrally, immediately in front of acetabulum, measuring 0.25 x 0.2 mm. Vitelline follicles extend laterally to intestinal caeca and acetabulum. Eggs elliptical in shape, measure 0.158-0.168 x 0.09-0.098 mm.

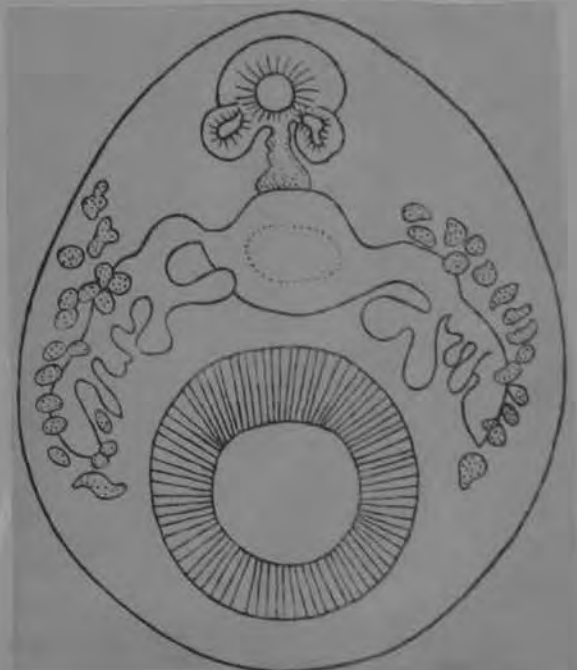
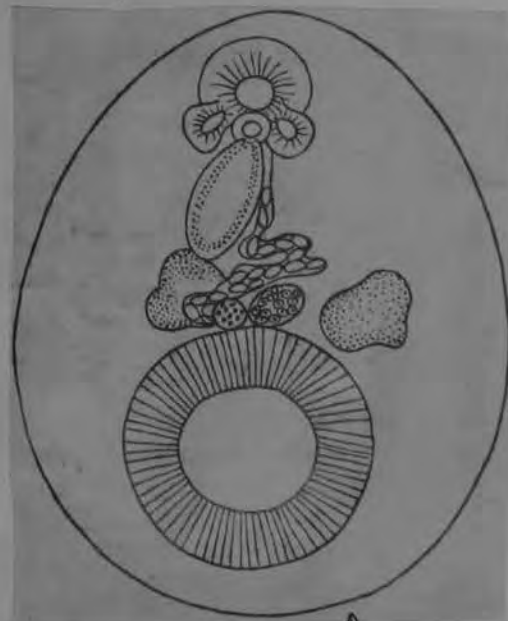
Host : Elephant.

Location : Intestine.

Distribution : Burma (Toungoo).

Bhalerao, 1935 stated that *P. birmanicus* in regard to the character of the intestinal caeca (diverticulated internally) differed from the genera *Pfenderius* and *Tagumaea* but it has some characters in common with both the species, i.e. *P. papillatus* and *T. heterocaeca*. He proposed the abolition of the genus *Tagumaea* and was of the opinion that it should be merged with *Pfenderius*.

FROM: MUKERJEE & CHAUHAN 1965



Text-fig. 29. *Pfenderius birmanicus* Bhalerao, 1935 (After Bhalerao, 1935)

Pfenderius heterocaeca (Fukui, 1926) Yamaguti, 1958.

Syn : *Tagumaea heterocaeca* Fukui, 1926.

Specific diagnosis : Body white in colour, measuring 3.13-4.8 x 2.5-3 mm., 1.8-2.4 mm. in thickness. Anterior end of oval body attenuated posterior hemispherical, anterior end with many prominent papillae. Mouth opening lies at bottom of papillated anterior portion, cavity surrounded by well developed oral sucker measuring 0.61-0.78 x 0.48-0.50 mm. Oral diverticula present. A sphincter present near anterior end of oral sucker. Oesophagus 1.53 mm. in length, provided with an oesophageal bulb at its posterior end, measuring 0.68-0.90 x 0.52-0.60 mm. Caeca terminate on either side of acetabulum, caeca short, stout, divided into a much swollen anterior and a slender posterior portions. Two large bi- or tri-lobed testes lie slightly in front of acetabulum, measure 0.425-0.51 x 0.33-0.425 mm. Cirrus sac clubshaped, measuring 0.62-0.82 x 0.7-0.33 mm. Genital papilla not prominent. Ovary oval, measures 0.23-0.33 x 0.2-0.3 mm., lying close behind left testis. Genital pore situated at a distance of 0.7-1.09 mm. from anterior extremity. Eggs measure 0.132-0.143 x 0.076-0.081 mm.

1965

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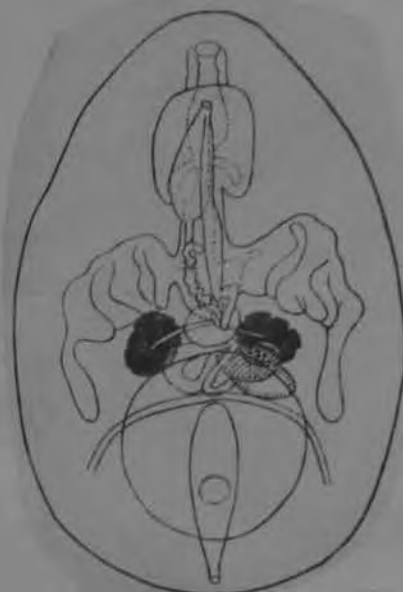
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Host : Elephant.

Location : Intestine.

Distribution : Andamans, Burma (Toungoo).

Fukui, 1926 recorded this parasite from an Indian elephant died in Japan. Bhalerao, 1935 reported it from elephant in Andamans.



Pfenderius heterocaeca (Fukui, 1926)
Bhalerao, 1935. (After Fukui, 1926)

PFEENDERIUS

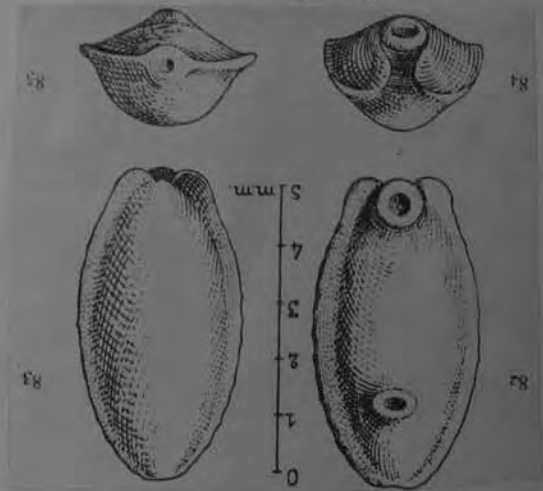
Platyamphistoma n. g. YAMAGUTI, 1958

Generic diagnosis. — Paramphistominae, Ceylonocotylini: Body small, approximately elliptical in outline, strongly flattened dorsoventrally unlike other paramphistomids, convex on both surfaces with a distinct ventral notch behind acetabulum and lateral margins somewhat curled and marked out in bluish white color in contrast with yellowish white of central portion. Acetabulum prominent, practically ventral, with its opening surrounded by circular body fold; acetabular index 1 : 10.5. Oral sucker without diverticula. Esophagus with distinct bulb. Testes tandem, with some notches due to dorsoventral muscles. No cirrus pouch. Genital papilla muscular. Ovary and vitellaria? Eggs large. Excretory vesicle anterodorsal to acetabulum, with its pore posterior to opening of Laurer's canal. Parasitic in stomach of *Hippopotamus*.

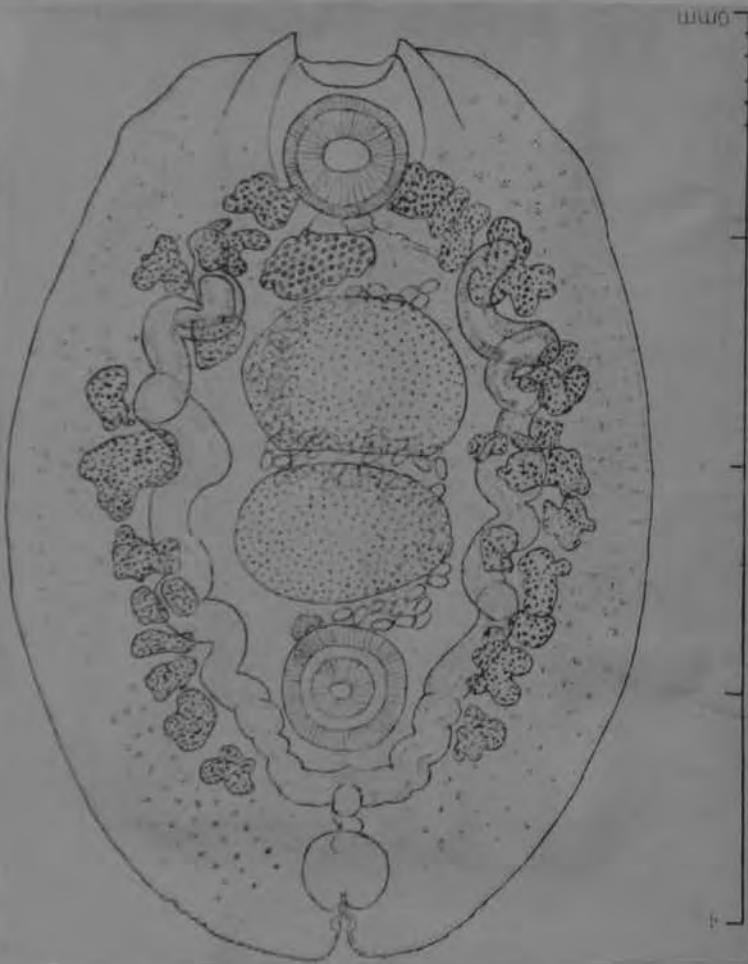
Genotype: *P. polycladiformae* (Näsmark, 1937), n. comb. (Pl. 100, Fig. 1212), syn. *Nilocotyle* sp. N., in *Hippopotamus amphibius*; Sudan.

Paramphistomatidae

Platyamphistoma polycladiformae (Näsmark, 1937) Yamaguti, 1958
Host: *Hippopotamus amphibius* L.



From Dollfus, 1950
Ex. H. amphibius L.
Belgian Congo



PLATYAMPHISTOMA

Pseudodiscinae Näsmark, 1937

Subfamily diagnosis. — Paramphistomidae: Body elongate conical to pyriform, flattened ventrally. Acetabulum ventral or ventroterminal. Oral sucker constricted at about middle, with paired pouch-like diverticula. Esophagus with or without muscular thickening. Ceca straight or sinuous, long. Testes tandem; pars muscosa more or less strongly developed. No cirrus pouch. No genital sucker. Ovary posttesticular. Laurer's canal opening anterior to excretory pore. Vitellaria lateral. Uterus winding posterior and dorsal to testes. Excretory pore caudad of vesicle. No ventral pouch.

Key to genera of Pseudodiscinae

1. Testes symmetrical; esophagus without muscular thickening *Pseudodiscus*
- Testes tandem, esophagus with muscular thickening 2

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SYSTEMA HELMINTHUM

- 2 Ceca very long, genital pore postbifurcal *Hawkesius*
- Ceca shorter, straight; genital pore prebifurcal *Watsonius*

Pseudodiscus Sonsino, 1895

Generic diagnosis. — Paramphistomidae, Pseudodiscinae: Body conical, slightly concave ventrally and convex dorsally. Acetabulum ventral, relatively small, with prominent border. Oral sucker constricted at equator, with paired pouch-like evaginations. Esophagus without muscular thickening. Ceca long, sinuous. Testes multilobed, symmetrical, preovarian. Pars muscosa well developed. Cirrus pouch absent. No genital sucker. Ovary anterior to acetabulum and excretory vesicle. Laurer's canal opening anterior to excretory pore. Uterus intercecal, convoluted posterior to testes. Vitellaria extending in extracecal fields between oral sucker and acetabulum. Excretory vesicle dorsal to acetabulum, pore postacetabular. Parasitic in colon of horses.

Genotype: *P. collinsi* (Cobb., 1875) Stiles et Goldberger, 1910, in *Equus caballus*; India. Also in *Elephas indicus*; India.

Development in *Indoplamorbis exustus* — Peter (1955).

Other species:

P. cobboldi Montgomery, 1906, in horse; India.

P. stanleyi (Cobbold, 1875) Stiles et Goldberger, 1910 (Pl. 100, Fig. 1215 a—b), syn. of *P. collinsi* (Cobb., 1875) — Fukui (1923), Mapleston (1923), Skrjabin (1949), in *Equus caballus*; India.

Subfamily : PSEUDODISCINAE Nilsmark, 1937.

Syn : *Watsoninae* Nilsmark, 1937.

Subfamily diagnosis : Body elongate, conical to pyriform, flattened ventrally. Acetabulum ventral or ventroterminal. Oral sucker slightly constricted at about middle, provided with paired pouches. Oesophagus with or without muscular thick-

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ening. Caeca straight or sinuous, long. Testes symmetrical or tandem, may be lobed. Pars musculosa more or less strongly developed. Cirrus pouch, genital sucker absent. Ovary posttesticular. Laurer's canal opening anterior to excretory pore. Vitellaria lateral.

Genus : *Pseudodiscus* Sonsino, 1895.

Syn : *Hawkesius* Stiles and Goldberger, 1910.

Watsonius Stiles and Goldberger, 1910.

Generic diagnosis : Body conical, slightly concave ventrally, convex dorsally. Acetabulum ventral, relatively small. Oral sucker generally constricted at equator, provided with paired pouches. Oesophagus with or without bulb. Caeca long, sinuous. Testes lobed, symmetrical or tandem, preovarian. Pars musculosa may be well developed. Genital sucker absent. Ovary anterior to acetabulum. Laurer's canal opening anterior to excretory pore. Vitellaria follicular, usually extending in extracaecal fields between oral sucker and acetabulum or restricted only to caecal portion.

Type species : *P. collinsi* (Cobbold, 1875) Stiles and Goldberger, 1910.

Formerly most of the workers included the genus *Pseudodiscus* Sonsino, 1895 under the subfamily Cladorchinae Fischeoeder, 1901 but Fukui, 1929 first created a new tribe Pseudodiscinae for this genus. He included this tribe under the subfamily Paramphistominae Fischeoeder 1901 but Nilsmark, 1937 raised it to the subfamily rank and included it under the family Paramphistomidae Fischeoeder, 1901. Skrjabin, 1949 accepted the view expressed by Nilsmark but included it under the family Cladorchidae Southwell and Krishner, 1937. Yamaguti, 1958 follows the position assigned by Nilsmark.

Key to species.

Testes side by side (symmetrical) *P. collinsi*

Testes tandem *P. hawkesi*

Mukherjee and Chauhan, 1965

(Cobbold, 1875)

SPECIFIC DIAGNOSIS OF *PSEUDODISCUS COLLINSI* (Plate-II).

The specific description of the adult worm furnished below is based on a study of the material raised experimentally in the donkey foal.

Colour bright pink, organism resembling pomogranate seeds when fresh. Body ovoid or oval in outline, oral end narrower and acetabular end broader and rounded. Dorsal side convex and ventral side concave. Body measurements of formalin fixed material: length 3.7-9.33 mm. breadth 2.2-5.1 mm. thickness 1.8-4.2 mm. Oral sucker 0.85-1.05 mm. in diameter, constricted in middle and with two well-defined globular oral pouches of 0.6-0.9 mm. in diameter. Ventral sucker 1.4-1.8 mm. in diameter, subterminal and possessing prominent margins. Mouth opening terminal. Oesophagus present, Oesophageal swelling absent. Caecal bifurcation at one-fourth body length from anterior end. Caeca simple, converge slightly in their middle course and extend nearly to one-seventh body length from posterior end. Excretory pattern U-shaped. Excretory pore posterior to Laurer's canal opening. Testes lobed, 0.7-2.32 mm. by 0.6-1.67 mm. about middle of body length. Ovary 0.25-0.7 mm. in diameter, situated posterior to testes towards right or left. Genital pore just anterior to middle of body length. Genital sucker and cirrus sac absent. Vitellaria follicular, extending from behind the oral pouches to about middle of acetabular level, follicles extracaecal but extending at the posterior end intracaecally upto the level of the ovary. Uterus convoluted. Ova of usual amphistome type, nearly oval in outline, anterior end being narrower and posterior end wider and marked with shell-thickening; measure 0.14-0.16 mm. \times 0.079-0.89 mm.; operculum distinct and 0.01 mm. in diameter; embryo located slightly anterior to centre of yolk mass and 0.01 mm. in diameter.

Under the genus *Pseudodiscus* Sonsino (1895) four species have been described, viz. *P. collinsi* (Cobbold, 1875), *P. hawkesii* (Cobbold, 1875), *P. stanleyi* (Cobbold, 1875) and *P. ornatum* (Cobbold, 1882). As Maplestone (1923) has pointed out, *P. stanleyi* is to be regarded only as an immature form of *P. collinsi* and not a valid species, since the relative sizes of the oesophageal portion of the oral sucker and of testes and acetabulum, and the relative positions of the opening of the Laurer's canal and of ovary in which these two species are said to differ may be due to a difference in age. *P. ornatum* has not been described in detail and the characters mentioned appear to be insufficient to distinguish it from *P. hawkesii*. *P. collinsi* is regarded as a closely related species to *P. hawkesii*. The differences between the two forms are mainly in the arrangement of the testes and in the presence or absence of an oesophageal bulb, which cannot be taken as of sufficient importance for separating them under different subgenera or genera. Thus, the genus *Pseudodiscus* is considered here as comprising of only two species, viz. *P. collinsi* (Cobbold, 1875) Sonsino, 1895, and *P. hawkesii* (Cobbold, 1875) Sonsino, 1895.

Besides being smaller in size, *Pseudodiscus hawkesii* differs from *P. collinsi* in that its oral sucker is smaller, oesophagus longer than the diameter of oral sucker and provided with a muscular bulb at the distal end, caecal bifurcation at one-third body length from the anterior end, testes tandem in arrangement and genital pore situated at two-fifths of body length from the anterior end.

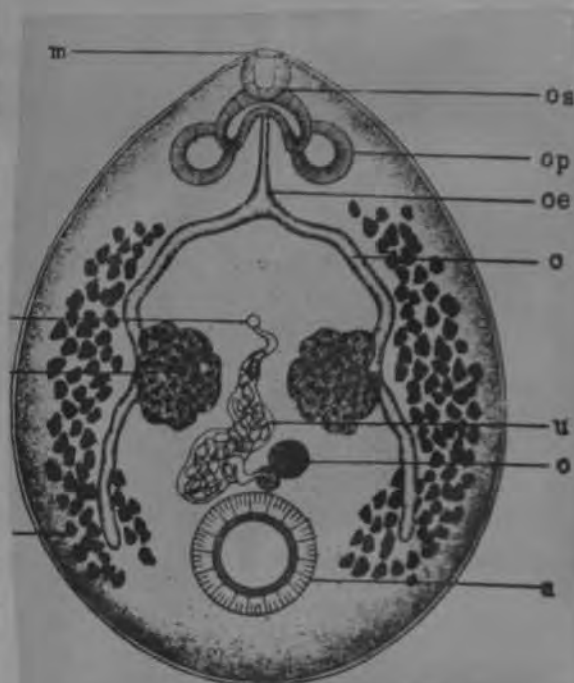


Plate 2

2 mm

SUMMARY

The life history of *Pseudodiscus collinsi* has been elucidated.

The morphological descriptions of the redia, cercaria, metacercaria and the adult stage of the parasite have been furnished in detail. Under natural conditions, *Indoplanorbis exustus* (Deshayes), acts as the intermediate host of the fluke. The cercaria readily encysts on any substratum after a free swimming existence not exceeding half-an-hour. In the donkey foal used as the experimental final host, the parasite matured in 90 days after infection.

From PETER AND SRIVASTAVA (1960)

Pseudodiscus collinsi (Cobbold, 1875) Sonsino, 1895.

Syn : *Amphistoma collinsi* Cobbold, 1875.

P. stanleyi (Cobbold, 1875) Stiles and Goldberger, 1910.

Specific diagnosis : Colour bright pink, body oval in shape, measuring 5.7-12.5 x 3-7 mm., 2.5-3.5 mm. in thickness. Oral end narrower, acetabular end broader. Oral sucker terminal, measuring 0.85-1.05 mm. in diameter, constricted in middle, 218 JOURNAL ZOOLOGICAL SOCIETY OF INDIA, 17 (1 & 2), 1965

provided with well developed oral pouches. Acetabulum subterminal, with prominent margins, 1.4-1.8 mm. in diameter. Oesophagus measures 0.93-1.62 mm. in length, its walls glandular. Oesophageal bulb absent. Caeca simple, converge slightly at middle, terminate posteriorly at middle level of acetabulum. Testes lobed, situated about middle of body, side by side, measure 1-2.48 x 0.73-2.28 mm. Ovary measuring 0.42-0.87 x 0.27-0.74 mm., situated posterior to testes, towards right or left side of middle line. Genital pore postbifurcal, a little anterior to middle of body. Genital sucker absent. Genital pore may be surrounded by prominently raised margin. Vitellaria follicular, extending from behind oral pouches to about middle of acetabular level, mostly extracaecal but some may overlap caeca, extending to posterior end intracaecally. Eggs measure 0.125-0.158 x 0.085-0.088 mm.

Host : Horse, Ass, Elephant.

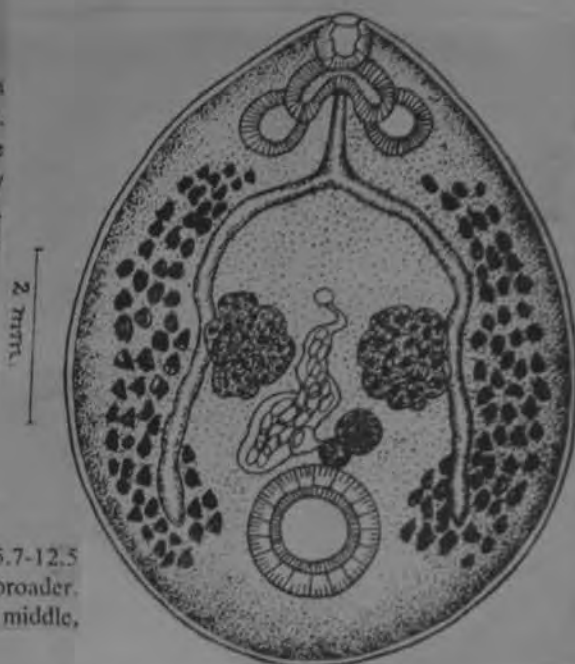
Location : Caecum and Colon.

Distribution : Widely distributed.

Intermediate snail host :—*Indoplanorbis exustus*. Peter and Srivastava, 1954 & 1960.

1965 MUKHERJEE & CHAUHAN — INDIAN AMPHIPTOMES

Type of cercaria :—Diplocotylea.



Pseudodiscus collinsi (Cobbold, 1875) Sonsino, 1895.
(After Peter and Srivastava, 1954, 1960).

Pseudodiscus collinsi (Cobbold, 1875) Stiles and Goldberger, 1910

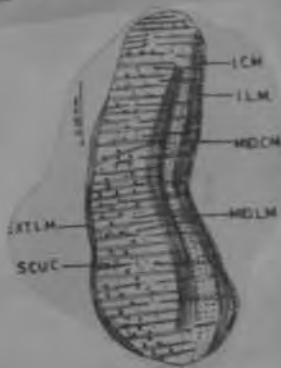
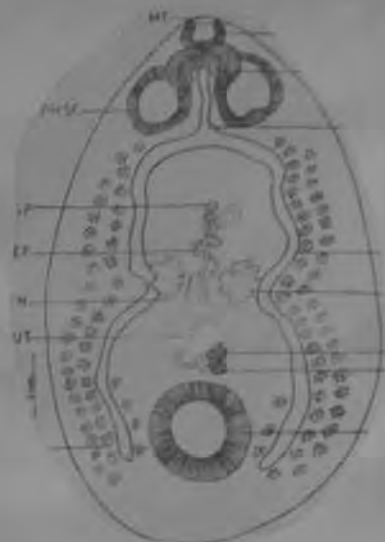
A live specimen of *Pseudodiscus collinsi* (Cobbold, 1875) Stiles and Goldberger, 1910, has a fleshy tint. It is oval with convex lateral margins. The flattened specimens measure 6.6-8.8 mm. in length and 4.2-5.1 mm. in maximum breadth.

Acetabulum (Figs. 1-3)

It is rounded, subterminal at 0.7-0.82 mm. in front of the posterior extremity. It is 1.4-1.61 mm. in diameter and its opening being 0.71-1.09 mm. in diameter in whole-mounts. In median sagittal sections, it measures 1.4-1.43 mm. in dorsoventral diameter, whereas in longitudinal sections, it is 1.2-1.3 x 1.01-1.09 mm. in size. It is attached to the body parenchyma by the mesenterial bands. The ratio between its diameter and length of the body is 1:4.71-1:5.5 in flattened specimens, and between its dorsoventral diameter and length of the body is 1:4.9-1:5.01 in median sagittal sections. Its concavity is lined by the cuticle. Underneath it there is a meshwork of oblique muscle fibres. These are followed by the circular muscle fibres which are more developed on the lateral sides. These have been counted from median sagittal sections. The units of dorsal exterior circular muscles number 50-54, the dorsal interior circular muscles 28-32, the ventral exterior circular muscles 18-22 and the ventral interior circular muscles 25-26. There are a few bands of longitudinal muscle fibres underneath the limiting membrane. The radial muscle fibres are numerous and run from the cuticle to the limiting membrane. A little away from the cuticle are present the subcuticular cells. Dorsally to these cells are found large-sized nerve cells. The parenchymatous cells fill the interspaces of the muscle fibres and are smaller in size than those of the body.

Digestive tract (Figs. 4-9)

Mouth: It is terminal and is surrounded by minute conical papillae. It is 0.29-0.39 mm. in diameter in whole-mounts. **Pharynx:** It is somewhat globular, 0.43-0.59 x 0.42-0.58 mm. in size in whole-mounts, the ratio between its length and that of the body in whole-mounts is 1:20.64-1:21.4. Its lumen is lined by a thin cuticle. Immediately surrounding it is a thick layer of interior circular muscle fibres which continue posteriorly in the pharyngeal bulb. This layer is followed by a narrow layer of longitudinal muscle fibres. A layer of middle circular muscles followed by a layer of compactly arranged longitudinal muscle fibres is present. The limiting membrane forms the outer covering of the pharynx. Below this is present a layer of slightly developed exterior longitudinal muscles. The radial muscle fibres extending from the cuticle to the limiting membrane are present and they show a fairly considerable ramification. The subcuticular cells are found scattered throughout its parenchyma. The nerve cells are also seen in it. The parenchymatous cells are much smaller than those of the body. **Pharyngeal bulb:** It is separated from the pharynx by a slight constriction. It broadens out on either side at the level of the origin of the oesophagus. Its muscular elements are poorly developed. Its lumen is continuous with the pharyngeal cavity. Next to its cuticle are present circular muscle fibres continuous with the interior circular muscles of the pharynx. This layer is followed by a layer of longitudinal muscle fibres which are scanty. The radial muscles extending between the cuticle and the limiting membrane are fairly developed. Beneath the limiting membrane are present the exterior longitudinal muscle fibres. The subcuticular cells are scattered throughout its parenchyma. Secondary pharyngeal sacs: These arise, one on each side, from the dorso-posterior aspect of the lateral pharyngeal bulb. Each sac is globular with considerable dimension. The right sac is a little larger than the left. Internally it is lined by the cuticle which is followed by the circular and longitudinal muscles, the latter being scarce. The radial muscles are moderately developed. The secondary pharyngeal sacs act as a kind of suction or vacuum pump when assistance is needed by the pharynx to suck the food. **Oesophagus:** It is 0.936-1.40 mm. in length and 0.062 mm. in thickness. Internally it is also lined by the cuticle, followed by the circular and longitudinal muscles, the latter being scanty. The subcuticular cells along the oesophagus are present in groups. **Intestinal caeca:** They are long, wavy in their course and terminate at the level of the posterior border of the acetabulum. It is lined internally by an epithelium bearing microvilli (= stereo-cilia), followed by the circular and longitudinal muscles.



Body wall (Fig. 10)

The outermost layer of the body is the cuticle. It is followed by the subcuticle which also runs all round the body. It has fine striations perpendicular to the body surface. The subcuticle is followed by the circular muscle fibres and a few bands of longitudinal muscle fibres. Between the subcuticular cells are present oblique muscle fibres. Then there is again a layer of inner longitudinal muscle fibres, *muscles and parenchyma*

There are two pairs of inner and outer retractor muscles which extend from the acetabulum up to the pharynx. The peripheral muscle bands are also in two pairs which run longitudinally. The parenchymatous cells of the body are irregular in outline due to the contraction of the body. The cells below the integument are narrower than those surrounding the internal organs. At some places the walls of the adjoining cells appear to have fused.

Nervous system (Figs. 11-13)

Brain: It lies dorsal to the oesophagus and a little behind the posterior margin of the pharyngeal sacs. **Nerves:** Three pairs of these arise anteriorly and three pairs posteriorly from the brain. They comprise the anterior dorsal, anterior lateral, anterior ventral, posterior dorsal, posterior lateral and posterior ventral nerves. From near the middle of the brain commissure, a pair of slender and short nerves, the anterior middle nerves, are given out, which run along the oesophagus and enter the pharynx.

The anterior dorsal nerves run on the dorsal side of the pharynx and supply its dorsal margin. These nerves continue anteriorly to supply the lateral margins of the mouth. The anterior ventral nerves lie on the ventral side of the pharynx and supply its ventral margin. The anterior lateral nerves run on the lateral sides of the body. The papillae around the mouth are supplied by the branches of these three pairs of nerves. The posterior dorsal nerve on each side leaves the brain almost perpendicularly and gives off many small branches as it proceeds backward. Near the posterior end of the body it divides into two branches, one of them runs further posteriorly and the other turns towards the acetabulum and unites with the posterior ventral nerve. The posterior ventral nerve on each side runs along the ventral side of the body; the posterior lateral nerve along the lateral side of the body close under the integument.

Excretory system (Fig. 14)

Longitudinal excretory canals: Two, one on either side of the body close to the alimentary tract and opens into the excretory vesicle from its antero-lateral side. Each main longitudinal canal before it enters the vesicle receives a branch, the posterior excretory canal, from the acetabular zone of the body. The main longitudinal excretory canal, at about the level of the ovary, receives a well-developed tributary formed of two longitudinal branches, one anterior and the other posterior. At the level of the intestinal fork, the main longitudinal excretory canal receives two branches, one internal and the other external, from the anterior region of the body. The internal branch runs along the oesophagus, but the external one is formed by two smaller branches which collect excretory material from the pharyngeal and secondary pharyngeal regions. Excretory vesicle is situated in the posterior region of the body partly dorsal to the acetabulum. It narrows down posteriorly.

Excretory canal: It runs from the excretory vesicle to the dorsal surface of the body and is lined by the cuticle. It opens out in the mid-dorsal line by an excretory pore which is post-vesicular and posterior to the opening of Laurer's canal.

Lymphatic system (Figs. 14-16)

Main lymph vessels: Two, one on each side, running from anterior to posterior extremities of the body. Anteriorly, the main lymph vessel gives off branches to the pharynx, the pharyngeal bulb and the secondary pharyngeal sac of the side. The main lymph vessel runs external to the intestinal caecum for a short distance and then curves inward near the level of the testes, again assuming its way external to the intestinal caecum and reaching the posterior end of the body. On its way it supplies branches to the various organs, the testes and ovary, the genital pore and the caeca etc. It gives off a lateral branch to the excretory vesicle, which repeatedly divides into smaller branches to envelop it. Posteriorly it gives large branches to surround the acetabulum.

Reproductive system (Figs. 17-19)

Male genital system: Testes are two, globular, cauliflower-like and are situated in the middle of the body between the two intestinal caeca. In flattened specimens the right testis is 0.53-0.54 x 0.69-1.09 mm. in size and the left 0.49-0.93 x 0.69-1.21 mm. A vas efferens arises from the inner lateral side of each testis. The two vasa

continued (next page)

From Gupta and Walia, 1967

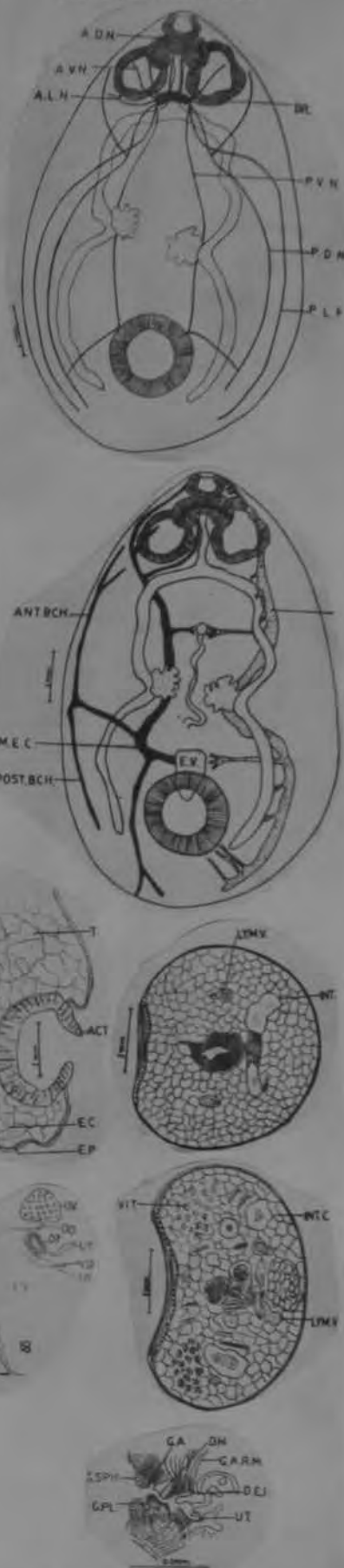


Pseudodracus collinsi (cont'd).

fferentia unite to form the vas deferens which is differentiated into a coiled vesicula seminalis, much convoluted pars muscosa and the pars prostatica. The last part is continued into the ductus ejaculatorius. The pars muscosa has a relatively thick muscular wall which gets reduced in thickness as it passes into the pars prostatica. The pars prostatica, after its emergence of the prostate gland cells, gets considerably reduced in thickness to form the ductus ejaculatorius. The ductus ejaculatorius unites with the terminal portion of the uterus to open into the ductus hermaphroditicus which opens out through the genital papilla. The genital atrium (Fig. 19) is strengthened by the genital-atrial-radial muscles. The genital sphincter and the genital papilla are well developed. The male genital ducts throughout their course are lined by the ciliated epithelium which is surrounded by the inner, circular and the outer longitudinal muscle fibres. Female genital system: The ovary (Fig. 1) is 0.34 x 0.38 mm. in size and is situated to the left of the median line in the post-testicular region of the body. The oviduct emerges from the posterior border of the ovary and soon enters the Mehlis' gland complex and then continues as the uterus. The Laurer's canal arises from the oviduct at a place where the latter enters the Mehlis' gland complex and then opens to the left of the median line in front of the excretory pore (Figs. 17 and 18). The vitelline glands consist of scattered follicles, mostly confined to the lateral regions of the body and extending from the level of the oesophagus to that of the posterior margin of the acetabulum. From vitelline glands, a duct passes transversely medially to unite with its fellow close to the posterior aspect of the Mehlis' gland complex to form a yolk reservoir. From the yolk reservoir emerges a smaller duct, the vitelline duct, that runs along the Mehlis' gland complex to open into the ootype. The uterus emerges from the ventral aspect of the Mehlis' gland complex, winds its way towards the left side of the ovary, forming coils and then proceeds anteriorly dorsal to the testes and opens into the ductus hermaphroditicus just beneath the ductus ejaculatorius. The ductus hermaphroditicus is formed by the union of ductus ejaculatorius and the metraterm. The genital pore lies in the ventro median line, just below the bifurcation of the intestinal caeca.

From Gupta and Walia, 1969

Paramphistomidae



Pseudodiscus hawkesii (Cobbold, 1875) Sonsino, 1895.

Syn : *Amphistoma hawkesii* Cobbold, 1875.

P. (Hawkesius) hawkesii Stiles and Goldberger, 1910.

Specific diagnosis : Body conical with anterior end tapering, posterior end round, measuring 3.2-6.7 x 2-3.7 mm., 2-3 mm. in thickness. Acetabulum measures 1.1-1.59 mm. in diameter. Oral sucker ellipsoidal with paired diverticula appearing as large vesicles latero-dorso-posteriorly to sucker. A few wrinkles may be present around mouth. Anterior part of oesophagus thinwalled but posterior part with enormously developed circular muscles forming a distinct bulb. Caeca in majority of cases end in equatorial zone of acetabulum, in few instances left caecum ends somewhat anteriorly. Genital pore on ventral surface may be located in a pit, occasionally it may slightly protrude out of ventral surface. Genital

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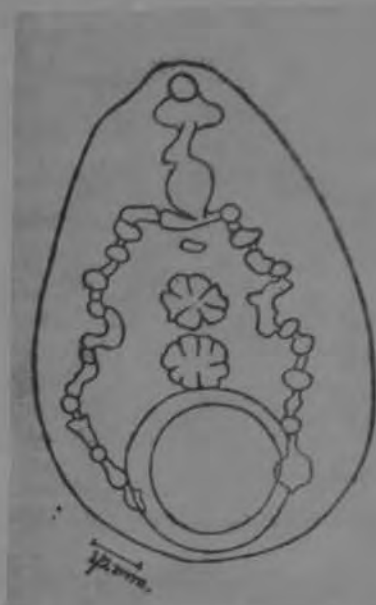
pore postbifurcal. Testes deeply lobed, tandem, zones may or may not overlap, located about middle of body. Ovary posterior to posterior testis. Eggs measure 0.135 x 0.07 mm.

Host : Elephant.

Location : Intestine.

Distribution : Assam, Bihar, Punjab, Malabar, Madras.

FROM : MUKHERJEE & CHAUHAN 1965



Pseudodiscus hawkesii (Cobbold, 1875)

Sonsino, 1895. (After Stiles and Goldberger, 1910)

PSEUDODISCUS

LOOSE LEAF ORGANIZER

SCHEDULE

PERIOD OR TIME								
COURSE MON.								
INSTRUCTOR								
COURSE TUE.								
INSTRUCTOR								
COURSE WED.								
INSTRUCTOR								
COURSE THU.								
INSTRUCTOR								
COURSE FRI.								
INSTRUCTOR								
COURSE SAT.								
INSTRUCTOR								

NAME _____

ADDRESS _____

SCHOOL _____

TELEPHONE _____

Pseudoparamphistoma n. g.

Generic diagnosis. — Paramphistominae, Ceylonocotylini: Body very much elongated, tapering gradually toward anterior end. Acetabulum ventroterminal; acetabular index approximately 1 : 1.65. Oral sucker without diverticula. Esophagus comparatively long, without distinct posterior bulb. Ceca moderately wide, terminating some distance short of acetabulum. Testes lobed, tandem, in posterior half of body. Seminal vesicle, pars muscosa, pars prostatica, ductus hermaphroditicus, genital papilla projecting into genital atrium, and genital pore just as in *Paramphistomoides*. Ovary rounded, small, submedian, between left cecal end and acetabulum. Laurer's canal opening a short distance anterior to excretory pore. Uterus winding forward lateral to testes; eggs large. Vitelline follicles large, extending from level of postbifurcal genital pore to anterior end of acetabulum. Excretory vesicle pre-acetabular, opening a short distance posterior to opening of Laurer's canal. Parasitic in stomach and intestine of carnivores.

Genotype: *P. cuonum* (Bhalerao, 1937), n. comb., (Pl. 83, Fig. 1013), syn. *Paramphistomum* c. B., in wild dog, *Cuon dukhunensis*, India.

Paramphistomatidae

Paramphistomum cuonum Bhalerao

Body flat, translucent, thin. Length 3.35-5.7 mm. Breadth 0.6-0.95 mm. Oral sucker 0.32-0.43 X 0.3-0.32 mm. Posterior sucker 0.47-0.55 mm. in dia. Esophagus 0.46-0.58 mm. long. Esophageal bulb very slightly differentiated. Intestinal ceca terminate 0.45-0.72 mm. in front of posterior sucker. Excretory pore situated 0.55 mm. from the posterior end. Genital pore central, slightly posterior to intestinal fork. Testes oval, lobed, tandem, post-equatorial. Anterior testis near the ends of intestinal ceca, posterior one near the midbody. Ovary rounded, posterior to hinder testis, slightly to the side of the middle line. Laurer's canal opens 0.35 mm. anterior to the excretory opening. Vitellaria extend from genital pore to anterior border of posterior sucker. Vitelline follicles few and large, caecal, extra-caecal and posterior to ovary inter-caecal. Eggs measure 0.120-0.123 X 0.054-0.065 mm.

Host: Cuon dukhunensis

Location: Stomach, small intestine

Locality: Calcutta Zoo



PSEUDOPARAMPHI-
STOMA

1947
Solenorchiinae Hilmy, 1948

Subfamily diagnosis. — Paramphistomidae: Body elongate, more or less fusiform, with lip-like terminal lobe. No ventral pouch. Acetabulum subterminal, with semilunar muscular cushion anterodorsally. Oral sucker elongate, with two inconspicuous diverticula (not mentioned for type genus). Esophageal bulb present or absent. Ceca long. Testes tandem, in midregion of body. Cirrus pouch present or absent. Cirrus opening into genital atrium immediately in front of uterus. Ovary median, posttesticular. Laurer's canal opening posterior to excretory pore. Vitellaria extensive in lateral fields. Uterine coils mainly dorsal and anterior to testes. Excretory vesicle intertesticular, opening dorsally at about level of vesicle. Lymph system with two pairs of longitudinal stems.

Key to genera of Solenorchiinae Hilmy, 1949

Esophageal bulb and cirrus pouch absent *Solenorchis*
Esophageal bulb and cirrus pouch present *Indosolenorchis*

Solenorchis Hilmy, 1949

Generic diagnosis. — Paramphistomidae, Solenorchiinae Hilmy, 1948:

978

SYSTEMA HELMINTHUM

Body elongate, rather flattened, with transverse terminal pad. Cuticle smooth. No ventral pouch. Acetabulum subterminal, with semilunar, muscular cushion anterodorsally. Oral sucker with anterior and posterior sphincter muscles. No esophageal bulb. Ceca with sinuous wall, reaching to anterior end of acetabulum. Testes indented or not, tandem, largely in middle third, somewhat nearer to anterior end than to posterior end. Seminal vesicle convoluted, hidden from view by uterine coils. Neither cirrus nor cirrus pouch. Pars muscosa and pars prostatica? Male duct opening separately into genital atrium anterior to female pore. Ovary posttesticular, submedian or median. No Laurer's canal(?). Uterus winding dorsal and anterior to testes. Genital atrium postbifurcal. Vitelline follicles extending in lateral fields from level of oral sucker or esophagus to level of cecal ends or a little more posteriorly. Excretory vesicle intertesticular, equatorial pore dorsal to anterior testis. Lymph system? Parasitic in cecum of marine mammals.

1-2 1949
Genotype: *S. travassosi* Hilmy, 1948 (Pl. 90, Fig. 1090), in *Halicore halicore*; Red Sea.

Other species:

S. baeri Hilmy, 1948, in *Halicore halicore*; Red Sea.

S. gohari Hilmy, 1948, in *Halicore halicore*; Red Sea.

S. naguibmahfouzi Hilmy, 1948, in *Halicore halicore*; Red Sea.



Fig. 1.

Solenorchis. Sagittal section through the pharynx, showing the anterior and posterior sphincters, the medial circular and basal circular muscles.

From Hulmý, 1949

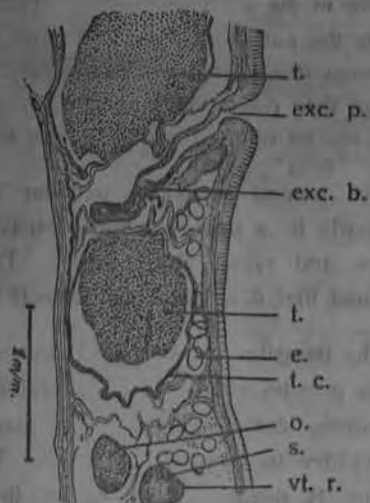


Fig. 2.

Solenorchis. Sagittal section through the equatorial region, showing excretory bladder and excretory opening between the two testes, e. = eggs; exc. b. = excretory bladder; exc. p. = excretory pore; o. = ovary; s. = shell gland; t. = testis; t. c. = capsule of testis; vt. r. = vitelline reservoir.



Fig. 3.

3. *Solenorchis*. Sagittal section through the ventral sucker, showing the ante-acetabular muscular cushion and the post acetabular lip. the dorsal exterior and interior and the ventral interior and exterior muscles. The last three groups of muscles are rather exaggerated in the figure.

SOLENORCHIS

Srivastavaia Singh, 1960?

Accordingly, a new genus and a new species are created for the present. The new genus, *Srivastavaia* may be defined thus:

Paramphistomidae: Orthocoeliinae: Body elongated, slightly convex. Pharynx of *Paramphistomum* type (in type species). Oesophagus comparatively short with an oesophageal bulb. Intestinal caeca long, twisted. Acetabulum subterminal, facing ventrally, of *Streptocoelium* type (in type species); ratio of acetabulum diameter to length 1:2.7. Testes one behind the other, deeply lobed, rounded in outline. Vagina with vesicula seminalis and pars prostatica. Ovary oval, usually lateral in position. Genital canal opens posterior to excretory pore without crossing the excretory duct. Genitalia of *Srivastavaia* type (in type species); ductus hermaphroditicus with genital papilla. Vitellaria follicular, lateral, well developed.

Type species: Srivastavaia indica n. sp.

Grivastavaia indica n. sp.

Paramphistomidae

Singh, K.S. 1960?
ADULT

The cercariae were allowed to encyst on grass leaves and after about a week, the metacercariae were fed to a sheep lamb and a goat kid. The lamb was fed with about 800 metacercariae and the kid about 200 metacercariae on September 14, 1961. The lamb was sacrificed on December 5, 1961, i. e., 82 days after infection when 182 specimens of adult parasites were recovered from the abomasum. These parasites had very few eggs in the uterus. The kid was sacrificed on February 2, 1962, i. e., 141 days after infection, when 77 gravid specimens were obtained. Unfortunately, it was very cold at that time of the year and the rest of the work on the life history had to be abandoned.

The following account is based on the study of 37 whole mounts of adult parasites (22 from sheep and 15 from goat kid) and one parasite, obtained from the goat kid, as microtome sections in the longitudinal vertical plane.

Description of whole mounts (12 specimens measured): The body is 5.61-7.7 (7.133) mm. long and 2.252-2.848 (2.605) mm. in maximum breadth just anterior to the acetabulum (fig. 7). The body is smooth except at the anterior end where small cuticular papillae are present surrounding the mouth opening.

The mouth opening is more or less terminal and leads to the muscular and also rounded pharynx, 0.445-0.765 (0.626) mm. in diameter. The oesophagus is 0.267-0.3 (0.38) mm. long. The two intestinal caeca run along the lateral sides, as sinuous tubes having three or four well-marked twists. When unflattened specimens are viewed from the lateral side, the caeca are seen to run in a wavy course going from dorsal to ventral side or four times. The caeca end at the posterior end, usually dorsal to the anterior margin of the acetabulum. The acetabulum is sub-terminal, facing the ventral side, rounded 1.335-1.513 (1.448) mm. in diameter.

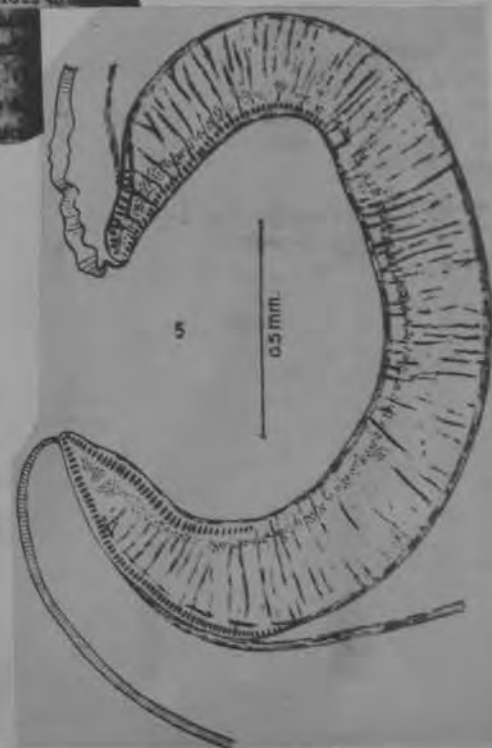
The two testes are present one behind the other in the posterior half of the middle third of the body. They are rounded to oval, and deeply lobed. The anterior testis measures 1.068-1.371 \times 1.104-1.469 (1.228 \times 1.279) mm. and the posterior one 0.935-1.264 \times 1.166-1.264 (1.142 \times 1.215) mm. The vas deferens runs along the median line and part, becomes slightly convoluted and widened to form the vesicula seminalis.

The ovary is rounded, 0.356-0.801 (0.484) mm. in diameter and normally present on the left side, posterior to the posterior testis. The Mehlis' gland cells are present anterior to and on the left side of the ovary and not very clearly seen, being partly overlapped by the ducts. The vitelline follicles are present on the lateral and dorsal sides extending from the base of the oesophageal region up to the anterior region of the acetabulum. The anterior, longitudinal vitelline ducts are quite long and join the posterior duct near the base of the posterior testis, from where they run towards the acetabulum. The transverse ducts of the two sides join each other immediately posterior to the acetabulum and the common duct is short. The uterus arises as an arrow tube, follows a similar



7

-over-



...towards the right, turns back to the left and then forward more or less along the plane to open to the outside through the genital pore. The genital pore is present 1.068 (0.912) mm. posterior to the intestinal bifurcation or, 1.246-2.314 (1.838) mm. from the anterior end. The eggs (in balsam) measure 0.13-0.16 \times 0.07-0.086 (0.147 \times 0.1) mm.

Description of 1 series of longitudinal vertical sections: The body is 4.245 mm. long and 0.9 mm. in the dorsoventral direction just anterior to the ventral sucker. It is moderately flattened on the dorsal side. The pharynx is a little elongated, 0.641 \times 0.472 mm., and is of the *Paramphistomum* type; the lip, anterior and posterior sphincters being absent. The pharynx, however, is not as broad as shown by Nasmak (1937) for the type (fig. 4).

Nasmak (1937) while describing the pharynx in amphistomes in general, identified the interior and the exterior longitudinal layers. In his figure 34, which gives a median sagittal section of an amphistome pharynx, only these two layers of longitudinal fibres are shown. Yet, there is a third layer of longitudinal fibres present in the present specimen which can be described as middle longitudinal layer due to its position. This layer has been shown to be present in *Gastrothylax* sp., (*Paramphistomum* type), *Galicophoron* (*Galicophoron* type) and *Galicophoron ijimai* (*Ijimai* type) by Nasmak (1937) as indicated by his figures 53, 54 and 55 respectively, though evidently he has not considered any taxonomic significance. The present material resembles these three closely related species, but more with *Gastrothylax* sp.

The radial muscle fibres, though present in several bundles, are neither so prominently stained nor are the bundles thick. The exterior circular muscle fibres are very distinct and rather difficult to distinguish. The basally circular layer consists of about 60 units, almost of the same size as those of the interior circular layer.

The pharynx leads into an oesophagus, 0.303 mm. long. The oesophagus is pear-shaped, and possesses the oesophageal bulb. There is a gradual thickening of the oesophagus wall which is not so apparent in the whole mounts.

The two testes are present one behind the other and show very deep lobation. The anterior testis measures 1.335 mm. dorsoventrally and the posterior testis 1.282 mm. The deferens is much widened in the distal region and forms tight coils dorsal to the genital pore and the terminal part is surrounded by a large number of prostate gland cells several layers deep. The male genital duct enters the genital sucker as a straight tube and prostate gland cells are not present inside the genital sucker.

The ovary is present just anterior to the acetabulum almost on level with its dorsal border. It is oval and measures 0.35 \times 0.22 mm. The Mehlis' gland cells are present a little posterior and dorsal to ovary, measuring 0.24 mm. in diameter. The Laurer's canal runs posteriorly without crossing the excretory duct to open to the outside dorsal to the acetabulum. The uterus forms a number of coils in the ovarian region and then runs forward dorsal to the testes. The distal region of the uterus enters the genital sucker at an angle and joins the male genital duct, to form the ductus hermaphroditicus, which is 0.14 mm. long.

The genital sucker is clearly delimited from the surrounding parenchyma of the body and 0.4 mm. in diameter. The muscle fibres, except the atrial radial layer and the weakly developed sphincter papillae, are difficult to see. The genital atrium is not very deep, voluminous, and the genital pore is present 0.935 mm. from the anterior end. The ventral atrium is absent.

The genital atrium of the present material somewhat resembles the rather ill-defined *Gracile* type of Nasmak, but shows a combination of characters not shown by any type described so far (fig. 6). Dinnik (1963) is of the opinion that this is characteristic of the present material and should be designated as a new type. In case the examination of further material shows this view to be correct, it would be called *Srivastavaia* type.

The excretory bladder is present anterodorsal to the ovary and the Mehlis' gland cells. The excretory duct arises from the anterodorsal aspect of the excretory bladder, runs forward to open dorsal to the posterior testis, about 2.27 mm. from the posterior end and almost in the sagittal plane.

The acetabulum is subterminal, the opening being directed towards the ventral side and measures 1.558 mm. in diameter and 0.935 mm. in the dorsoventral direction. It is of the *Streptocoelium* type (fig. 5). The d. e. circular muscles consist of about 60 units, all of the almost of the same size and equal to the units of d. i. circular layer which contains about 40 units. The units of d. i. circular layer show a gradual decrease in size. The v. i. circular layer has about 12 units and the v. e. circular layer about 46 units.

-continued-

DISCUSSION

Due to the presence of a genital sucker, which is distinctly delimited from the surrounding parenchyma of the body, the present material could have been assigned to the genus *Cotylophoron* Stiles and Goldberger, 1910. But since the Laurer's canal does not cross the excretory duct the present material can be assigned only to one of the following genera: *Ceylonocotyle* Nasmark, 1937 (= *Orthocoelium* Stiles and Goldberger, 1910), *Nilocotyle* Nasmark, 1937 and *Buxifrons* Nasmark, 1937, which are separated from each other mainly on the nature of the acetabulum. As the acetabulum is determined to be of *Streptocoelium* type, the present material, it could only be included in the genus *Ceylonocotyle*.

Nasmark (1937) included four species under the genus *Ceylonocotyle*: *C. scolicoelium* (Fischöder, 1904), *C. dicranocoelium* (Fischöder, 1901), *C. streptocoelium* (Fischöder, 1901) and *C. orthocoelium* (Fischöder, 1901). Price and McIntosh (1953) transferred *Cotylophoron ovatum* Harshey, 1934, *C. orientalis* Harshey, 1934 and *C. elongatus* Harshey, 1934, to the genus, for which they preferred the name *Orthocoelium* Stiles and Goldberger, 1910, according to the law of priority. Since the details of the musculature of Harshey's species are not available, I am unable to consider them here. Of the four species of Fischöder, *C. scolicoelium* and *C. dicranocoelium* possess a strong oesophageal bulb and lip sphincter, the latter being entirely absent in the present material. Of the remaining two species, *C. streptocoelium* possesses a genital sphincter in the genital atrium, and thus the present material resembles *C. orthocoelium* more than any other species.

The present material shows considerable differences from *C. orthocoelium* (as described by Nasmark, 1937) in the size of the body and the various organs. According to Nasmark, the ratio between acetabulum diameter and body length is 1:6.6 in *C. orthocoelium* and 1:7.2 in *C. streptocoelium* (1:4.5 according to Durie, 1953), but in the present material the ratio is out to be 1:2.7, which is considered to be significant. Similarly, the ratio between oesophagus length and body length in *C. orthocoelium*, *C. streptocoelium* and the present specimens is 1:7.7, 1:15.2 and 1:6.6 respectively, and the oesophagus length in ratio to body length is 1:10.0 and 1:14 respectively. Further, in *C. orthocoelium*, the intestinal caeca are shallowly lobed and the genital atrium is "entirely without musculature, *Gracile* type." In the present material, the intestinal caeca are twisted, testes are deeply lobed and much larger and the genital atrium, though resembling *Gracile* type, does contain spiral-radial muscles and sphincter papillae.

In all the three genera, *Ceylonocotyle*, *Nilocotyle* and *Buxifrons* in which the Laurer's canal does not cross the excretory duct the Laurer's canal always opens anterior to the excretory pore as shown by the diagrams of Nasmark (1937, Figs. 100, 101 and 103) and Durie (1953, Plate IV, Fig. 3). In the present specimens, however, the excretory bladder is situated antero-dorsal to the ovary and the Mehlis' gland cells and not posterior and on level with the three genera mentioned above. Consequently, the Laurer's canal opens posterior to the excretory pore without crossing the excretory duct, whereas in those forms where the Laurer's canal opens posterior to excretory pore, it always crosses the excretory duct. The relative position of these two ducts is considered to be of considerable taxonomic importance in the amphistomes and is so accepted by most of the workers. Price and McIntosh (1953) even created a new subfamily, *Orthocoeliinae*, for the three genera then known, in which the Laurer's canal does not cross the excretory duct. If this view is accepted, then it becomes necessary to create a new genus for the present material, which otherwise closely resembles the genus *Ceylonocotyle*.

The present material shows some resemblance to *Paramphistomum thapari* Price and McIntosh, 1953 (= *Cotylophoron indicum* Stiles and Goldberger, 1910) specially in the musculature of pharynx, genital atrium and acetabulum, and the position of the Laurer's canal in relation to the excretory pore. I have compared the present material with the material which I have identified as *P. thapari* (account to be published later) and find several differences. There are many more units in the d. e. circular layer, which are of almost the same order, in the present material than either in the *Calicophoron* or the *Cotylophoron* type, though the v. e. circular layer is separated by an oblique muscular layer. The number of units in each layer is different in the two species as shown below:

	<i>S. indica</i>	<i>P. thapari</i>
d. e. circ. layer	60	16-18
d. l. circ. layer	40	40-42
v. l. circ. layer	46	36-38
v. e. circ. layer	12	14-15

In the genital atrium, the sphincter papillae are weakly developed both in the present material and *P. thapari* but in the latter, a few muscle units much better developed than

SRIVASTAVAIA

Stephanopharynginae Stiles et Goldberger, 1910

Subfamily diagnosis. — Paramphistomidae: Body plump, with rounded extremities. Acetabulum ventroterminal. Oral sucker with unpaired diverticle. Esophagus without bulb; ceca long, strongly winding. Testes tandem. Pars musculosa strongly developed. Genital papilla conical, genital atrium muscular. Ovary anterodorsal to acetabulum. Laurer's canal opening anterior to excretory pore. Uterus dorsal to testes. Vitellaria lateral, extending whole length of ceca. No ventral pouch.

Stephanopharynx Fischöder, 1901

Generic diagnosis. — Paramphistomidae, Stephanopharynginae: Body plump, with rounded extremities, slightly curved ventrad and slightly flattened dorsoventrally. Acetabulum ventroterminal, with its opening covered with corrugated cuticle. Oral sucker produced backward into unpaired diverticle. Esophagus without bulb. Ceca strongly winding and terminating in acetabular zone. Testes indented, tandem. Pars musculosa strongly developed. No cirrus pouch. Genital papilla conical, genital atrium muscular. Ovary anterodorsal to acetabulum; Laurer's canal opening anterior to excretory pore. Uterus dorsal to testes. Vitellaria lateral, extending throughout the length of ceca. Parasitic in stomach of mammals.

Genotype: *S. compacta* Fischöder, 1901 (Pl. 95, Fig. 1143), in *Bos taurus*, *Bos* sp., *Cobus* sp.; Africa.

Other species:

S. secunda Stunkard, 1929, in stomach of *Redunca bohor*; Africa.

Stephanopharynx secundus, new species Stunkard, 1929

The material of this genus present in the Congo collection consists of five specimens, found together with many specimens of *Paramphistomum cervi* in the stomach of the antelope, *Redunca bohor* (Congo Exp. vial No. 961, February 10, 1912, Faradje). These specimens conform in every respect to the diagnosis of the genus as given by Fischæder, but differences in the size of the specimens and in the size of individual structures make it impossible to assign them to the species *S. compactus*. They are at least twice the size of Fischæder's specimens, the internal organs are much larger, and the worms are still sexually immature. Consequently they are regarded as a new species for which the name *Stephanopharynx secundus* is proposed. Fischæder's largest specimens were 5 mm. in length and filled with eggs. Maplestone reports worms up to 7 mm. in length, and adds that "none of the worms were gravid, and prolonged search of the ample material failed to reveal any specimen containing eggs." It seems possible then that Maplestone's material belongs to the new species, *S. secundus*.

Four of the five specimens in this collection were sectioned, and one, the type specimen, preserved in alcohol. The material was so hard that satisfactory sections could not be obtained. Although the gross structure could be determined, it was impossible to follow the smaller tubules or to work out the details of the lymph system.

The worms measure 8 to 11 mm. in length, 5 to 7 mm. in width, and 4 to 6 mm. in thickness. The acetabulum is from 2.3 to 3.0 mm. in diameter. The oral sucker is 1.0 to 1.5 mm. in length, and from 1.6 to 1.7 mm. in diameter. It is probable that the sucker is spherical in living specimens and capable of much variation in shape as different attitudes are assumed. The oral sucker is not sharply delimited from the large median evagination as may be seen by examination of figure 18. Figures 18, 19, and 20 give a better idea of the oral evagination than a verbal description. The structure is very large, but so irregular in form that measurements are almost useless. It may extend 3.0 mm. in length. The wall varies in thickness, due to contraction or elongation of a particular part, and may be almost as thick as the wall of the oral sucker. In the sectioned worms it measures from 0.4 to 0.5 mm. in thickness. Its structure it does not differ essentially from the wall of the oral sucker; the texture is somewhat more loose and open, but the same elements are present. The oral evagination extends almost to the dorsal wall of the body; ventrally it is in close apposition to the genital structures (Fig. 20), and caudally it extends to the level of the cephalic testis. The esophagus arises from the median, anterior, ventral aspect of the oral evagination and passes caudally to about the level of the genital pore. The wall is only slightly thickened. On the ventral side of the body the alimentary tract bifurcates and the two ceca then turn dorsally one on each side of the body. Their course is very sinuous (Fig. 18) and they extend into the zone of the acetabulum.

The excretory system shows no differences from that found in *Paramphistomum*. It seems probable that the system is characteristic and uniform for each subfamily and consequently no differences would be expected. The vesicle is large with much-folded walls (Fig. 19) and communicates with the exterior by means of a short, thick-walled canal. As noted previously, it has not been possible to trace the course and relations of the smaller tubules.

The lymph system also manifests agreement with that found in *Paramphistomum*, type of the subfamily, and with that of *Cotylophoron* described in the preceding section. There are two principal vessels which run longitudinally on the median sides of the digestive ceca. Posteriorly, branches from these vessels form a plexus about the excretory vesicle and others supply the region of the acetabulum. Numerous flattened offshoots from the longitudinal canals merge with each other and form a reticulum which encloses the digestive ceca. Anteriorly the longitudinal canals subdivide to form many sinusoidal tubules supplying the cephalic end of the worm. From the chief longitudinal canals branches pass medially from either side to supply the testes and ovary. The testes are subdivided into many small lobes, each of which is partially enclosed by a lymph sinus.

The testes lie in or near the median plane, one before the other. Maplestone reports that the posterior testis is much nearer the ventral wall than the anterior one and such a condition is shown in his figure. Examination of the figure, however, shows that the specimen is much contracted and this undoubtedly accounts for the position of the testes. These organs are deeply lobed, and the lobes are small and numerous. It is possible that with increasing maturity the separate branches may grow larger, giving the organ a more uniform appearance. The vasa deferentia were not traced, the seminal vesicle was empty and consisted of a small coiled tube. The musculature which surrounds the genital pore, the relations of the genital ducts, and the structure of the copulatory structure is shown in figure 20. In general form the male system is similar to that of *S. compactus* as described by Fischæder. The female system in these specimens is not so well developed as in the male. The ovary and shell-gland are very small, and the vitellaria consist of a few small follicles along the sides of the body. The ovary measures from 0.3 to 0.35 mm. in diameter. The uterus occupies the usual position; at first it turns backward, then ventrally under the posterior testis in a few loose coils, then dorsally behind the caudal testis and anteriorly over the testes where it turns ventrad and unites with the ejaculatory duct to form a hermaphroditic canal opening through a small papilla. No eggs were present in any of the specimens and no spermatozoa were observed in the female tract. Laurer's canal branches from the oviduct just where it enters the shell gland and passes dorsally, opening to the dorsal surface in the median line anterior to the excretory pore.

STEPHANOPHARYNX

LOOSE LEAF ORGANIZER

SCHEDULE

DD TIME								
IRSE ON. RUCTOR								
IRSE E. RUCTOR								
IRSE ED. RUCTOR								
IRSE U. RUCTOR								
IRSE I. RUCTOR								
IRSE T. RUCTOR								

NAME _____

ADDRESS _____

SCHOOL _____

TELEPHONE _____

Stichorchis (Fischöder, 1901) Looss, 1902

Generic diagnosis. — Paramphistomidae, Cladorchiinae, Cladorchiini: Body elongate pyriform, straight or somewhat curved ventrad. Acetabulum ventral. Oral sucker with anterior sphincter and posterior diverticula. Esophagus without bulb. Ceca slightly wavy, reaching to level of

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SYSTEMA HELMINTHUM

acetabulum or beyond it. Testes large, branched, tandem, in middle third of body. Cirrus pouch small. Genital sucker present. Ovary posttesticular, pre-acetabular. Laurer's canal opening anterior to excretory pore. Uterus winding dorsal to testes. Vitellaria extending along ceca throughout their length or from testicular zone to acetabular zone, intruding medial to cecal ends. Excretory pore dorsal to acetabulum. Lymphatic system of three pairs of longitudinal trunks. Parasitic in intestine of mammals.

Genotype: *S. giganteus* (Dies., 1835) Fischöder, 1901 (Pl. 94, Fig. 1129), in *Dicotyles albirostris*, *D. torquatus*, *D. pecari*, *Sus scrofa*; Brazil, Venezuela. Also in agoutis; Trinidad.

Other species:

S. subtriquetrus (Rud., 1814), syn. *Paramphistomum castori* Koloid et Park, 1937 — Erikson (1944), in *Castor fiber* and *Bos taurus*; Germany. Also in *Castor canadensis carolinensis*, *C. canadensis mexicanus*; N. America, Mexico. *Ondatra zibethica*; N. America, Europe.

Precercarial development — Bennett and Humes (1939); cercaria develops in *Fossaria parva*, emerges about 50 days after infection and encysts within an hour on lettuce, becoming infective immediately. Mature worms were recovered from guinea-pigs four and a half months after ingestion of cysts — Bennett and Humes (1939). Cf. Orloff (1941).

STICHORCHIS

Taxorchis Fiscoeder, 1901

Generic diagnosis. — Paramphistomidae, Cladorchiinae, Cladorchiini: Body elongate pyriform to elliptical, flattened ventrally and somewhat convex dorsally. Acetabulum terminal. Oral sucker with diverticula, esophagus without muscular thickening. Ceca wide, long, somewhat sinuous, terminating in acetabular zone. Testes branched, symmetrical, near intestinal bifurcation and widely separated from acetabulum and ovary. Cirrus pouch containing winding seminal vesicle and prostatic complex. Ductus hermaphroditicus and genital sucker present. Ovary pre-acetabular. Uterus intercecal, chiefly posttesticular, unusually well developed. Vitellaria extending in extracecal fields between testes and acetabulum. Excretory pore in acetabular zone, caudad of opening of Laurer's canal. Lymph system of three pairs of longitudinal trunks. Parasitic in ceca of mammals.

Genotype: *T. schistocotyle* (Fiscoeder, 1901) (Pl. 95, Fig. 1150), in *Dicotyles torquatus*, *Tayassus tajacu*, *Hydrochoerus capibara*; Brazil. Also in *Hydrochoerus isthmus*; Panama.

LOOSE LEAF ORGANIZER

SCHEDULE

PERIOD OR TIME								
COURSE MON.								
INSTRUCTOR								
COURSE TUE.								
INSTRUCTOR								
COURSE WED.								
INSTRUCTOR								
COURSE THU.								
INSTRUCTOR								
COURSE FRI.								
INSTRUCTOR								
COURSE SAT.								
INSTRUCTOR								

NAME _____

ADDRESS _____

SCHOOL _____

TELEPHONE _____

Ugandocotyle Näsmark, 1937

Generic diagnosis. — Paramphistominae, Paramphistomini: Body oval. Acetabulum ventroterminal, with its margin covered up by body fold; acetabular index 1 : 3.8. Oral sucker enormous, deeply imbedded in body. Esophagus without muscular thickening. Testes lobed, quadrangular to wedge-shaped, tandem. Seminal vesicle convoluted, pars muscosa absent. No cirrus pouch. Neither genital sucker nor genital calyx, though the genital pore is surrounded by somewhat muscular tissue. Ovary anterior to acetabulum. Laurer's canal crossing excretory vesicle. Vitellaria in lateral fields. Uterine coils dorsal and anterior to testes. Parasitic in stomach or intestine of *Hippopotamus*.

Genotype: *U. pisum* (Leiper, 1910) (Pl. 92, Fig. 1105), syn. *Paramphistomum cervi* of Fukui, 1929 — Sprehn (1932), Dawes (1936), in *Hippopotamus amphibius*; Uganda.

UGANDOCOTYLE

Wardius Barker et East, 1915

Generic diagnosis. — Paramphistomidae, Cladorchiinae, Cladorchiini; Body subcylindrical. Acetabulum subterminal. Oral sucker with diverticula. Esophagus without bulb. Ceca distinctly sinuous, terminating in acetabular zone. Testes indented, tandem, in middle third of body. Neither cirrus pouch nor genital sucker. Genital pore bifurcal. Ovary about midway between posterior testis and acetabulum. Laurer's canal opening anterior to excretory pore. Uterus winding posterior and dorsal to testes. Vitellaria extending in lateral fields from level of oral sucker to acetabular zone. Excretory vesicle and pore dorsal to acetabulum. Lymphatic system? Intestinal parasites of mammals.

Genotype: *W. zibethicus* Barker et East, 1915 (Pl. 93, Fig. 1118), in cecum of *Fiber zibethicus*; N. America.

Wardius sibethicus Barker and East, *Gen. et sp. nov.*¹⁰ (Plate II, Fig. 3).

Large thick worms, 4 to 13 mm. long by 1 to 4.5 mm. wide; body broadly oblongate; anterior end tapering and bluntly conical, posterior end broader and rounded. Cuticula smooth without spines or

PARASITES OF AMERICAN MUSKRAT

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wart-like projections. Oral sucker absent; large muscular, cup-shaped sucker, posterior, ventral and subterminal; antero-posterior diameter 1.116 to 2.79 mm., transverse diameter 1.116 to 2.294 mm.; opening of sucker 0.3 to 1.55 mm. in diameter. Small, terminal mouth leads directly into muscular, elongated, cup-shaped pharynx (or oral sucker), size 0.434 to 0.992 mm. by 0.434 to 0.992 mm. pharynx with two dorsal, postero-lateral pockets often as large as pharynx; 0.45 to 1.08 mm. in length by 0.45 to 0.99 mm. in breadth. Pharynx leads into well-developed simple esophagus, without muscular thickenings; 0.62 to 2.17 mm. long and 0.186 to 0.30 mm. wide, bifurcating at level of first and second fourths of body; intestinal ceca sinuous, with numerous short lateral pockets, terminating blindly at level of anterior margin of posterior sucker.

Two testes weakly, but not regularly lobed, close together in tandem position in middle third of body. Testes vary from orbicular to transversely elliptical, 0.496 to 1.736 mm. in length by 0.496 to 2.294 mm. in width.

Male genital tract terminates in much convoluted and distended vesicula seminalis followed by slightly convoluted pars muscosa and pars prostatica surrounded by prostate gland. Short ductus ejaculatorius opens at base of genital papilla, ventral, right or left of median plane just posterior to intestinal bifurcation and slightly anterior to anterior margin of anterior testis; hermaphroditic duct and genital sucker absent. Ovary median, at level of posterior third of body, orbicular or transversely oval with smooth or undulating margin. Shell gland somewhat diffuse, right or left of, and posterior to ovary. Laurer's canal right or left and posterior to ovary; opening dorsal, median, slightly anterior to posterior sucker. Vitelline glands small globular acini, continuous, extending from level of pharynx to middle of posterior sucker, almost entirely outside of intestinal ceca. Two transverse vitelline ducts and prominent yolk reservoir at level of shell gland. Uterus in median plane, anterior to the ovary. Coils transverse, loose to compact. Metraterm opens at base of genital papilla through common genital pore.

Eggs, elongated, oval, numerous; opercular end tapering, 0.016 to 0.019 mm. by 0.009 to 0.014 mm. Operculum small, opercular rim absent. Excretory system complex consisting of two longitudinal canals, mesal of intestinal ceca, with numerous anastomizing laterals, extending from anterior end to posterior sucker where they empty into large vesicular reservoir dorsal and in part posterior to anterior margin of posterior sucker. Excretory pore dorsal, median at level of anterior margin of posterior sucker.

Generally found in cecum of host.



10. Abstract from unpublished research by Franklin D. Barker and Anna M. East.

SEE MURRELL (1965) FOR LIFE CYCLE.

WARDIUS

LOOSE LEAF ORGANIZER

SCHEDULE

OD TIME								
IRSE ON. TRUCTOR								
IRSE E. TRUCTOR								
URSE ED. TRUCTOR								
URSE IU. TRUCTOR								
URSE II. TRUCTOR								
URSE AT. TRUCTOR								

NAME _____

ADDRESS _____

SCHOOL _____

TELEPHONE _____

Watsonius Stiles et Goldberger, 1910

Generic diagnosis. — Paramphistomidae, Pseudodiscinae: Body pyriform, flattened ventrally and convex dorsally. Acetabulum ventral or ventroterminal, with small aperture. Oral sucker with paired pouch-like evaginations, esophagus with posterior muscular thickening. Ceca straight, terminating at level of acetabulum or further in front. Testes lobed, tandem; pars muscosa not enormously developed. Cirrus pouch absent. No genital sucker. Ductus hermaphroditicus apparently absent. Genital pore prebifurcal. Ovary posttesticular, Laurer's canal opening cephalad of excretory pore. Uterus intercecal, winding posterior and dorsal to testes. Vitellaria extending along outside of ceca from bifurcal zone to slightly postcecal or acetabular zone. Excretory pore caudad of vesicle, in acetabular zone. Parasitic in intestine of man and monkeys.

Genotype: *W. watsoni* (Conyngham, 1904) Stiles et Goldberger, 1910 (Pl. 94, Fig. 1140), syn. of *Pseudodiscus hawkesi* (Cobb., 1875) — Bhale-
rao (1933), in jejunum and duodenum of man and monkeys (*Cercopithecus*, *Papio*); Africa.

Other species:

W. deschiensi Pick, 1951, in *Papio sphinx*; locality not given.

W. macaci Kobayashi, 1915, syn. of *W. watsoni* — Maplestone (1923), Lane and Low (1923), in cecum of *Macacus cynomolgus*; Japan.

Paramphistomatidae

Watsonius watsoni (Conyngham, 1904) Stiles & Goldgerger, 1910

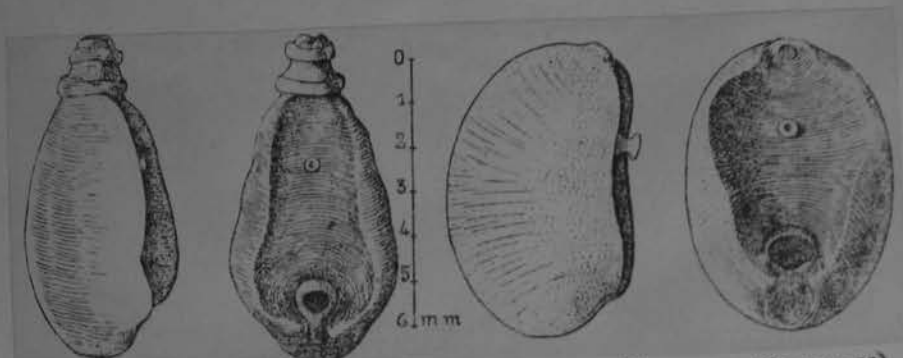


Fig. Papio sphinx (L.)
FRENCH GUINEA

Fig. Papio papio (DCSMABET)
FRENCH GUINEA

FIGS. FROM DELLEUS, 1950

WATSONIUS