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Binder 191, Spirochiidae A-Z [Trematoda Taxon Notebooks]

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Spirorchidae

History up to 1935 (frpm Sinha,1934)

" The family Spirorchidae was erected by Stunkard (1921) to include the blood flukes from the turtles and originally contained only two genera - Spirorchis and Hapalotrema- which differ from each other in many features of their anatomy, and were placed in distinct subfamilies, Spirorchinae and Hapalotreminae. The same year Stunkard had shown that Spriorchis MacCallum,1918, and Proparorchis Ward,1921 are synonymous thereby invalidating the family Proparorchidae as defined by the latter author. The bulk of the work on the family has been done by Stunkard, who in 1922 described two new genera, Henotosoma and Hapalorhynchus, one under each of the two subfamilies, from North American turtles. The same author (1923) while reviewing the family Spirorchidae, described a new genus Haematotrema, and several new species of the genus Spirorchis. Subsequently he has considerably added to our knowledge of the family and has furthur described two new genera, Vasotrema and Unicaecum, from tortoises. Ejsmont (1927) added the genus Spirhapalum, from the blood vessels of Emys orbicularis and erected the genus, Diarmostorchis for Spirorchis blandingi of MacCallum (1926) owing to the position of the ovary between the testes. Thapar(1933) described a new genus Tremarhynchus from an Indian tortoise, Trionyx gangeticus and considered it to be a connecting link between the two known genera of the subfamily Hapalotreminae Stunkard,1921. Mehra (1933) described two new species of a new genus, Coeuritrema, from Allahabad and furthur discussed the relationships of the families of the blood flukes."

Sinha (1934) names a new genus, new species, Comtiotrema sabguina from the blood vessels of an Indian tortoise, Hardella thurgi (Gray).

Spirorchidae

GOMTIOTREMA Sinha, 1934

"Hermaphroditic, blood-inhabiting distomes, with protrusible suckers; no cuticular spines; relatively long esophagus; a loop in the intestineal caeca at their origin from the esophagus. Testes 12, oval to spherical, preovarial, arranged in linear series, intercaecal; vesicular seminalis continued into a narrow ejaculatory duct; genital pore lateral and posterior. Ovaru dome-shaped, trilobed posteriorly, anterior to the genital pore; vitellaria extensive; receptaculum seminis and Laurer's canal present . Uterus short, with a single large egg which is knobbed.

Host: Hardella thurgi (Gray)
Locality: Lucknow, River Gomti. India
Reference: Records of the Indian Museum vol.36, p.147-151

SPIRORCHIDAE Stunkard, 1921

Small, delicate hermaphroditic blood flukes with poorly developed musculature; monostomes or distomes. Pharynx absent; esophagus long, surrounded by salivary gland cells, which are numerous near its extremity; intestinal ceca ending blindly near posterior end, with or without fowardly directed loops at their origin; onely one cecum in Unicaecum. Genital pore sinistral, dorsal or ventral, about middle of body length or near hind end. Testes two with ovary between them (Hapalorhynchus, Coeuritrema), divided into a large number of follicles forming two masses, one in front of and other behind ovary (Hapalotrema), one large undivided testis behind ovary (Vasotrema) in front of ovary (Unicaecum), divided into follicles in a linear series anterior to ovary (Spirorchis, Spirhapalum) or last one or two follicles behind ovary (Diarmostorchis, Spirhapalum). Ovary usually lobed, median, to right or left side, a little behind middle, or near hind end of body, or long and rolled in posterior part of body (Unicaecum); seminal receptacle and Laurer's canal present or absent. Cirrus sac small, well developed or rarely absent (Hapalorhynchus); external seminal vesicle large; protrusible cirrus well developed in some genera. Uterus short; metraterm poorly or strongly developed; ovum large with or without polar filament or filaments, discharged singly. Vitellaria lateral and extensively developed. Excretory vesicle small, dividing almost immediately into lateral ducts. Parasites in blood of turtles.

Type genus : Spirorchis MacCallum, 1918
Synonym: Proparorchis Ward, 1921

Key to subfamilies:

1. Genital pore and ovary near middle of body. ~~Genital p-~~ Hapalotreminae

   Genital pore and ovary near hind end.....2

2. Testes in a linear series all, or except one or two in front of ovary; two intestinal ceca..... Spirorchinae

   Testes one continuous lobed structure and not divided into follicles; one intestinal cecum present.....Unicaecumiinae.

Stunkard (1921) described the family Spirorchiidae for the genera *Hapalotrema* Looss, 1899; *Spirorchis* Mac Callum, 1919 syn. *Proparorchis* Ward, 1221; *Hematosoma* Stunkard, 1923; *Haematotrema* Stunkard, 1923; *Hapalorhynchus* Stunkard, 1923; *Vasotrema* Stunkard, 1926; *Unicaecum* Stunkard, 1927; *Spirhapalum* Ejsmont, 1927 and *Diarmosterchis* Ejsmont, 1927. The same year Stunkard divided the family Spirorchiidae into two subfamilies SPIRORCHIINAE for the genera *Spirorchis*, *Hematosoma*, *Haematotrema* and *Unicaecum* and subfamily HAPALOTREMINAE for the genera *Hapalotrema*, *Hapalorhynchus* and *Vasotrema*.

Ejsmont (1927) considered the genera *Spirhapalum* and *Diarmosterchis* as connecting genera and suggested to drop the two subfamilies.

Mehra (1933) described the genus *Coeuritrema* under the subfamily HAPALOTREMINAE for *C. lyssimus* and *C. odhneresis*. Same year Thapar described *Tremarhynchus indicus* which Price (1934) considerd synonymous with *Hapalorhynchus* and transferred it to the genus *Hapalorhynchus* under the name *H.* (*T.*) *indicus* and added three genera of blood flukes under the family Spirorchiidae; *Neospirorchis*, *Amphiorchis* and *Learedius*. Mehra (1934) held *Tremarhynchus indicus* synonymous with *Coeuitrema* and transferred *T. indicus* to the genus *Coeuritrema* under the name *C. indicus* (Thapar, 1933). The genus *Coeuritrema* was retained on the basis of priority of publication. (Mehra, 1933 described *Coeuritrema* in the month of May whereas Thapar, 1933 described *Tremarhynchus* in the month of June.) Same year Mehra described a new genus *Plasmiorchis* with *P. orientalis* as type species, other species being *P. pelluccha*, *P. hardelli* and *P. obscurum*. Mehra (1934) held *Hematosoma* Stunkard, 1922 and *Haematotrema* Stunkard, 1923 synonymous with *Spirorchis* and described subfamily UNICAECUMINAE with the type genus *Unicaecum* Stunkard, 1937. He proposed that *Neospirorchis* should also be included in this subfamily, the close relationship of which has already been discussed by Price.

Byrd (1939) while revising the family Spirorchiidae followed Stunkard in considering *Plasmiorchis* synonymous with *Spirorchis* and *Spirahapalum* with that of *Hapalotrema* and added three species of blood flukes to the genus *Hapalorhynchus*; *H. vaginatum*, *H. reelfooti* and *H. stunkardi*. Skrjabin (1951) did not agree to this synonymy. Mehra (1939) described *Learedius orientalis* and a new genus *Monticellus* with the type species *M. indicus*, held *Gomtiotrema* Sinha, 1934 synonymous with *Plasmiorchis* and described the genus *Hemiorchis* for the reception of *Plasmiorchis hardelli* which differed from its allied species in having a well developed glandular vesicle. Mehra (1940) described a new genus *Enterohaematotrema* from the intestine of freshwater tortoise *Lissemys punctata* with *E. palaeorticum* as its type species and added one more species to the genus *Hemiorchis*, *H. bengalensis*. Manter and Larson (1950) described the genus *Carettacola* for the reception of the blood flukes having 'vagina' with *C. bipora* as type species.

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Skrjabin (1951) described the subfamily NEOSPIRORCHINAE for the reception of *Neospirorchis* Price, 1931. Martin and Bamberger (1952) added the genus *Haemoxenicon* with *H. stunkardi* as type species. Simha (1958) described the genus *Hepatohaemotrema* under the subfamily HAPALOTREMINAE for the reception of *H. hepaticum* collected from the liver of *Kachuga kachuga*.

Yamaguti (1958) divided the subfamily SPIRORCHIINAE into two tribes, tribe SPIRHAPALINI for *Learedius*; *Monticellus*; *Spirhapalum* and *Plasmiorchis* and tribe SPIRORCHIINI for *Diarmostorchis* and *Spirorchis*. Same year he held *Hemiorchis* Mehra, 1939 synonymous with *Plasmiorchis* Mehra, 1934 without amending the generic diagnosis of *Plasmiorchis* Mehra, 1934. Author thinks that this synonymy is not justified because the presence of well developed cirrus sac, great reduction in the size of external seminal vesicle and the enormous development of glandular vesicle in *Plasmiorchis hardellii* Mehra, 1934 are sufficient characters for separating the above mentioned species under a new genus *Hemiorchis*. In view of the above discussion *Plasmiorchis hardellii* is again being transferred to the genus *Hemiorchis*. Same year Yamaguti described five subfamilies under the family Spirorchiidae; TREMARHYNCHINAE for *Tremarhynchus* and *Enterohaematotrema*; AMPHIORCHIINAE for *Amphiorchis*; VASOTREMATINAE for *Vasotrema*; CARETTACOLINAE for *Carettacola* and *Haemoxenicon* and HAPALORHYNCHINAE for *Hapalorhynchus*. Under TREMARHYNCHINAE he had included *Coeuritrema* as a synonym of *Tremarhynchus*. Srivastava (1960) in his Presidential address pointed out that the above synonymy is untenable on account of the priorty of publication of *Coeuritrema* over *Tremarhynchus* therefore the subfamily should be named COEURITREMATINAE SYN. TREMARHYNCHINAE.

DWIVEDI, 1967
INDIAN J. HELMINTHOL. 19(1): 1-14

Classification of Spirorchidae after Mehra (1933) and largely in accord with Stunkard (1926,1927,1928) and Ejsmont (1927).

SPIRORCHIDAE

Spirorchinae Stunkard

Spirorchis MacCallum,1918
(Synonym: Proparorchis Ward,1921)
Henostomoma Stunkard,1923
Haematotrema Stunkard,1923
Unicaecum Stunkard,1927
Spirhapalum Ejsmont,1927
Diarmostorchis Ejsmont,1927

Haplotreminae Stunkard

Hapalotrema Looss,1899
Hapalorhynchus Stunkard,1922
Coeuritrema Mehra,1933
Vasotrema Stunkard,1926

see Byrd,1939

Classification of Spirorchidae after Mehra (1933) and
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SPIRORCHIDAE

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Henostomoma Stunkard,1923
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Unicaecum Stunkard,1927
Spirhapalum Ejsmont,1927
Diarmostorchis Ejsmont,1927

Haplotreminae Stunkard

Hapalotrema Looss,1899
Hapalorhynchus Stunkard,1922
Coeuritrema Mehra,1933
Vasotrema Stunkard,1926

see Byrd,1939

SPIRORCHIIDAE Stunkard, 1921

Syn. Proparorchidae Ward, 1921

Family diagnosis. — Digenea with slender to lanceolate body. Acetabulum present or absent. Oral sucker present. Pharynx usually lacking. Esophagus surrounded by gland cells. Ceca long, exceptionally single. Testes single, double or numerous, intercecal, anterior or posterior to ovary or separated by this. Cirrus pouch present or absent. Genital pore ventral, lateral or dorsal. Ovary submedian, in posterior or anterior half of body, variable in position in relation to testes. Receptaculum seminis and Laurer's canal present or absent. A peculiar vagina-like organ may be present (*Carettacola*). Vitellaria follicular, extracecal or circumcecal. Uterus short. Eggs large, single or few. Excretory vesicle V- or Y-shaped. Parasitic in circulatory system, occasionally in intestine (?) of turtles.

Type genus: *Spirorchis* MacCallum, 1919

Key to subfamilies of Spirorchiidae

1. Ceca single; acetabulum absent; testes forming a longitudinal central column; vas deferens winding dorsal to testis; cirrus pouch present; genital pore near posterior extremity ..... Unicaecinae
   Ceca double 2
2. Ceca united into a long unpaired duct; testis and ovary tubular, long, winding backward alongside each other; genital pore near posterior extremity ..... Neospirorchiinae
   Ceca not united posteriorly 3
3. Testes numerous, entirely or mostly preovarian; cirrus pouch small; genital pore postovarian; vitellaria extending whole length of ceca; acetabulum present or absent ..... Spirorchiinae
   Testes two, with ovary between; acetabulum present; vitellaria extending whole or almost whole length of ceca .. 4
   Testes numerous, divided by ovary and terminal genitalia into an anterior and a posterior group; acetabulum present; vitellaria extending for whole postacetabular portion of ceca ..... Hapalotrematinae
   Testes entirely postovarian; acetabulum present; vitellaria extending for whole postovarian portion of ceca 5
4. Cirrus pouch more or less strongly developed between acetabulum and anterior testis; genital pore immediately postacetabular, dorsal or ventral, median or submedian ..... Tremarhynchinae
   Cirrus pouch well developed between anterior testis and ovary, with external seminal vesicle in front; genital pore immediately preovarian, ventral; vitellaria interrupted opposite ovary ..... Amphiorchiinae
5. Acetabulum muscular as usual; testis coiled spirally; seminal vesicle voluminous, cirrus pouch small, both between acetabulum and ovary; genital pore ventral at level of ovary or between ovary and acetabulum. Vasotrematinae
   Acetabulum weakly muscular or rather membranous; testes numerous, occupying whole postovarian intercecal field; cirrus pouch well developed, with external seminal vesicle in front; genital pore ventral, at level of cirrus pouch; peculiar saccular organ ("vagina") present or absent ..... Carettacolinae

Spirorchiinae Stunkard, 1921

Subfamily diagnosis. — Spirorchiidae: Body lanceolate, spatulate or band-like. Oral sucker small, occasionally well developed. Esophagus usually long, ceca simple or somewhat sinuous, terminating at or near posterior extremity. Acetabulum present or absent. Testes numerous, arranged in longitudinal row or massed together in postacetabular intercecal field; posterior testes (1—2) may be separated from the rest by ovary and terminal genitalia. External seminal vesicle anterior, lateral or dorsal to ovary. Cirrus pouch weakly developed. Genital pore ventral, median or submedian, immediately postovarian. Ovary submedian, near posterior extremity. Vitellaria extending whole length of ceca. Excretory vesicle Y-shaped, small. Divided into two tribes as follows:

Key to tribes of Spirorchiinae

Acetabulum present; cirrus pouch more or less well developed ..... Spirhapalini
Acetabulum absent; cirrus pouch weakly developed .... Spirorchiini

Spirorchiini n. trib.

Tribe diagnosis. — Spirorchiinae: Acetabulum absent. Posteriormost testis may be postovarian. Cirrus pouch weakly developed. Genital pore submedian. Vitellaria extracecal.

Key to genera of Spirorchiini

Posteriormost testis separated from the rest by ovary and terminal genitalia ..... *Diarmostorchis*
Testes entirely preovarian ..... *Spirorchis*

SPIRORCHINÆ

The subfamily Spirorchinæ is characterized as follows.

Hermaphroditic blood inhabiting monostomes with small oral sucker. Esophagus without pharynx and surrounded by secretive cells which are more numerous near its posterior end. Ceca end blindly near posterior end of body; excretory vesicle small, dividing almost immediately into lateral collecting ducts. Testes numerous (usually ten) arranged in a linear series in the intercecal area anterior to the ovary; cirrus sac small; ovary dextral in position between the testes and the genital pore; seminal receptacle and Laurer's canal present; vitellaria both extra and intercecal; genital pore ventral, sinistral, near the posterior end of body; uterus short, containing a single oval egg.

From Stunkard, 1922

SPIRORCHIDAE

Spirorchis MacCallum, 1919
Syn. *Proparorchis* Ward, 1921
Haematotrema Stunkard, 1923

Generic diagnosis. — Spirorchiidae, Spirorchiinae, Spirorchiini: Body lanceolate or slender, band-like, smooth. No acetabulum. Oral sucker small, prominent. Esophagus long or rather short, surrounded by gland cells, which are massed together at its posterior end. The pharynx is illustrated in MacCallum's original figure of the type specimen, but it has not been observed in any of the other species of the genus reported hitherto. Ceca with simple or sinuous wall, terminating at or near posterior extremity. Testes numerous, lobed or not, arranged in a single longitudinal row in preovarian median field, leaving a small or considerable free space behind intestinal bifurcation. Seminal vesicle immediately behind posteriormost testes. Cirrus pouch small. Genital pore sinistral, ventral, at or near level of posterior end of ovary. Ovary posttesticular, on right of median line or practically median near posterior extremity. Laurer's canal present but no receptaculum seminis. Vitellaria chiefly lateral or circumcecal, extending throughout entire length of ceca; transverse ducts and median reservoir postovarian. Receptaculum seminis uterinum may be present; uterus short, containing not more than one egg; oculate miracidia in eggs taken from blood vessels of host. Parasitic in blood vessels of freshwater turtles. Divided into two subgenera as indicated in the key.

Genotype: *S.* (*S.*) ***innominatus*** Ward, 1921 (Pl. 45, Fig. 552), syn. *S. eustreptos* MacCallum, 1921; *S. emydis* MacCallum, 1921; *S. pictae* MacCallum, 1926, in *Clemmys insculpta*, *Graptemys geographica*; N. America.

Key to subgenera of *Spirorchis*

Body slender, band-like; testes in posterior half of body .... *Henotosoma*
Body lanceolate; testes occupying most of preovarian intercecal field ..... *Spirorchis*

A. Subgenus *Spirorchis* (MacCallum, 1919) (Type: ***innominata*** Ward, 1921)

S. (*S.*) *artericola* (Ward, 1921) Stunkard, 1925, syn. *Proparorchis a.* W., in heart and arteries of *Pseudemys*, *Malacoclemmys*, *Graptemys*, and *Chrysemys*; U.S.A. *Helisoma trivolvis* — Pieper (1953).

S. (*S.*) *blandigioides* Byrd, 1939, in mesenteric vessels of *Pseudemys troostii* and *P. hieroglyphica*; Tennessee. Also in *P. floridana*, *P. scripta*; U.S.A.

S. (*S.*) *elegans* Stunkard, 1923, in washings of dissected intestine of *Pseudemys elegans*, *P. scripta*, *Chrysemys picta*; N. America.

S. (*S.*) *emydis* MacCallum, 1921, syn. of *S. innominata* Ward — Byrd (1939), in lung of *Emys blandingii*; Ohio.

S. (*S.*) *eustreptos* MacCallum 1921, syn. of *innominata* Ward, 1921 — Byrd (1939), in mesenteric artery of *Chelopus insculptus*; N. America.

S. (*S.*) *magnitestis* Byrd, 1939, in wall of heart of *Chelydra serpentina*; N. America.

S. (*S.*) *picta* Stunkard, 1923, syn. of *S. elegans* Stunkard, 1923, in arteries of *Chrysemys picta*; N. America.

S. (*S.*) *pictae* MacCallum 1927, syn. of *S. innominata* Ward, 1921 — Byrd, 1939, in mesenteric artery of *Chrysemys picta*; N. America.

S. (*S.*) *pseudemydae* Byrd, 1939, in *Pseudemys troosti*; Tennessee.

S. (*S.*) *scripta* Stunkard, 1923, in heart of *Pseudemys scripta*, *P. floridana*, *Graptemys pseudogeographica*; N. America.

S. sp. in arterioles of muscular gut wall of *Chrysemys picta*.

Eggs containing miracidia when passed from host, hatching after 4 to 6 day incubation at room temperature; miracidia have 18 dermal plates in 4 rows, each with 6, 6, 4 and 2 plates respectively; flame cells of two pairs. Mother sporocysts develop in lymph spaces along gut of snail hosts, *Helisoma trivolvis* and *H. campanulatum*. Daughter sporocysts with 6 pairs of flame cells and terminal birth pore. Cercaria oculate, apharyngeal, brevifurcate, resembling *C. elephantis* and *C. wardi*; body and tail spinose, body with dorsal fin, humped above insertion of tail; esophagus long, ceca short; oral sucker larger than acetabulum; tail more than twice as long as body; furcae with dorsoventral fin-

folds; bladder V-shaped; main excretory ducts with ciliated patches; flame cell formula 2 [(1+1+1)+(1+1+1)]; penetration glands of 7 pairs in immature cercaria from crushed snails, 6 pairs in free-swimming cercaria. At room temperature worms become sexually mature 3 and a half months after infection. — Wall (1939).

B. Subgenus *Henotosoma* (Stunkard, 1922) (Type: *haematobius* Stunkard, 1922)

S. (*H.*) *chelydrae* (MacCallum, 1926) syn. of *S. haematobius* (Stunkard) — Byrd (1939), in heart of *Chelydra serpentina;* N. America.

S. (*H.*) *elephantis* (Cort, 1917) in *Chrysemys picta;* Michigan.
Apharyngeal, oculate, furcocercous cercaria develops in *Helisoma trivolvis* and *H. campanulatum*. Free-swimming cercariae emerge from the hosts 26 to 30 days after infection. Sexually mature worms were recovered in 3 and a half months. — Wall (1941).

S. (*H.*) *haematobius* (Stunkard, 1922) in heart, larger arteries, lung, etc. of *Chelydra serpentina;* U.S.A.

S. (*H.*) *minutus* (Byrd, 1939) in mesenteric vessels of *Chelydra serpentina;* Tennessee.

S. (*H.*) *parvus* (Stunkard, 1923), syn. *Haematotrema p.* S., in arteries of *Chrysemys picta;* New York and New Jersey.
Apharyngeal furcocercous cercaria develops in *Helisoma trivolvis* and *H. campanulatum* — Wall (1941).

Genus Spirorchis MacCallum, 1918

Syn: *Proparorchis* Ward, 1921; *Henotosoma* Stunkard, 1922; *Haematotrema* Stunkard, 1923; *Diarmostorchis* Ejsmont, 1927; *Plasmiorchis* Mehra, 1934; and *Gomtiotrema* Sinha, 1934.

Generic diagnosis: Spirorchinae. Small to medium sized monostomate or distomate blood flukes, with unarmed integument. Esophagus long, with gland cells forming a conspicuous area around posterior part. Intestinal tract often with conspicuous median pouch opposite entrance of esophagus. Caeca ending blindly near posterior end of body. Nerve ring often conspicuous about anterior part of esophagus. Testes indistinctly or distinctly divided into follicles, arranged in linear series anterior to ovary, occasionally with posterior testicular follicle placed posterior to ovary. Vas deferens arising from posterior end of testicular group. Seminal vesicle between ovary and posterior testis, leading into short cirrus sac with weak musculature. Genital pore ventral, left in position, at about level of ovary. Ovary posterior to main testicular mass, close to posterior end of body. Vitellaria follicular, usually occupying all available space in body not occupied by reproductive organs, from esophagus to beyond ends of caeca. Laurer's canal, receptaculum seminis, and small yolk reservoir usually present. Uterus short, containing single ovum. Metraterm weakly muscular. Ova large and spherical, containing miracidia with pigmented eyespots. Excretory bladder short, with short cornua, usually with much coiled reserve vesicle between bladder and genital ducts. Parasitic in blood stream of turtles.

Type species: *Spirorchis innominata* Ward, 1921 (= *S. eustreptos* MacCallum, 1921, *S. emydis* MacCallum, 1921; and *S. pictae* MacCallum, 1926).

Additional species: *S. artericola* Ward, 1921, *S. haematobium* (Stunkard, 1922) (= *Henotosoma haematobium* Stunkard, 1922, and *Spirorchis chelydrae* MacCallum, 1926), *S. scripta* Stunkard, 1923, *S. elegans* Stunkard, 1923 (= *S. picta* Stunkard, 1923), *S. parvum* (Stunkard, 1923) (= *Haematotrema parvum* Stunkard, 1923), *S. blandingi* MacCallum, 1926 (= *Diarmostorchis blandingi* (MacCallum, 1926) Ejsmont, 1927), *S. orientalis* (Mehra, 1934) (= *Plasmiorchis orientalis* Mehra, 1934, and *P. pellucidus* Mehra, 1934), *S. hardelli* (Mehra, 1934) (= *Plasmiorchis hardelli* Mehra, 1934, *P. obscurum* Mehra, 1934), *S. sanguina* (Sinha, 1934) (= *Gomtiotrema sanguina* Sinha, 1934), *S. blandingioides* n. sp., *S. pseudemydae* n. sp., *S. minutum* n. sp., and *S. magnitestis* n. sp.

From the above list of additional species it will be noted that we are able to recognize 10 of the 17 species formerly described as belonging to the genus *Spirorchis* or to a closely related genus. We add 4 new species to the list and these will be described below. Only such species as are represented in the present collection will be discussed in the present paper.

Already we have given reasons for considering the genera *Proparorchis* Ward, *Henotosoma* Stunkard, *Haematotrema* Stunkard, *Diarmostorchis* Ejsmont, *Plasmiorchis* Mehra, and *Gomtiotrema* Sinha to be synonymous with the genus *Spirorchis* MacCallum. The type and additional species formerly included in each of these genera are transferred to the genus *Spirorchis*.

In considering the species we are in agreement with Stunkard (1923) in regarding *S. emydis* MacCallum, 1921, as being identical with *S. innominata* Ward, 1921. MacCallum (1926) described *S. pictae* apparently without regarding *S. picta* Stunkard, 1923, thus making the specific name *pictae* of MacCallum a homonym and unavailable. The material described and illustrated by MacCallum as *S. pictae* closely resembles *S. emydis*, differing only in the slightly smaller size of the body and the slightly more distinct separation of the testes into follicles. These variations would easily fall within the range of species variation, and for this reason we consider *emydis* and *pictae* of MacCallum synonyms of *innominata* Ward. The species *S. chelydrae* MacCallum is considered synonymous with *S. haematobium* (Stunkard) since the almost identical size range of the body and internal organs of the former species led MacCallum to augment the identity of the two species, but in transferring the species to the genus *Spirorchis* apparently MacCallum deemed it necessary to assign a new specific designation to the species.

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The species *Spirorchis picta* Stunkard is considered to be synonymous with *S. elegans* Stunkard, *S. elegans* being selected for the specific designation due to page priority. The general topography of the body of these two species is quite similar in regard to size, the position of the genitals and genital pore, the distribution of the vitellaria and the number of testes. In commenting on the species, *S. picta*, Stunkard stated that it was very closely related to both *S. scripta* and *S. elegans*, but differed from these species in the relative size of the ovary and testes. We are of the opinion that *S. elegans* (or *S. picta*) is justified as a separate species from *S. scripta* only in that the testicular follicles begin some little distance behind the bifurcation and the ovary is larger than any single follicle of the testes whereas in *S. scripta* the ovary is smaller than the testes and these begin very close behind the bifurcation.

We are unable to detect any specific differences between *Spirorchis orientalis* (Mehra) and *S. pellucidus* (Mehra) except for the fact that fully matured specimens of *pellucidus* lose the ventral sucker. The differences noted in the number of testicular follicles and the shape of these structures depend to some extent on the age of the individual specimen. We cannot accept *pellucidus* as a distinct species from *S. orientalis*. The nature of the description and the specific designation of the species *obscurum* Mehra is in question, and since the large number of testicular follicles noted for that species and the characteristic inward loop of the intestine in the area of the genital pore agree so closely with the description of *S. hardellii* (Mehra), we regard *obscurum* as the immature stage of that species.

BYRD, 1939

Key to the Species of the Genus Spirorchis

1	Monostomate flukes	2
	Distomate flukes	12
2	Testicular follicles beginning nearer bifurcation of caeca than middle of body	3
	Testicular follicles begin near middle of body	9
3	Testicular follicles entirely anterior to ovary	4
	Testicular follicles not entirely anterior to ovary	8
4	Testes beginning close behind bifurcation of caeca	*scripta* Stunkard, 1923.
	Testes beginning a little distance behind bifurcation of caeca	5
5	Ovary larger than testes	6
	Ovary as large as or smaller than testes	7
6	Genital pore one-fifth body length from caudal end	*pseudoscriptus* n. sp.
	Genital pore more than one-fifth body length from posterior end	*elegans* Stunkard, 1923.
7	Testes distinctly separated into follicles	*arteriicola* Ward, 1921.
	Testes not separated into distinct follicles	*mammata* Ward, 1921.
8	Posterior testicular follicle large, placed entirely behind genital complex	*blandingi* MacCallum, 1926.
	Posterior testicular follicle small, placed immediately behind ovary	*blandingioides* n. sp.
9	Body large, more than 3 mm. long	10
	Body small, less than 3 mm. long	11
10	Testicular mass large, not separated into distinct follicles	*magniteatis* n. sp.
	Testicular follicles well separated	*haematobium* (Stunkard, 1923).
11	Testicular follicles 10 in number	*minutum* n. sp.
	Testicular follicles 5 or less in number	*parvum* (Stunkard, 1923)
12	Testicular follicles less than 10 in number	*orientalis* (Mehra, 1934).
	Testicular follicles more than 10 in number	13
13	Testicular follicles 12 in number	*sinuosa* (Sinha, 1934).
	Testicular follicles more than 12 in number	*hardellii* (Mehra, 1934).

BYRD, 1939

SPIRORCHIS MacCallum,1918

Small to medium sized monostomate or distomate blood flukes,with spinose or aspinose integument. Esophagus usually long, with gland cells forming a conspicuous area around posterior part. Intestinal tract often with conspicuous median pouch opposite entrance to esophagus. Ceca ending near posterior end of body. Nerve ring often conspicuous about anterior part of esophagus. Testes indistinctly or distinctly divided into follicles,arranged in linear series anterior to ovary. Vas deferens arising from posterior end of testicular group. Vesicular seminalis between ovary and posterior testis, leading into short cirrus sca with weak musculature. Genital pore ventral,sinistral, at about level of ovary. Ovary posterior to main testicular mass,usually close to posterior end of body. Vitellaria follicular,usually occupying all available space in the body not occupied by reproductive organs, from esophagus to beyond eneds of ceca. Laurer s canal receptaculum seminis, and small yolk reservoir usually present. Uterus short, containing single ovum. Metraterm weakly muscular. Ova large,ovoidal or spheroidal, with or without operculum, containing miracidia with pigmented eyespots. Excretory bladder small, V-shaped, with coiled reserve vesicle between bladder and genital ducts. Parasitic in blood stream of turtles.

Type species: Spirorchis innominata Ward,1921

(synonyms: S.eustreptos MacCallum,1921
S.emydis MacCallum,1921
S.pictae MacCallum,1921)

Other species: S.parvus (Stunkard,1923)
(syn. Haematotrema parvum Stunkard,1923)
S.orientalis (Mehra,1934)
(syn. Plasmiorchis orientalis Mehra,1934)
P.pellucidus Mehra,1934)
S.hardellii (Mehra,1934)
(syn. Plasmiorchis hardellii Mehra,1934
P.obscurum Mehra,1934)
S.arteericola

S.elephantis (Cort,1917)

KEY TO SPECIES OF SPIRORCHIS

(from Stunkard,1923)

1(4) Genital pore 1/7 of body length from posterior end.....2
2(3) Testes larger than ovary, not distinctly separated..S.innominata
3(2) Testes smaller " ",distinctly spearated....S.artericola
4 (1) Genital pore ⅛ body length from posterior end.....5
5 (6) Testes large,extend to bifurcation.....S.scripta
6 (7) Testes large, do not extend to " .....S.elegans
7 (6) Testes small, not more than ½ size of ovary....S.picta

Spirorchis innominata Ward, 1921

Spirorchis innominata Ward, 1921

Plate II, Figure 1

This species at present is known by three specimens mounted in toto, the most characteristic of which I have shown in Fig. 1. This is the specimen designated by MacCallum as type, and the measurements of the specimen are, I believe, representative. The other specimens are about the same size and, although bent and slightly distorted, agree in diagnostic features. The type specimen manifests those features described as characteristic of the genus. This worm is 4 mm. long and 0.66 mm. in width near the middle of the body.

The oral sucker is oval, longer than broad, and measures 77 by 54 microns. The esophagus passes posteriad in spiral fashion, the coils elongating and enlarging posteriorly. There are five of these turns, the hinder one much straightened. The esophagus is narrow at its origin from the oral sucker and gradually widens through the first third of its course. Here it is crossed by the commissure of the nervous system. The region posterior to the commissure is broader, measuring 60 microns in width. In total length the esophagus measures 0.64 mm. Its anterior portion is surrounded by a layer of gland cells, giving it a beaded appearance, and at the posterior end for a distance of 0.26 mm. there is a deeply staining mass of these cells around the esophagus. The origin of the intestinal diverticula is well shown in the figure. The ceca slightly exceed the esophagus in width, have lobed or crenated walls, and extend almost to the posterior end of the body. They are filled with decomposing blood, which gives them a black color, and the ends of the ceca approach each other but do not fuse.

The ovary is situated a little to the right of the median line, about one-third of the distance from the posterior testis to the end of the body. It is lobed, about 0.17 mm. in diameter, and the oviduct arises at its median posterior margin. After about 0.09 mm. it expands into the receptaculum seminis uterinum, which passes posteriad on the right side of the body. The seminal receptacle is about as long as the narrow portion of the oviduct and then it is obscured by the large transverse duct from the vitellaria. The vitellaria extend as a mass of follicles from the level of the posterior part of the esophagus to the posterior end of the body. They are principally extraceral in position, but extend into the intercecal areas anterior and also posterior to the other reproductive organs. About 0.42 mm. from the posterior end of the body vitelline ducts pass medial from either side to form a common reservoir. The connection of the vitelline duct with the ootype can not be distinguished, but from this region the uterus passes forward ventrally and laterally to the genital pore. In the uterus there is an egg which measures 77 by 48 microns. I have examined many individuals of *Cleomys inculpta* in the attempt to find worms of this species in the blood vessels. Although I have not been successful in securing adults, I have found eggs in the tissue and in the feces which I believe belong to this species. In the tissue they are slightly larger than the one present in the specimen here described, and eggs in the feces containing living miricidia have an average measurement of 108 by 85 microns.

The testes were described by MacCallum as a rough spiral column almost filling the whole cavity between the ceca. He distinguished an anterior conical mass and nine other irregularly shaped masses. They begin 0.38 mm. behind the bifurcation of the alimentary tract and extend within 0.95 mm. from the caudal end of the body. The seminal

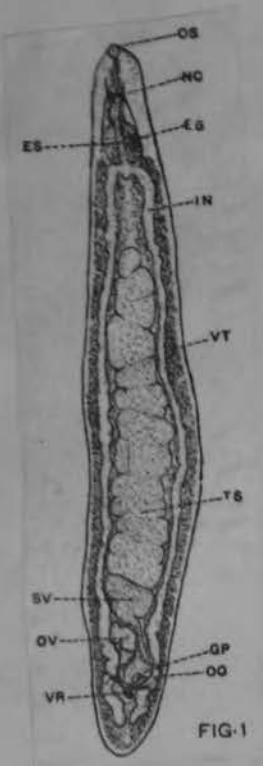


FIG. 1

-OVER-

vesicle as described by MacCallum is conical in shape, its base flush with the posterior face of the last testis, and its apex directed posterad, ventrad and sinistrad. It passes underneath and at the left of the anterior median margin of the ovary. The cirrus sac in this specimen is rather small and opens at the genital pore located beneath the ceca of the left side 0.47 mm. from the posterior end of the body.

Type host, *Clemmys insculpta* (syn. *Chelopus insculptus*).

This species resembles *S. artericola* in the position of the genital pore and *S. scripta* in the massive character of the testes. It differs from *S. elegans* and *S. picta* in both of these features.

STUNKARD, 1923

Spirorchis artericola (Ward, 1921)Stunkard, 1925
syn. Proparorchis artericola Ward, 1921

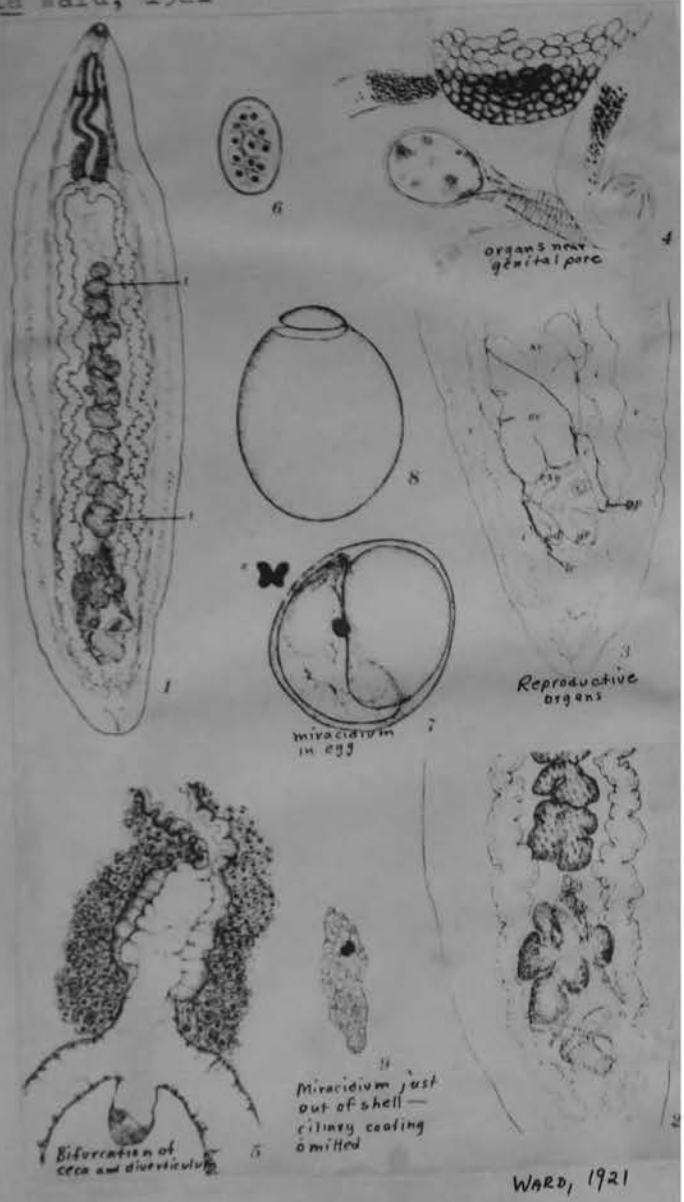
Hosts and localities:
Pseudemys elegans, Havana, Ill.
Malacoclemmys leseuerii,
Newton, Texas
Pseudemys scripta; Raleigh, N.C.
Chrysemys marginata, Fairport, Ia.

Length: 1.62 - 2.62 mm.

Width: 0.28 - 0.77 mm.

Eggs: in blood vessels
70 - 124 x 53 97 μ
in worm
81 - 97 x 68 - 80 μ

Ref.: Ward, 1921



-OVER-

Spirorchis artericola (Ward, 1921) (Figure 4).

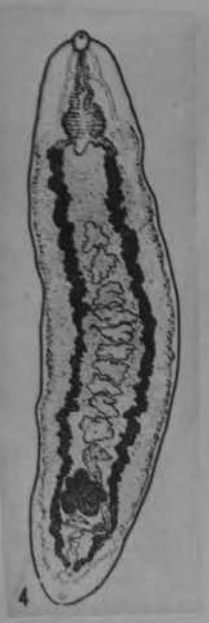
Two specimens, one recovered from the ventricle of the heart and the other from intestinal washings of *Chrysemys picta belli*, correspond closely to the descriptions of *S. artericola* as presented by Ward (1921) and by Stunkard (1923). The body length of these specimens is 1.6 and 1.8 mm. respectively. The genital pore is situated at a point between one-fifth and one-sixth the body length from the posterior end. Vitellaria extend from the bifurcation of the digestive tract to the posterior end of the body. In one of the specimens the vitellaria partially obscure the reserve vesicle. In the other specimen, however, the vesicle is clearly apparent.

Some difficulty was encountered in identifying these two specimens when Byrd's (1939) key was used. According to his key, our specimens would be *S. pseudemyae* rather than *S. artericola* because the ovary in each specimen exceeds the testes in size. However, Ward (1921) and Stunkard (1923) in their descriptions of *S. artericola* made no definite statement that the ovary exceeded the testes in size. Furthermore, in the figure presented by Ward and in one of two figures by Stunkard, the testes were shown to be smaller than the ovary. In this respect, Byrd's key is inadequate in differentiating *S. pseudemyae* from *S. artericola*. In the extent of the vitellaria, and in body size, our specimens correspond more closely to *S. artericola*.

Whether these differences between *artericola* and *pseudemyae* could be the result of individual variations within a single species depends upon elucidation of the life cycle of *S. pseudemyae* and the examination of a large number of experimentally-reared adults.

That wide variation exists within an individual species was suggested by Byrd (1939) when he considered two species of *Spirorchis* (*elegans* and *picta*) as synonymous. These two species had previously been considered by Stunkard (1923) as separate and distinct. If they are indeed synonymous, wide variation in the relative size of reproductive organs within a species is common. As previously indicated, our specimens of *Spirorchis scripta* exhibit this same variation in size of gonads. This is a factor which might vary with maturity. It is also possible that some difference may result from methods of handling the specimens. Differences in the size and form of testes, ovary, and intestinal caeca induced by the use of various fixatives and different degrees of pressure are illustrated by Ulmer (1952) in studies on *Postharmostomum helicis* (Leidy, 1847) Robinson, 1949.

FROM SCHROEDER AND ULMER, 1959



Spirorchis artericola Ward, 1921

Ten specimens of this species were collected from *Pseudemys troostii*, *P. floridana*, *Chrysemys picta dorsalis*, and *Graptemys pseudogeographica pseudogeographica* from Bedford Lake in Tennessee. Our material differs from the material described by Ward (1921) and Stunkard (1923) in the general distribution of the vitellaria which spread across the body in front of the gonads and end almost abruptly just caudad to the level of the ovary. This difference is not deemed of sufficient importance to warrant the separation of our material from *S. artericola* as a distinct species.

BYRD, 1939

Spirorchis arteriocola (Ward), 1921

Plates IV to VIII, Figures 7–36

This form was described by Ward as the only species parasitic the vascular system of various fresh-water turtles. He was unab however, to make his description cover all his material and clearly w not satisfied with his conclusion. I have restricted the specific descri tion to a group of specimens collected from the heart and arteries *Chrysemys marginata*, *C. picta*, and *Pseudemys scripta* which have u form and common characters.

Adult worms (Figs. 7 and 8) vary in size from 1.4 by 0.24 to 2.84 0.67 mm. As described by Ward, the body is an elongated oval, with t anterior end more nearly pointed and much more mobile than the po terior, and it is often slightly concave on the ventral side. It is relative thin, but I find the dorso-ventral measurement considerably greater tha stated by Ward. He gave the thickness as varying from 70 to 80 micro and, while I have specimens equally thin, others measure as much as 17 microns in thickness. The oral sucker is oval, longer than broad, an measures from 60 to 78 microns in length and from 42 to 60 microns width. The esophagus is on the average about one-fifth as long as th body and has the usual gland cells around it. The ceca have no peculi features and vary in diameter depending on the amount of material the contain.

The testes are usually ten in number. They are irregular in shap oval or lobed, and form a regular consecutive series just behind th center of the body. The testicular area occupies about one-fourth of th width of the body, and from one-third to one-half of the length of thi area intervenes between the anterior testis and the bifurcation of th alimentary tract. The two or three anterior testes are situated in th anterior half of the body and the seven or eight are located in the posterio half. The distance between the caudal testis and the posterior end of the body is about two-thirds of the distance between the cephalic testis and the anterior end of the body. The seminal vesicle is conical or pyriform, situated immediately behind the caudal testis. The wider end is anterior, and posteriorly it passes underneath the anterior median part of the ovary. This posterior part narrows to a small duct which communicates directly with the cirrus. The cirrus sac is small, the muscles of the sac weakly developed. As pointed out by Ward, the vesicle and duct form a nearly straight passageway from the posterior testis to the genital pore.

The ovary is a many-lobed organ, situated slightly at the right of the median line a short distance behind the testes. It is somewhat dorsal in position and about one-sixth to one-seventh of the body length from the posterior end. It varies considerably in size. In the smallest sexually mature specimen it measures only 67 to 78 microns and in the largest 190 by 190 microns. The character and extent of the vitellaria are well described by Ward:

> The yolk glands are exceedingly voluminous. They begin at about the end of the esophagus and extend just a little beyond the posterior ends of the intestinal crura. The cells though not crowded form an almost continuous strip or band which lies below, and to some extent, on both sides of the crura but only in the immediate proximity to those structures, for the central area of the body is entirely without yolk cells. At the end of the esophagus and behind the crura, the cells from the two sides approach and become confluent in the median line. Behind the ovary on the ventral side of the body, the transverse yolk duct joins the two yolk glands and on it in the median line is formed a prominent yolk reservoir

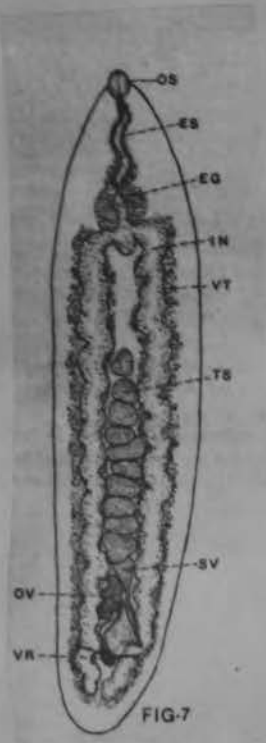


FIG-7

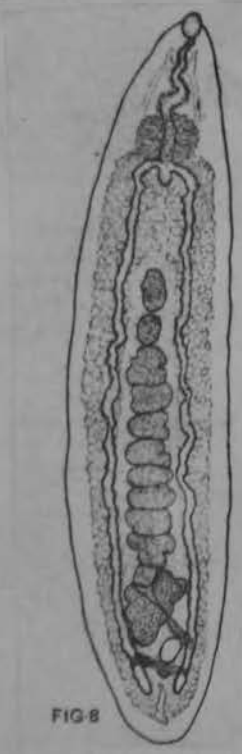


FIG-8

—OVER—

The ducts of the female system show no marked variation from type usual in the genus. The genital pore is situated below the cecum of the left side about one-seventh of the body length from the posterior end. The eggs vary considerably in size. One present in the uterus of the smallest sexually mature specimen measures 50 by 35 microns and eggs in the uteri of larger worms measure as much as 75 by 60 microns. The average size of a large number of eggs taken from the feces and containing living miricidia was 86 by 74 microns, although there was considerable variation from these figures.

This species has been found in *Chrysemys marginata*, *C. picta* and *Pseudemys scripta*.

It resembles *S. innominata* in the relative position of the reproductive organs and genital pore, but the oral sucker is larger, the ovary is larger, and the testes are smaller.

STUNKARD, 1923

Spirorchis blandingioides — BYRD, 1939

(Plate I, Fig. 1.)

Specific diagnosis: Spirorchis. Small monocotomate blood flukes with rounded ends and almost parallel sides. Body from 0.86 to 1.20 mm long by 0.22 to 0.28 mm in greatest width. Oral sucker 55 to 80 μ long by 55 to 60 μ wide, protrusible. Esophagus long, from 170 to 320 μ long by a maximum width of 20 μ at its posterior end, surrounded by numerous gland cells that are more compact about posterior part. Nerve ring prominent. Digestive tract with prominent median pouch posterior to entrance of esophagus. Caeca long, with irregular margins and few undulations, ending approximately half way between genital pore and posterior end of body. Testes 9 or 10 in number, separated into distinct follicles, the last follicle of which may lie anterior to, to one side of or immediately posterior to ovary, in two of the four specimens it lies posterior to the ovary; anterior group of follicles arranged in linear series anterior to ovary, beginning 50 to 110 μ behind bifurcation; follicles small, 20 to 50 μ long by 20 to 52 μ wide, irregular in outline. Cirrus sac small, inconspicuous. Vesicula seminalis anterior to ovary, outside cirrus sac. Genital pore ventral, just inside left caecum, close behind level of ovary. Ovary irregular to deeply notched in outline, larger than a testicular follicle, from 80 to 160 μ in diameter, placed 260 μ in front of caudal end of body. Oviduct short. Ootype, shell gland, Laurer's canal, and seminal receptaculum present. Vitellaria follicular, filling all available space in body not occupied by other organs, from bifurcation of caeca to ends of caeca. Small yolk reservoir present at union of two transverse vitelline ducts, close behind uterus. Uterus short. Metraterm slightly muscular. Ova unobserved. Excretory system typical, with reserve vesicle.

Host: Pseudemys insculpta (Holbrook) and *P. hieroglyphica* (Holbrook).

Habitat: Mesenteric circulation.

Locality: U. S. A. (Reelfoot Lake in Tennessee).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 9221.

Spirorchis blandingioides closely resembles *S. blandingi* MacCallum in the arrangement of the follicles of the testes, but differs from that species in the small size of the body and internal organs, the ovary being larger than the follicles of the testes, and the lobed condition of the testes. *S. blandingioides* is distinguished by the smallness of the testicular follicles, the posterior follicle of which lies anterior to, to one side of or immediately posterior to the ovary, and the ovary being so much as twice the size of a single testicular follicle.

1

Spirorchis elegans, ~~n. sp.~~ STUNKARD, 1923

Plate II, Figures 2 and 3

The material of this species consists of two worms taken from the washings of dissected intestines of *Pseudemys elegans* collected near Havana, Illinois. One was found on November 5 and the other on November 18, 1913. Both were stained and mounted *in toto* (Figs. 2 and 3). These two specimens differ so markedly from all others I have examined that they can not be assigned to any of the other groups and I regard them as representatives of a separate and distinct species. The first one found (Fig. 3) is much contracted and flattened but, on comparing the two specimens, the relative position and relationship of structures are strikingly constant and this agreement shows that features like the position of the genital pore, location and extent of testes, as well as size of the various organs, do not vary greatly with the degree of contraction and may well serve as specific criteria. The longer of the two specimens is designated as type and the species is based on its description. Measurements of the other are included for comparison.

In shape the type specimen is an elongated oval, widest at about the middle of the body. The contracted specimen is oval, slightly wider anteriorly, with somewhat pointed extremities. The longer worm measures 1.71 mm. in length by 0.41 mm. in extreme width, the shorter is 1.15 by 0.62 mm.

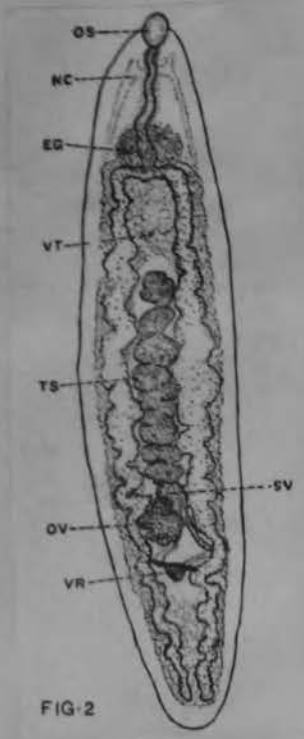
The oral sucker of the type specimen is 73 microns in length and 62 microns in breadth; that of the contracted worm is 54 microns in length and 81 microns in breadth. The esophagus extends through about one-sixth of the body length and conforms to the pattern typical for the genus. The large glandular mass surrounds the posterior third of the esophagus. The intestinal crura are comparatively large and their course is very sinuous.

The testes are not distinctly separated from one another and it is difficult to distinguish their limits with certainty. In the contracted specimen they appear to form follicles in a single testis, but in the longer specimen the ten testes may be recognized. The testes are deeply lobed, and consequently it is difficult to give precise measurements of individual testes. The group of testes is situated nearly in the middle of the body and extends through slightly less than one-third of the length of the worm. At the center of the series the testes measure 106 microns in width, while at the anterior and posterior ends the testes are only about 70 microns in width. The distance from the cephalic testis to the bifurcation of the alimentary tract is two-thirds the length of the esophagus. The seminal vesicle and cirrus sac are clearly visible, as shown in the figures. The genital pore in both specimens is one-fourth of the body length from the posterior end, and this ratio thus appears to be constant.

The ovary is conspicuously lobed, slightly larger than any one of the testes, and situated relatively close to the caudal testis. It is on the right side, immediately in front of the level of the genital pore. The oviduct and vagina are visible in both specimens but the vitelline ducts and receptacle make it difficult to determine the details of the oötype in the whole mounts. There is, however, no indication that there is any variation from the usual form. The vitellaria extend from the level of the bifureation of the esophagus almost to the posterior end of the body and in front of the testes and behind the vitelline receptacle occupy the region between the ceca. Neither specimen contains an egg.

Type host: *Pseudemys elegans*.

In position of genital pore this species agrees with *S. scripta* and *S. picta* but differs from both in the size and character of the testes. In the confluent form of the testes it resembles *S. innominata*, but the testes are much smaller and the genital pore is farther forward.



FIG·2


FIG·3

Spirorchis elegans Stunkard, 1923.

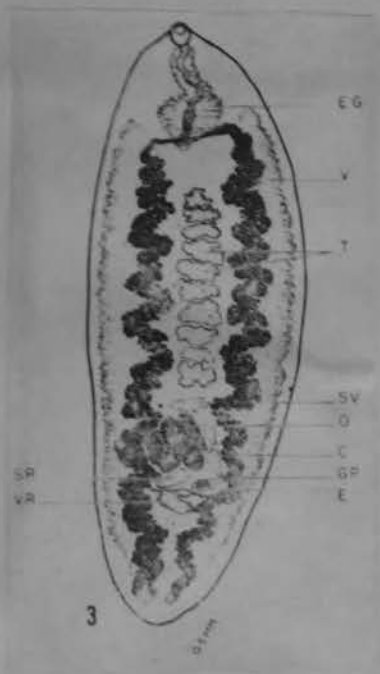
Adults. The most commonly encountered of the spirorchid species in this study was *S. elegans* (Figure 3), found in *Chrysemys picta belli*. Byrd considered *S. picta* Stunkard, 1923, as a synonym of *S. elegans*. Specimens in our collection range from 1.67 to 7.18 mm. in length. The genital pore is located one-fourth the body length from the posterior end. Vitellaria extend from the bifurcation of the digestive tract almost to the caudal end of the body. The prominent reserve vesicle characteristic of many members of this genus is not visible in any whole mounts of *S. elegans*, nor is it present in cross-sections of the worm. Stunkard (1923) did not mention its presence in his original description of *S. elegans;* he did show it, however, in a figure of *S. picta*.

Although these worms are of delicate structure, they are capable of the intense movements characteristic of some other members of this genus. When a living worm is teased out of the host tissue into the dissection fluid, it flexes and extends its body with extreme rapidity. This bending alternates with a distinct fluttering movement. When the fluke comes in contact with the surfaces of the container or dissecting instruments, these rapid movements cease but are sometimes replaced by waves of constrictions passing over the length of the body. Such contractions begin at either end of the body or in the middle. Movement of this nature may enable the organism to move through narrow lymph vessels, tissue spaces, or blood vessels.

A preliminary report on the life cycle of *S. elegans* by Goodchild and Kirk (1957) listed *Menetes dilatatus* and young *Helisoma* sp. as intermediate molluscan hosts of this trematode.

Location in the definitive host. Members of the family Spirorchiidae have been characterized as parasites in the blood stream of turtles. Wall (1941b) stated, "In all reports on the Spirorchiidae in which their habitat has been definitely determined and in my investigation dealing with blood flukes from seven genera (nine species) of hosts, the specimens have always been found in the arteries and heart." In 1952, Martin and Bamberger reported finding two species of a new genus (*Haemorvenicon*) in the mesenteric veins of the marine turtle, *Chelonia mydas* (L.) and, more recently, Ulmer (1959) found *S. haematobium* in the lymphatics and sub-mucosal tissue of the esophagus of *Chrysemys picta belli*.

All specimens in our collection which were definitely identified as *Spirorchis elegans* were taken from the sub-mucosa of the esophagus. The intestinal caeca of the worm, when filled with partially digested blood, appear as strikingly black, sinuous stripes, making the worms easily visible. Sometimes the flukes may be seen moving quite rapidly through the tissue. In order to determine the exact position of the trematodes in the sub-mucosa, cross-sections of the esophagus were prepared. These indicate that the parasite is definitely not within blood vessels. In some sections, the worm appears to be within lymphatics (Fig. 7). These thin-walled vessels become greatly distended due to the size of the fluke, and often appear to have ruptured. In some cases, the connective tissue of the sub-mucosa may be seen in direct contact with the cuticle of the worm, apparently with no intervening lymphatic wall between two areas. In all sections, the sub-mucosal tissue of the host is damaged and the lymphatics distended, especially in those areas immediately adjacent to the parasite. The worm itself, as well as host tissues other than the sub-mucosa, does not show any distortion. Figures 6 and 7 are photomicrographs of cross-sections of the esophagus showing the parasite *in situ*.



The specimens from esophageal tissue which were used for whole mounts are all sexually mature. Thus, in view of the frequency of the worms in this region, and their consistent maturity, it appears that this is the normal location within the host for this species.

The report by Ulmer (1959) on *Spirorchis haematobium* and this study on *S. elegans* indicate that the diagnosis for the family Spirorchiidae should be extended to include the lymphatics and connective tissues of the sub-mucosa of the esophagus as normal habitats within the definitive host.

FROM SCHROEDER AND ULMER, 1959

Spirorchis (Henotosoma) elephantis (Cort, 1917)

Yamaguti (1971) elevated Henotosoma to full generic status.

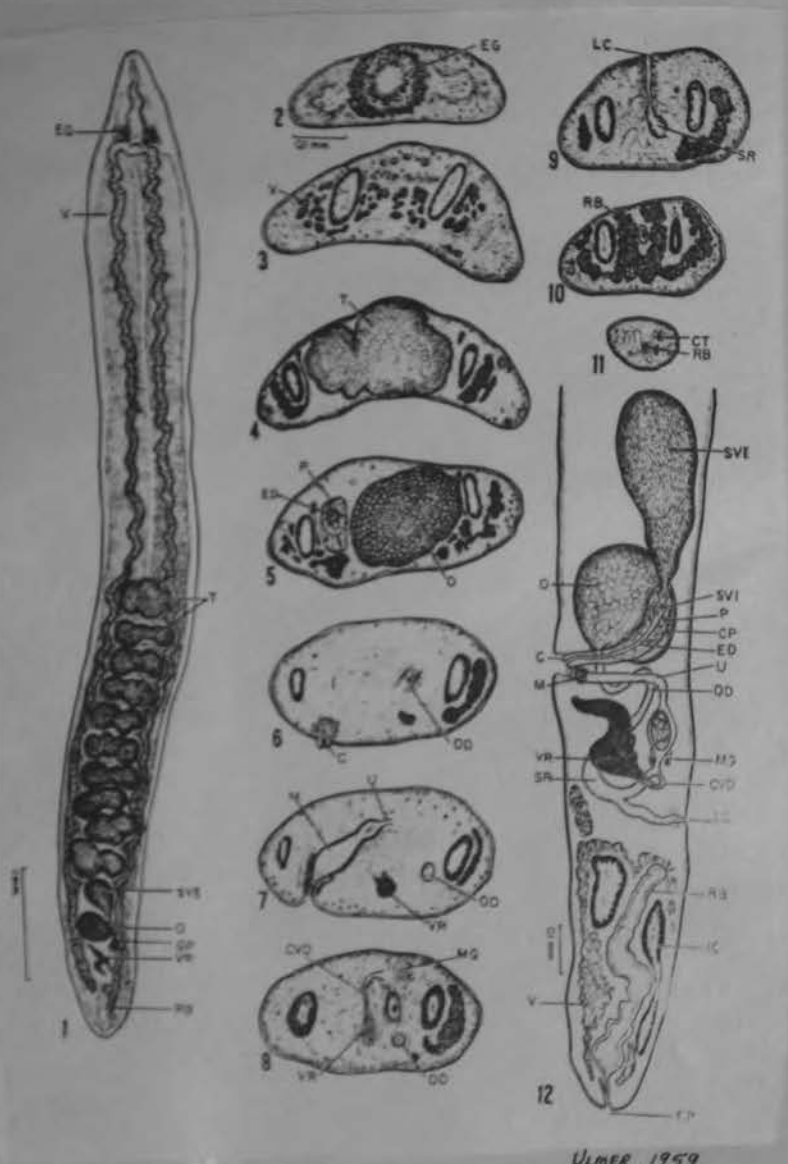
See file of correspondence between Cort and LaRue (et al.) re S. elephantis. This file is under "Spirorchis elephantis" in the general correspondence file.

Spirorchis haematobium (Stunkard, 1922) Price, 1934

syn Hematosoma haematobium Stunkard, 1922

Wall 1941. Pieper (1953) studied the cycle of *Spirorchis* [illegible] Ward 1921. Of the other genera comprising the family Spirorchiidae, only one additional life cycle, namely that of *Vasotrema robustum* Stunkard 1928, has been published by Wall (1951).

Spirorchis haematobium was originally described by Stunkard in 1922 as *Hematosoma haematobium*. A fuller account of the same species published by Stunkard appeared the following year (1923). His specimens were recovered from the subclavian arteries, lungs, pulmonary arteries, heart, mesenteric arteries and dorsal aorta of turtles collected in New Jersey, North Carolina, Indiana and New York. MacCallum (1926) described the same species as *Spirorchis chelydrae*. Price (1934) considered the genera *Hematosoma* and *Spirorchis* as synonymous and concluded that Stunkard's species should be named *Spirorchis haematobium* on the basis of priority of the generic designation *Spirorchis*. Both Stunkard and MacCallum indicated the snapping turtle, *Chelydra serpentina* as the definitive host, as did Byrd (1939) who found *S. haematobium* in the heart of turtles collected in Louisiana and Tennessee.



Ulmer, 1959

Spirorchis haematobium (Stunkard, 1922)

Syn: Hematosoma haematobium Stunkard, 1922

Three fully matured and about 30 immature specimens of this species were taken from the heart of *Chelydra serpentina* from Raceland, Louisiana, and Redfoot Lake in Tennessee. Our material agrees very closely with that described by Stunkard (1922) except for the presence of a well defined sphincter muscle that surrounds the posterior end of the esophagus. This muscle often is observed to be prominent enough to be mistaken at first glance as the rudiment of a ventral sucker, although on closer observation it is clearly seen that this is not the case. The size of the body, the size of the internal organs, and the arrangement of all structures definitely identify the material as *Spirorchis haematobium*.

BYRD, 1939

ADULT MORPHOLOGY

Study of whole mounts of *S. haematobium* and of sections prepared from unflattened gravid adults disclosed several morphological features of the adult worm (Fig. 1) heretofore not recorded by previous workers. The lobate ovary described by Stunkard (1923: 200) was observed only in flattened specimens. Serial sections of adults and whole mounts of unflattened mes indicate that this organ is smooth in outline (Figs. 1, 5, 12). That pressure effects due to flattening may cause morphological alteration in the shape of reproductive organs has been noted by Ulmer (1952).

Stunkard (1923: 200) did not observe a Mehlis' gland in *S. haematobium*. My sections of adult worms, however, indicate its presence, although much reduced (Figs. 8, 12). Byrd (1939) has shown that this gland occurs in several species of *Spirorchis*, although Wall (1941) was unable to locate it in *Spirorchis elephantis* or *Spirorchis parvus*.

The conspicuous sphincter muscle in *S. haematobium* described by Byrd (1939: 127) which appears at the junction of esophagus and intestinal crura is clearly seen in frontal section (Fig. 13). Esophageal pouches, so extensively developed in some species of related genera such as *Vasotrema* and *Hapalorhynchus* appear in *S. haematobium* in modified form (Fig. 13) and are surrounded by extensively developed esophageal glands.

The seminal vesicle in this species consists of a large, conspicuous, pyriform external seminal vesicle and a smaller internal seminal vesicle. Previous workers dealing with species of the genus *Spirorchis* have observed only a single seminal vesicle situated outside the cirrus pouch. In the genus *Learedius* and *Amphiorchis*, however, Price (1934) has shown that both occur.

Near the posterior end of the worm is a conspicuous coiled vesicle (Figs. 1, 12, 14), mentioned by numerous investigators as a characteristic structure in spirorchiid trematodes. Stunkard (1923: 178) suggested that it might be a lymph receptacle since he was unable to determine its outlet or any connecting tubules associated with it. Stunkard (1928: 307), in his study of *Vasotrema amydae*, made reference to a similar structure in this species and called it a lymphatic vesicle. Byrd (1939: 125) in his description of the genus *Spirorchis* referred to an "... excretory bladder ... usually with much coiled reserve vesicle between bladder and genital ducts ..." Wall, too, (1941a: 405 and 1951: 178) suggested that it might be associated with some type of reserve excretory system such as is frequently found in the related superfamilies Strigeoidea and Clinostomatoidea. In my preparations of sagittal sections of adult worms, what apparently is a definite connection between the coiled reserve bladder and the excretory bladder may be seen (Fig. 14). Careful studies on the development of this structure should provide information as to its function. It does appear, however, that it definitely is associated with the excretory system and not with a lymphatic system as suggested by Stunkard.

ULMER, 1959

Spirorchis magnitestis — BYRD, 1939

(Plate II, Fig. 4)

Specific diagnosis: Spirorchis. Medium sized mass-stomate blood fluke with rounded extremities and almost parallel sides. Body extremely flat and weakly muscular, from 4.80 to 5.00 mm. long by 1.00 mm. wide, unarmed. Oral sucker 70 μ in diameter, protrusible. Esophagus 380 μ long, irregular, surrounded by gland cells. Gland cells forming compact mass around posterior third of esophagus. Nerve ring small, around esophagus in anterior third. Digestive tract with prominent median pouch opposite entrance of esophagus. Caeca much pouched, giving a jagged appearance on both the outer and inner margins, passing through irregular course to very near posterior end of body. Testes large, much lobed and irregular in outline, follicles not distinctly separated; testicular mass extending from near ovary to within 1.10 mm. of bifurcation, 2.10 mm. long by 0.76 mm. wide. Vesicula seminalis large, widely separating ovary from testes, passing around right side of ovary to genital pore. Cirrus sac long, narrow, with weakly developed musculature. Genital pore ventral, just inside left caecum, slightly caudal to level of ovary, about 300 μ from posterior end of body. Ovary small, 240 μ long by 190 μ wide, with two main lobes, about 400 μ from posterior end of body, close beside left caecum. Oviduct, ootype, receptaculum seminis, shell gland, Laurer's canal, and yolk reservoir present. Vitellaria follicular, extensive, from just in front of bifurcation to posterior end of body, filling all available space not occupied by other organs. Uterus short, with weakly developed tetrathyrm. Ova in tissue adjacent site of worms very large, 140 μ long by 85 μ wide (no ova were observed in uterus of worms). Excretory system typical, with transverse and much coiled reserve vessels.

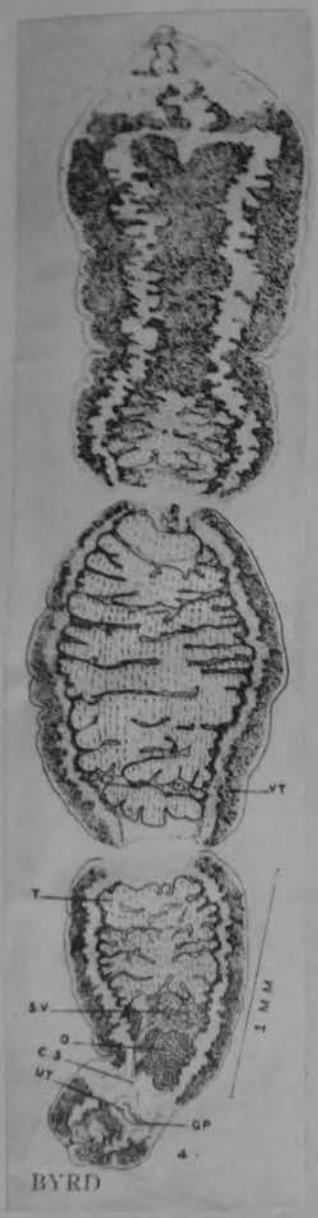
Host: Chelydra serpentina (L.).

Habitat: Wall of heart.

Locality: U. S. A. (Bayliss Lake in Tennessee).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 8254.

Spirorchis maandergi (Looss) resembles *S. haematobium* (Stunkard) but differs from this species in the greater width of the body, the indistinct separation of the testes into follicles, the greater development of the testes, the more forward extension of the testes, the shape of the ovary, and the irregularity of the intestinal wall.



Spirorchis minutum ← BYRD, 1939

(Plate I, Fig. A)

Specific diagnosis: *Spirorchis*. Small, delicate, monostomate blood fluke with bluntly rounded posterior end and tapering anterior end. Unarmed. Body elongated, thread-like, from 0.70 to 1.00 mm. long by 0.08 to 0.10 mm. in maximum width. Oral sucker small, 35 μ long by 26 μ wide, protrusible. Esophagus long, narrow, 190 μ long by 25 μ wide, surrounded by gland cells. Gland cells more compact around posterior third of esophagus. Nerve ring present, inconspicuous. Digestive tract with inconspicuous median pouch opposite entrance of esophagus. Caeca irregular in their course, rather smooth in outline, extending to within 20 μ of posterior end of body. Testes 10 in number, distinct, rather large, 35 μ long by 26 μ wide, beginning at middle of body, arranged in linear series in front of ovary. Vesicula seminalis small, lying between ovary and cranial follicle of testes. Cirrus sac about 100 μ long, slightly muscular, with prostatic gland cells. Genital pore ventral, just inside left caecum, on level with cranial boundary of ovary, approximately 115 μ from posterior end of body. Ovary slightly larger than a testicular follicle, cup-shaped, 52 μ long by 70 μ wide, widely separated from testes. Short oviduct, ootype, receptaculum seminis, and Laurer's canal present. Vitellaria follicular, extensive, from bifurcation to ends of caeca, in all available space not occupied by other organs. Small yolk reservoir present behind genital ducts. Uterus short, with slightly muscular metraterm. Ova not observed. Excretory system typical, with prominent, much coiled reserve vesicle between yolk reservoir and excretory bladder.

Host: *Chelydra serpentina* (L.).

Habitat: Mesenteric circulation.

Locality: U. S. A. (Redfoot Lake in Tennessee).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 9223.

Spirorchis minutum is more closely related to *S. parvum* (Stunkard) than to the other members of the genus. From this species *S. minutum* can be distinguished by its smaller size, more slender body, the presence of 10 fully developed testicular follicles, the shape and size of the ovary, the position of the ovary and genital pore, and the slightly more muscular and longer cirrus sac.

Spirorchis parvus Stunkard, 1923

Spirorchis parvus Stunkard 1923

Host: *Chrysemys picta* (1 in 1 host).
Site: Mesenteric blood vessels.
Specimen: 1, Univ. Neb. State Mus., H. W. Manter Lab. No. 20223.

This is the only known species of *Spirorchis* with five testes, and the single specimen was easily identified on that basis. Nebraska is a new locality.

BROOKS AND MAYES, 1976

Spirorchis picta, new species STUNKARD 1923

Plate III, Figure 6

This species is represented by four worms taken from the arteries of *Chrysemys picta* collected in the vicinity of New York City. While these specimens have definite spirorchid characters and certainly belong to this genus, they manifest marked differences from all other members of the genus and especially from *S. innominata*, the type species.

The first difference noted is in the shape of the body. These worms have rounded posterior and pointed anterior ends, while the sides of the body throughout most of its length are nearly parallel. The region of greatest width is at or slightly anterior to the center of the body. The largest specimen is 2.33 mm. in length and 0.47 mm. in width, the smallest is 1.48 mm. in length and 0.35 mm. in width.

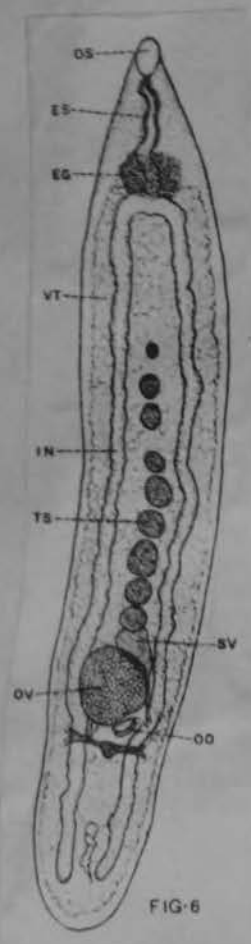
The oral sucker is large, oval in shape and longer than broad. It varies in size from 0.046 by 0.038 mm. in the smallest individual to 0.077 mm. by 0.054 mm. in the largest. The remaining portions of the alimentary tract are similar in essential respects to those of other species, but the ceca are large and comparatively straight.

It is in the reproductive organs that the species differs most markedly from *S. innominata*. The testes are small, distinctly separated, and frequently there is considerable of an interval between them. They are lobed, but the indentations are very shallow and under low magnification they appear to be round. With the exception of the one or two most anterior testes they do not differ much in size. In one specimen they are all 55 microns in diameter; in the specimen shown in Figure 6 the largest testis is 60 microns in diameter and the cephalic testis is very small, measuring only 30 microns in diameter. The testes are situated almost in the center of the body, the cephalic testis about one-third of the body length from the anterior end, the caudal testis about one-third from the posterior end. There is considerable space between the testes and the ceca, and the vitellaria extend into the intercecal area on both sides of the testes throughout the testicular region. This condition is not present in any other species in the genus. The seminal receptacle is of the usual pyriform shape, larger than any one of the testes, and the genital pore is situated one-fourth of the body length from the posterior end.

The ovary is very large, faintly lobed, but almost spherical. In the smallest specimen it is 0.1 mm. in diameter and in the largest it is 0.2 mm. In the specimen shown in Figure 6 it measures 0.17 mm. The ovary has a diameter about three times that of any of the testes, a prominent feature characterizing this species. The ovary is pressed against the cecum of the right side for a considerable distance and closely approaches the cecum of the left side. The oviduct is short, and the structures of the ootype are compressed into a small area. The genital pore is slightly anterior to the level of the caudal margin of the ovary. The vitellaria are extensively developed and lie on both sides of the ceca throughout their length in front of the ovary and behind the vitelline receptacle. Eggs in the uterus average 77 by 54 microns in size.

Type host: *Chrysemys picta*.

In the position of the genital pore this species agrees with *S. scripta* and *S. elegans*, but it differs from both these species in the relative size of ovary and testes.



FIG·6

Spirorchis pseudemyae —— BYRD, 1939

(Plate I, Fig. 2)

Specific diagnosis. Spirorchis: Small monostomate blood flukes with rounded ends and almost parallel sides. Body from 1.18 to 1.41 mm. long by 0.43 to 0.50 mm. wide. Oral sucker 130 μ long by 100 μ wide, slightly protrusible. Esophagus 300 to 380 μ long by 70 μ wide in posterior part, with many undulations, surrounded by gland cells that form compact mass around posterior half of esophagus. Nerve ring prominent, in region close behind oral sucker, giving rise to prominent posterior nerve trunks that can be traced to near posterior end of body. Digestive tract with conspicuous median pouch posterior to entrance of esophagus. Caeca irregular in outline, with few undulations, ending near posterior end of body. Testes 16 in number, small, 90 μ long by 55 μ wide, arranged in linear series on midline anterior to ovary, beginning about 200 μ behind bifurcation of caeca. Vesicula seminalis separating ovary from posterior testicular follicle, vas efferens sac, passing around left side of ovary to cirrus sac. Cirrus sac small, weakly muscular, about 100 μ long. Genital pore ventral, to left of midline just inside left caecum, on level with caudal boundary of ovary, 300 μ from posterior end of body. Ovary large, 300 μ long by 140 μ wide, more than twice as large as testes, deeply lobed. Oviduct, ootype, Laurer's canal, shell gland, seminal receptacle, and yolk reservoir present. Vitellaria follicular, extensive, from just behind nerve ring to beyond ends of caeca, filling all available space not occupied by other organs. Uterus short, with weakly developed metraterm. Ova 20 μ long by 42 μ wide. Excretory system typical. Reserve vesicle prominent and much coiled, extending from crotch of bladder to genital ducts.

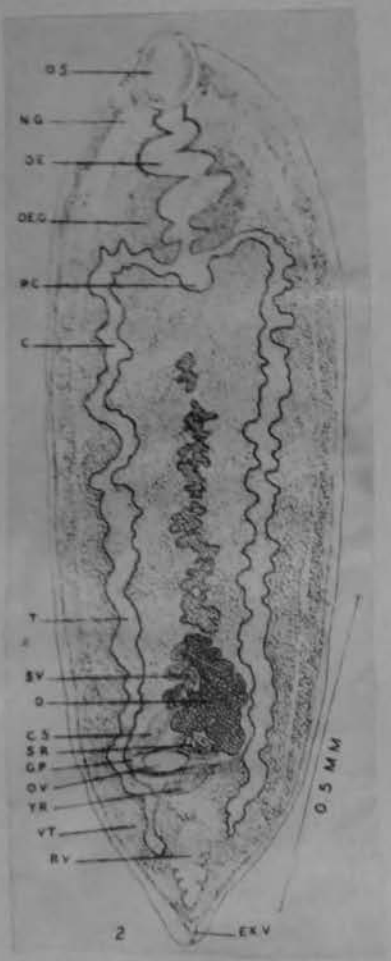
Host: Pseudemys troostii (Holbrook).

Habitat: Mesenteric circulation.

Locality: U. S. A. (Redfoot Lake in Tennessee).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 9222.

Spirorchis pseudemyae appears to be more closely related to *S. elegans* and *S. blandingioides* than to the other members of the genus. From *S. elegans* the species may be distinguished by the smaller size of the testes, the larger proportionate size of the ovary, the more caudal location of the genital pore, and the more forward extension of the vitellaria. From *S. blandingioides* the species differs in its considerably larger body size, larger sucker, much larger ovary, more extensive distribution of the vitellaria, and the arrangement of the testes.

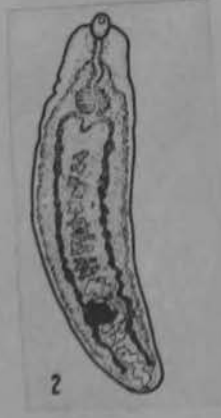


Spirorchis pseudemyae Byrd, 1939 (Figure 2).

Only two flukes of this species were collected. Whole mounts of these specimens measure 1.23 and 1.3 mm. These worms agree in all respects with those described originally by Byrd (1939). The genital pore is one-fifth the body length from the posterior end, the vitellaria extend as far forward as the nerve ring, and the testes are very small in relation to the ovary. The reserve excretory vesicle is prominent.

Byrd (1939) reported this species as a parasite of the mesenteric circulation of *Pseudemys troostii* (Holbrook). Both of our specimens were recovered from intestinal washings, one from *Chrysemys picta bellii* and the other from *Emys blandingi*. These turtles represent new host records for the species.

SCHROEDER AND ULMER, 1959



Spirorchis scripta, ~~new species~~ STUNKARD, 1923

Plate III, Figures 4, 5

The material of this species consists of one specimen from *Graptemys pseudogeographica* (syn. *Malacoclemmys kohnii*) collected near Newton, Texas, and several others from *Pseudemys scripta* collected near Raleigh, North Carolina. The first specimen was taken December 15, 1913, from the trachea of *G. pseudogeographica*. At that time the true character of the worm was unknown, but the card recording the dissection bears the following note: "This worm moves rapidly by a peculiar flapping or wriggling movement of the lateral edges and also by rapid contractions and elongations. It contracts till very short and then extends a long slender anterior portion. The movements are very rapid and violent, although graceful. Monostome; rather long esophagus with nerve commissure and two trunks running forward and two backward extending laterally almost to the posterior end of body. Ceca with dark contents. Genital organs between ceca, single egg in body." This worm was then stained and cut in serial sections. The next specimen was found November 10, 1914, in the washings of the dissected intestine of a specimen of *Pseudemys scripta* collected near Raleigh, North Carolina. This worm undoubtedly came from the mesenteric vessels. It was stained and mounted *in toto*. Later dissections revealed the true nature of these worms, and on October 21, 1916, twelve additional specimens were removed from the heart and arteries of another specimen of *P. scripta* from Raleigh, N. C.

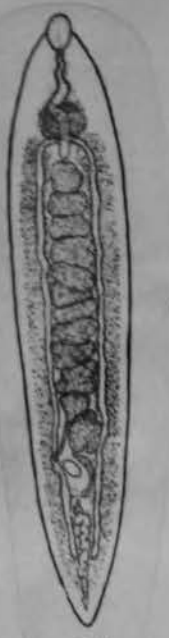


FIG-4

These worms are almost fusiform in outline; the reproductive organs are large, situated nearly in the middle of the body; and the anterior and posterior ends taper uniformly to rather pointed tips. They vary in length from 1.15 to 1.66 mm. and in width from 0.23 to 0.35 mm. The body is very thin, in one specimen cut in cross-sections it measures only 54 microns in greatest thickness.

The digestive system is of the usual type but marked by the large size of the oral sucker and the small caliber of the intestinal crura. The oral sucker is oval, longer than broad, and measures from 64 by 46 microns to 77 by 54 microns. The esophagus is narrow where it joins the oral sucker and increases in width in the anterior half. The posterior half is of an almost uniform diameter. It is slightly sinuous in preserved specimens and surrounded by the characteristic glandular cells. The enlarged portion of the gland encloses the posterior third of the esophagus. The median pocket, which extends posteriad and ventrad from the bifurcation of the alimentary tract, is large and conspicuous, reaching almost to the anterior testis. In all the specimens the ceca are small and almost uniform in diameter. These blind tubes undoubtedly vary in size and may be distended by the presence of large amounts of blood, but in this species they seem to be appreciably more slender than in others.

FIG-5

There are ten testes, forming an almost solid column between the ceca from the posterior end of the esophagus to the seminal vesicle. The testes are large, irregularly oval or lobed, and not always distinctly separated from one another. The testicular area is situated almost exactly in the middle of the body and extends about two-fifths of the total body length. The testes are flattened antero-posteriorly and measure from 80 to 100 microns in width and from 40 to 80 microns in length. The seminal vesicle and cirrus sac conform to the regular pattern and show no peculiar variations. The genital pore is situated about one-fourth of the body length from the posterior end, and in this respect is quite different from the condition in *S. innominata* and *S. arteriosa*. Not only is the genital pore relatively farther forward, but the other reproductive organs, testes, ovary, and oötype are correspondingly more anteriad than in the other two species.

-OVER-

The ovary is deeply lobed, about the size of one of the testes, and separated from the caudal testis by slightly less than its width. It is situated at the caudal end of the penultimate fourth of the body. The oviduct arises at the posterior median margin and passes dorsad and dextrad. It soon expands and the enlarged portion is filled with spermatozoa. This section of the genital duct passes posteriad and the oötype is about the diameter of the ovary behind it. The vitellaria occupy the usual position, extending from the level of the bifurcation of the digestive tract almost to the posterior end of the body. Their ducts pass mediad at the level of the oötype to form a common reservoir, which discharges into the oötype just left of the median plane. Immediately before the opening of the vitelline receptacle and slightly right of the median plane, the seminal receptacle branches from the oötype and following an expanded vesicular portion a short Laurer's canal opens to the dorsal surface in the median line. The opening of this canal is behind the vitelline receptacle. Eggs in the uterus vary in size from 65 by 38 microns to 77 by 46 microns.

This species has been found in *Pseudemys scripta* from Raleigh, N. C. and in *Graptemys pseudogeographica* from Newton, Texas.

It resembles *S. tuscumiata* in the large size and massed arrangement of the testes, but is much smaller and the genital pore is farther forward.

STUNKARD, 1923

Spirorchis scripta Stunkard, 1923

From the present collection we are able to assign 17 specimens from *Pseudemys troosti*, *P. hieroglyphica*, and *Graptemys pseudogeographica pseudogeographica* from Reelfoot Lake in Tennessee to this species. This material differs from *S. scripta* only in regard to the distribution of the vitellaria. In our specimens the vitellaria extend forward to very near the nerve ring, although in the forward portion the follicles are more widely separated from each other and in senescent specimens these follicles are the first to disappear. With the disappearance of the follicles in the region of the esophagus our material gives the typical appearance described for *S. scripta*.

BYRD, 1939

Spirorchis scripta Stunkard, 1923 (Figure 1).

This is the smallest of the species encountered, its body length ranging from 0.78 to 1.36 mm. in our specimens. The genital pore is located about one-fourth of the body length from the posterior end. The vitellaria extend from the nerve ring almost to the posterior end of the body. Previous descriptions of adult worms of this species indicate that the vitellaria extend anteriorly only to the bifurcation of the digestive tract. The reserve vesicle is prominent. Using a key to the species of *Spirorchis* presented by Byrd (1939), *S. scripta* was easily identified on the basis of the anterior limits of the testes. In this species, they begin immediately posterior to the median caecal pouch. In other species of the genus *Spirorchis*, testes commence at varying distances posterior to the caecal pouch. Examination of the four whole mounts of *S. scripta* in our collection indicates that there is considerable variation in the relative size of the testes. In the specimen illustrated in Figure 1, the testes are much larger than the ovary, the width of each testis being greater than one-third the body width. In the other whole mounts they are proportionally much smaller, corresponding more closely to those of *S. elegans* as indicated previously. This size variation may be associated with the maturity of the worm.

S. scripta was recovered from the atria of the heart, from pericardial washings, and from washings of the intestinal and esophageal regions of *Chrysemys picta belli*. Figures 9 and 10 are photomicrographs of sections of the atrium of the heart showing trematodes, probably *S. scripta, in situ*. In Figure 9, the parasite appears to be within the cavity of the heart. In Figure 10, it appears to be embedded in the muscular atrial wall.

SCHROEDER AND ULMER, 1959

1

Spirorchis scripta Stunkard, 1923

Host: *Chrysemys picta* Schneider (5 in 1 host).
Site: Cranial cavity, blood vessels of heart.
Specimens: 3, Univ. Neb. State Mus., H. W. Manter Lab. No. 20214.

The specimens collected in Nebraska are uniformly larger than any previously reported. The body is 1.9 to 2.37 mm long by 0.3[illegible] to 0.47 mm wide; the oral sucker is 80 to 112 long by 57 to 65 wide; and the ventes are 61 to 69 long by 34 to 57 wide. The anterior testis in all specimens is immediately postbifurcal, a configuration unique to *S. scripta*. Nebraska is a new locality for the species.

BROOKS AND MAYES, 1976

SPIRORCHIS

Amphiorchiinae n. subfam. Yamaguti, 1958

Subfamily diagnosis. — Spirorchiinae: Body slender, subcylindrical. Oral sucker prominent, esophagus long, ceca terminating short of poste-

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[1]) syn. of Spirorchis MacCallum, 1919 — Byrd (1939).

Amphiorchiinae n. subfam.

Subfamily diagnosis. — Spirorchiinae: Body slender, subcylindrical. Oral sucker prominent, esophagus long, ceca terminating short of poste-

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x) Syn. of *Spirorchis* MacCallum, 1919 — Byrd (1939).

rior extremity. Acetabulum small, in anterior half of body. Testes two, in middle third of body, wide apart, with male terminal genitalia and ovarian complex between. External seminal vesicle immediately behind anterior testis, cirrus pouch well developed between external seminal vesicle and ovary. Genital pore ventral, median or lateral, at level of anterior end of ovary. Ovary approximately equatorial, immediately behind cirrus pouch. Receptaculum seminis and Laurer's canal present. Vitellaria extending from intestinal bifurcation to beyond cecal ends, interrupted at level of ovary or more widely interrupted. Excretory vesicle Y-shaped, small. Parasitic in marine turtles.

Amphiorchis Price, 1934

Generic diagnosis. — Spirorchiidae, Amphiorchiinae: Body slender, subcylindrical. Cuticle may be marked with fine transverse ridges. Acetabulum small, in anterior half of body. Oral sucker prominent; esophagus long, surrounded by gland cells. Ceca terminating blindly at a short distance from posterior extremity. Testes two in number, one anterior to male terminal genitalia, the other posterior to ovarian complex. Vesicula seminalis externa intercalated between cirrus pouch and anterior testis. Cirrus pouch well developed, containing internal seminal vesicle, prostate cells and a short cirrus. Genital pore ventral, median or lateral, at level of anterior end of ovary. Ovary immediately posterior to cirrus pouch, in middle third of body. Receptaculum seminis and Laurer's canal present. Shell gland complex behind ovary. Uterus short. Vitelline follicles extending along ceca from intestinal bifurcation to excretory vesicle, interrupted at level of ovary or to a greater extent (from anterior testis to vitelline reservoir). Excretory vesicle Y-shaped, at posterior extremity. Parasitic in blood vessels of turtles.

Genotype: *A. amphiorchis* Price, 1934 (Pl. 48, Fig. 584), in visceral blood vessels of *Chelone mydas;* U.S.A.

Other species: *A. lateralis* Oguro, 1938, in blood vessels of *Eretmochelys squamosa;* Palau Isl.

AMPHIORCHIS

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 _____

Cardiotrema Dwivedi, 1967

Generic diagnosis of *Cardiotrema* n. g. :— Spirorchiidae, Couritrematinae : Hermaphroditic blood flukes; delicate musculature, grey or dull white in coloration, elongated with both ends pointed, body smooth. Oral sucker oval, protrusible; ventral sucker membranous or rudimentary and represented by mass of nuclei of parenchymatous cells, smaller than ventral sucker and situated one-fifth to one-sixth of the body length from the anterior end. Prepharynx and pharynx absent; 'oesophageal sac' present; salivary glands surround the intestinal bifurcation; intestinal bifurcation follows the oesophageal sac and far away in front of the ventral sucker; the caeca run lateral to the body, come close together posterior to posterior testis and end asymmetrically in front of the excretory bladder forming 'knobs', right caeca always longer than left one. Genital opening dorsal sinistral, marginal situated a little in front of one-third of the body length from anterior end or on its one fourth. Testes two, lobed or branched, anterior testis pre-equatorial or just below the cirrus sac, placed a little towards the right side, posterior testis equatorial or post-equatorial, external seminal vesicle voluminous tubular, 'S' shaped or irregularly coiled extending up to anterior level of ventral sucker or beyond it, cirrus sac membranous situated at third of the body length from the anterior end or a little in front of it enclosing internal seminal vesicle, pars prostatica and huge cirrus. Ovary entire or lobed, pre-equatorial; situated in the middle level of anterior testis on its left side, Laurer's canal and receptaculum siminis present. Transverse vitelline ducts just below the ovary; yolk reservoir opening in the oviduct prior to that of receptaculum seminis. Vitellaria, with small vitelline follicles distributed in the entire length of the body except the region just below the ventral sucker. Excretory opening terminal, excretory bladder composed of five chambers, the fifth one divides into two cornua which extend up to the posterior level of the posterior testis.

Type species *Cardiotrema vaidya* n. g. n. sp.

DISCUSSION

The blood flukes under study have been assigned to the family Spirorchiidae Stunkard, 1921 because of their habitat mainly in the ventricle of *Kachuga kachuga* and to the snbfamily Coeuritrematinae owing to the presence of double un-united caeca, two testes with ovary in between: ventral sucker present; an extension of vitellaria in the whole length of body; cirrus pouch present between anterior testis and ventral sucker and ultimately in having post-acetabular genital opening immediate to the ventral sucker. The subfamily Coeuritrematinae at present includes two genera *Coeuritrema* and *Enterohaematotrema* The present flukes,due to following characters could not be assigned to anv of the aforeaid genera of the subfamily Coeuritrematinae.

- OVER -

1. Presence of "oesophageal sac".
2. Enormously developed seminal vesicle upto the ventral sucker or in front of it.
3. Enormous size of cirrus sac with membranous wall.
4. Vitellaria distributed in the entire body except the region just below the ventral sucker.
5. Ovary pre-equatorial and situated in the mid-level on the left side of anterior testis.
6. Ventral sucker membranous, poorly developed or represented by the mass of nuclei situated about one-fifth to one sixth of the body length from the anterior end.
7. Genital pore marginal, sinistral and situated a little above the one-third of the body length from the anterior end or on its one fourth.
8. Internal seminal vesicle present.
9. Cirrus of enormous size.
10. Intestinal bifurcation far away, anteriorly in front of the ventral sucker.
11. Excretory bladder composed of five chambers and the excretory bladder cornua extending up to the posterior level of the posterior testis.

In view of the above differences author describes *Cardiotrema* n. g. with *C. raidya* type species.

DWIVEDI, 1967
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Cardiotrema vaidya Dwivedi, 1967

C. VAIDYA ~~H. G. & S.~~ (FIGS 1-2) DWIVEDI, 1967

The worms are thin, semi-transparent, elongated with both ends pointed and measure 1.85-3.061 mm. in length and 0.205-0.323 mm. in breadth, in the genital area, 0.155-0.221 mm. in the anterior end and 0.111-0.121 mm. in the posterior end. The body wall is devoid of spines or tubercles which are present in other blood flukes.

The oral sucker is well developed, larger than ventral sucker, situated at the anterior end, protrusible and measures 0.045-0.051 mm. in length and 0.057-0.071 mm. in breadth. The ventral sucker is much smaller, delicate, membranous, thin with poorly developed musculature, situated 0.375-0.395 mm. from the anterior end, i.e., a little less than one fifth of the body length and 0.034-0.041 mm. breadth. The ratio in the diameter of the two suckers is 1 : 1.7.

The prepharynx and pharynx are absent. The oesophagus swells up to form a sac-like structure which author calls oesophageal sac, and is a distinctive feature in all the specimens. The oesophageal sac measures 0.135-0.246 mm. in length and 0.041-0.085 mm., in breadth. The intestinal bifurcation is surrounded by salivary glands, immediately following the oesophageal sac, and measures 0.185-0.195 from the ventral sucker. The two caeca run parallel and close to the lateral margin of the body wall and reach up to the posterior level of the posterior margin where they gradually come close to each other and reach 0.275-0.32 mm. in front of posterior end and 0.105-0.123 mm. in front of excretory bladder. On their terminal ends the caeca are constricted to form 'knob' which appears to be a permanent character of these specimens. The two caeca do not end at the same level; left one is little longer than right.

The genital opening is dorsal sinistral, marginal measures 0.122-0.172 mm. from ventral sucker, 0.440-0.601 mm. in front of the middle of body length, i.e., situated a little in front of one-third of the body length from the anterior end. The testes are two in number, strongly lobed, equatorial or pre-equatorial. Anterior testis pre-equatorial lies immediately behind the cirrus sac or at the distance of 0.015 mm. from the latter, slightly lateral towards right side, 0.195 to 0.291 mm. from genital opening and measures 0.192-0.289 mm. in length and 0.183-0.218 mm. in breadth. Posterior testis lobed, equatorial, median, little larger than anterior testis and measures 0.212-0.314 mm. in length and 0.192-0.289 mm. in breadth. The external seminal vesicle is voluminous, tubular, roughly 'S' shaped extends upto the anterior level of ventral sucker and measures 0.215 to 0.457 mm. in length and 0.061-0.119 mm. in breadth. The external seminal vesicle enters into a voluminous cirrus sac through a narrow duct, duct of seminal vesicle which measures 0.031 to 0.161 mm. in length. The cirrus sac is well developed, voluminous, situated one-third of the body length from the anterior end, measures 0.289-0.295 mm. in length and 0.119-0.190 mm. in breadth and encloses well developed internal seminal vesicle, lying horizontally and measuring 0.075-0.128 mm. in length, pars-prostatica

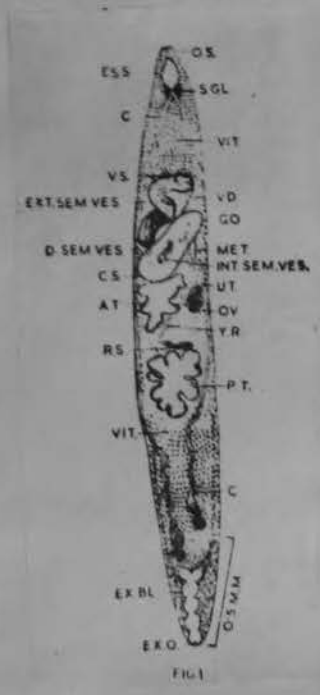

FIG.1

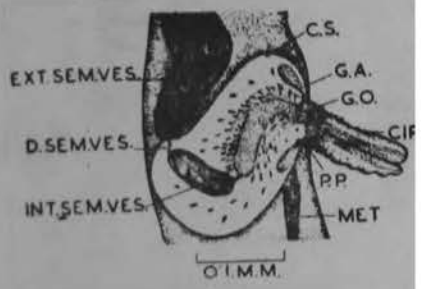

Fig. 2

-OVER-

measuring 0.112 mm. in length. The cirrus is stumpy inclined over the left body wall and its extruded portion measures 0.191 mm. in length and 0.055 mm. in breadth in maximum protruded condition.

The ovary is situated in the middle level of anterior testis, on its left side, oval or flask-shaped, entire and measures 0.041-0.187 mm. in length and 0.048-0.119 mm. in breadth. The oviduct arises from its right inner margin and receives the yolk reservoir and duct from receptaculum seminis one after another. Laurer's canal is present. Receptaculum seminis is pre-equatorial voluminous, situated just in front of the posterior testis in median line, measures 0.981-0.112 mm. in length and 0.289-0321 mm. in breadth and sends a narrow duct which opens in the oviduct close to the right side of yolk reservoir. Metraterm not muscular but can be distinguished from uterus in wider diameter, situated in between ovary and cirrus sac on the left side and measures 0.189-0.201 mm. in length and 0.031-0.048 mm. in breadth. and opens in the shallow genital atrium. Only one ovum is contained in the uterus or metraterm which is filamented, oval and measures 0.089-0.091 mm. in length and 0.025-0.026 mm. in breadth; polar filaments could not be measured as the preparation is in whole mount.

The vitellaria are extensive, almost traverse the entire body except the post-acetabular region where it is not confluent and the genital area where it is thinly present. The vitellaria send the vitelline duct just below the posterior margin of ovary. The two vitelline duct unite in the median line to form yolk resevoir.

Excretory opening is situated on the hinder end of the body. Excrerory bladder, which measures 0.180-0.206 mm. in length, is constricted to produce five chambers, the fifth one sends two lateral cornua, extending up to the posterior level of the posterior testis.

Host : *Kachuga kachuga*

Habitat : Ventricle, intestinal washing, body cavity and liver.

Locality : The Gokalpur tank, Jabalpur, (M. P.) India.

About fifty specimens of the above-mentioned blood flukes were obtained from the ventricle, intestinal washing, body cavity and liver of a freshwater tortoise, *Kachuga kachuga* collected from the Gokalpur tank, Jabalpur (M. P.), in the summer months of 1962.

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CARDIOTREEMA

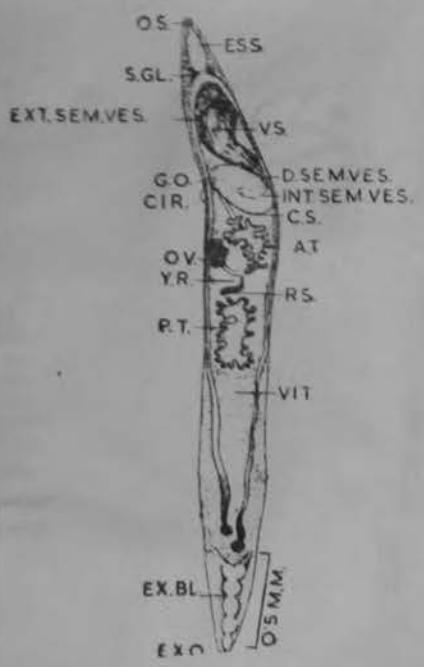
C. LONGIVESTICULATA n. sp. (Fig. 3) DWIVEDI, 1967

Four specimens of flukes were obtained from the ventricle of a freshwater tortoise, *Kachuga dhongoka* collected from It River Hiren during fishing in the month of May, 1962. These parasites were clinging to the internal wall of the ventricle by their protrusible oral sucker and took about half an hour in saline water to become free.

The body of the worm is thin, semi-transparent, dull white and measure 3.145-3.43 mm. in length and 0.357-0.408 mm. in breadth in genital region, 0.289-0.341 mm. in the level of ventral sucker, and 0.272-0.323 mm. in the level of intestinal bifurcation. The oral sucker is anteriorly situated, terminal, protrusible bigger than ventral sucker and measures 0.575-0.595 mm. in length and 0.0575-0.0595 mm. in breadth. Ventral sucker is rudimentary, non-muscular, membranous, just represented by mass of nuclei of the parenchymatous cells, situated one-fifth and one-sixth of the body length from the anterior end of the body and measures 0.0413-0.0425 mm. in length and 0.0413 mm. in breadth. Size ratio of the two suckers is 1: 2.2.

The pre-pharynx and pharynx are absent. The oesophagus widens to form oesophageal sac which measures 0.319-0.348 mm. in length and 0.068-0.085 mm. in breadth. The intestinal bifurcation is surrounded by salivary gland cells, immediately follows the oesophageal sac and measures 0.346-0.356 mm. from anterior end and 0.221-0.234 mm. from the ventral sucker. The two caeca run parallel and close to the lateral margin of the body; behind the posterior testes come close to each other and reach just in-front of the excretory bladder and measure 0.48-0.55 mm. in front of the hinder end. The two caeca do not end at the same level; left one is little longer than right one. The terminal ends of the caeca constrict to form 'knobs'.

The genital opening is dorsal, sinistral, marginal measures 0.213-0.284 mm. from ventral sucker 0.782-0.841 mm. in front of middle of the body length, i.e., situated at one-fourth of the body length from the anterior end. The testes two, branched, equatorial or pre-equatorial, anterior testis pre-equatorial, lies immediately behind the cirrus sac, a little to the right side of median line and measures 0.238-0.255mm. in length and 0.251-0.255mm. in breadth. The external seminal vesicle is enormously developed hammer-shaped tubular extends in front of the ventral sucker and measures 0.512-0.56 mm. in length and 0.234-0.238 mm. in breadth in the pre-acetabular region and 0.064-0.090 mm. in the post-acetabular region. The duct of seminal vesicle is present. The cirrus sac is membranous, non-muscular and encloses internal seminal vesicle, measuring 0.187-0.214mm. in length and 0.0321-0.0324 mm. in breadth, small pars prostatica measuring 0.098-0.111 mm. in length. The terminal part of cirrus outside the genital opening measures 0.113 mm. in length and 0.078 mm. in breadth.



CARDIOTREMA LONGIVESTICULATA (dorsal view)

- OVER -

Ovary is pre-equatorial, situated on the left side of the middle of anterior testis, lobed and measures 0.101-0.170 mm. in length and 0.102-0.187 mm. in breadth. The receptaculum seminis, and Laurer's canal are present. The vitelline ducts are present just below the posterior level of ovary and unite to form the yolk reservoir which opens in the oviduct prior to that of the duct of receptaculum seminis. The metraterm is poorly developed situated between ovary and cirrus sac on the left side and measures 0.220-0.248 mm. in length. Only one ovum is contained in the uterus at a time. Ovum is filamented, oval and measures 0.0911-0.0921 mm. in length and 0.024-0.0251 mm. in breadth.

The vitellaria are distributed in the entire body except the post-acetabular region where the vitellaria are not confluent and the genital area where the follicles are poorly present.

The condition o excretory system is similar to that of *C. vaidyai*

DISCUSSION

The blood flukes under study have been assigned to the genus *Cardiotrema* n. g. owing to the pesence of oesophageal sac, intestinal bifurcation surrounded by salivary glands situated far a way in front of the ventral sucker; enormous development of external seminal vesicle, internal seminal vesicle, pre-equatorial positicn of genital opening, anterior testis and ovary and lastly in having excretory bladder composed of five chambers out of which the last one bifurcates into two cornua which extend up to the posterior level of posterior testis It differs from type species, *C. vaidyai* in having pre-acetabular extension of external seminal vesicle, rudimentary ventral sucker situated at one-fifth to one sixth of the body length from the anterior end, suckers ratio 1:2.2; lobed ovary, centrally situated testis and ultimately in having the genital opening at one fourth of the body length from the anterior end. In view of the above differences author proposes the name *Cardiotrema langivesiculata* for these worms.

Host : *Kachuga dhongoka* Gray
Location : Ventricle
Locality : The river Hiren, Jabalpur (M. P.), India.

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CARDIOTREMA

Carettacolinae n. subfam.

Subfamily diagnosis. — Spirorchiidae: Body slender, long. Oral sucker prominent, esophagus long, ceca terminating near posterior extremity. Acetabulum weakly muscular or rather membranous, immediately postbifurcal. Testes numerous, arranged in linear or zigzag row in greater posterior intercecal field. External seminal vesicle saccular, between acetabulum and cirrus pouch. Cirrus pouch voluminous, immediately preovarian. Genital pore sinistroventral, at level of cirrus pouch. Ovary

submedian, pretesticular, immediately behind cirrus pouch. Receptaculum seminis present. A peculiar saccular organ connecting germiduct with right body margin behind ovary in *Carettacola*. Vitellaria extending along ceca between ovary and excretory vesicle. Excretory vesicle Y-shaped, small. Parasitic in marine turtles.

Key to genera of Carettacolinae

Testes in linear row, a peculiar vagina-like organ present behind ovary ..... *Carettacola*
Testes in zigzag row, no vagina-like organ behind ovary .. *Haemoxenicon*

Carettacola Manter et Larson, 1950

Generic diagnosis. — Spirorchiidae, Carettacolinae: Body slender, almost uniform in width. Oral sucker terminal, esophagus long, ceca terminating near posterior extremity. Acetabulum located immediately posterior to intestinal bifurcation, apparently of a flexible, rather membranous structure, very changeable in form. Testes numerous, arranged in linear series, filling most of posterior intercecal field; vesicula seminalis externa saccular, filling intercecal area between acetabulum and cirrus pouch. Cirrus pouch large, postacetabular, containing tubular seminal vesicle, numerous prostate cells and short cirrus. Genital pore ventrosinistral to cirrus pouch, a little posterior to acetabulum, pre-ovarian. Ovary intercecal, immediately behind cirrus pouch. Receptaculum seminis small. A peculiar saccular organ interpreted as vagina with some reservation by the original authors, extending diagonally behind ovary, connecting germiduct with right body margin. Vitelline follicles extending in extracecal fields from level of anterior testis to cecal ends. Uterus very short, containing a single egg with polar filament. Excretory vesicle Y-shaped, with terminal pore. Parasites of marine turtles.

Genotype: *C. bipora* Manter et Larson, 1950 (Pl. 58, Fig. 705), found in washings of intestine, probably from some blood vessel; Tortugas, Florida.

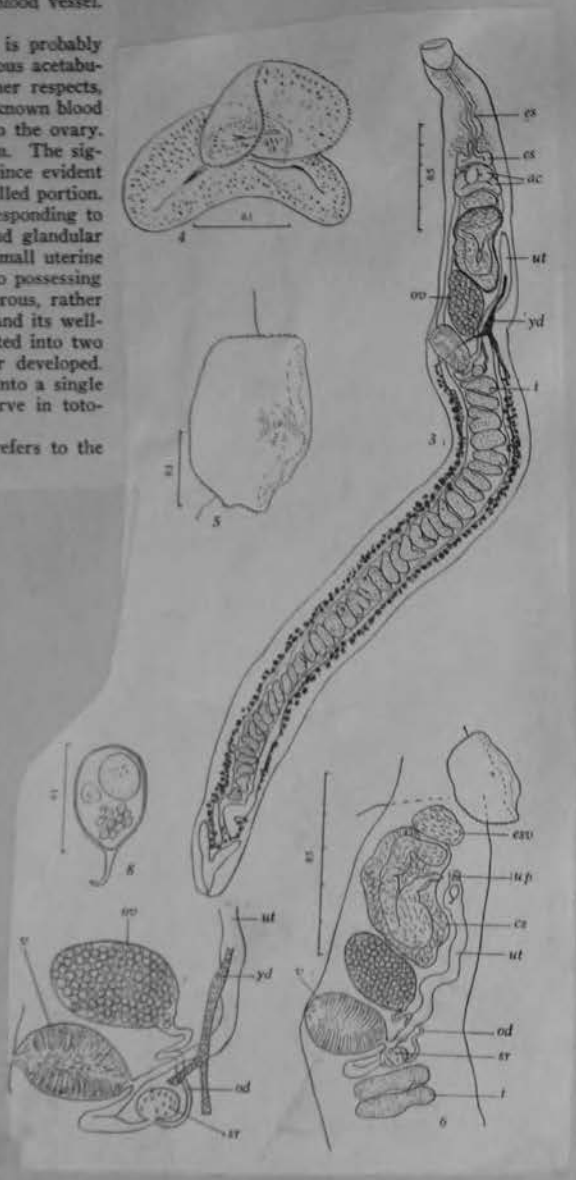
Carettacola

Caretta bipora Manter & Larson, 1950

Host: *Caretta caretta*, the loggerhead turtle
Location: Found in washings of the intestine, probably originally from some blood vessel.
Locality: Tortugas, Florida

Discussion: *Carettacola* is clearly a member of the family Spirorchidae, and is probably most closely related to *Vasotrema*, *Hapalotrema*, or *Hapalorhynchus*. A membraneous acetabulum apparently also occurs in the genus *Leardius* which is entirely different in other respects, notably its precovarian testes and posterior genital pore. *Carettacola* differs from all known blood flukes in possessing a very large vagina-like structure opening laterally posterior to the ovary. In fact, all digenetic trematodes supposedly lack a vagina separate from a metraterm. The significance of this organ is not understood. It is probably at least partly glandular since evident granules occurred in the basal portion of its cells. Near the pore is a short, thick-walled portion. The organ narrows abruptly to open into the oviduct. Thus, it has a position corresponding to Laurer's canal. It differs from a typical Laurer's canal in that it is very large and glandular and opens laterally rather than dorsally. Possibly it could be compared with the small uterine pouch described by Byrd (1939) in *Unicaecum distimilis* Byrd, 1939. In addition to possessing this distinctive organ, *Carettacola* differs from *Hapalorhynchus* in possessing numerous, rather than two, testes which are not separated by the ovary; in its ventral genital pore; and its well-developed cirrus sac. It differs from *Hapalotrema* in that the testes are not separated into two groups by the ovary, the genital pore is more anterior, and the cirrus sac better developed. *Carettacala* resembles *Vasotrema* except the testes are separated rather than fused into a single spiral testis. However, connections between testes are sometimes difficult to observe in toto-mount, and *Vasotrema* is perhaps the most closely related genus.

The name "*Carettacola*" indicates an inhabitant of *Caretta*; the name *bipora* refers to the uterine pore and the lateral pore of the vagina-like organ.



CARETTACOLA

Diarmostorchis Ejsmont, 1927

Generic diagnosis. — Spirorchidae, Spirorchiinae, Spirorchiini: Body lanceolate, without acetabulum. Oral sucker small, esophagus of moderate length; ceca simple, terminating at posterior extremity. Testes divided by ovary into two groups, anterior testes arranged in a linear series, between two cecal ends. Seminal vesicle small, between ovary and posteriormost testis. Cirrus pouch poorly developed. Genital pore sinistral, ventral, postovarian. Ovary on the right of median line, about middle of posterior half of body. Vitellaria extending along ceca throughout their length. Parasitic in turtles.

Genotype: *D. blandingi* (MacCallum, 1926) Ejsmont, 1927 (Pl. 44, Fig. 543), in lung of *Emys blandingi*; N. America.

DIARMOSTORCHIS

Enterohaematotrema Mehra, 1940

Generic diagnosis. — Spirorchiidae, Tremarhynchinae: Body minute, slender, delicate, smooth. Oral sucker somewath cup-shaped, protrusible; esophagus long, sinuous, surrounded by gland cells, bifurcating just in front of acetabulum; ceca terminating a short distance in front of posterior extremity. Acetabulum transversely elongated, situated about one-third to one-fourth of body length from anterior extremity. Testes two, entire, tandem, in posterior half of body. Cirrus pouch large, elongated longitudinally on the right of median line between acetabulum and anterior testis, containing internal seminal vesicle, prostate complex and unarmed eversible cirrus; external seminal vesicle on the right of basal portion of cirrus pouch. Genital pore median, ventral, immediately post-acetabular. Ovary transversely elongated or somewhat oval, intertesticular. Receptaculum seminis present. Laurer's canal not observed. Uterus short, containing only one, long, slightly coiled, tubular ovum. Metraterm long, muscular, opposite cirrus pouch. Vitellaria extending along intestinal ceca from behind acetabulum to a short distance in front of posterior extremity, confluent behind posterior testis. Excretory vesicle? Parasitic in small intestine [1]) of freshwater turtles.

Genotype: *E. palaeorticum* Mehra, 1940 (Pl. 60, Fig. 727), in *Lyssemys punctata;* India.

ENTEROHAEMATOTRE
MA

Tremarhynchinae n. subfam.

Subfamily diagnosis. — Spirorchiidae: Body lanceolate. Oral sucker prominent, esophagus long. Ceca reaching to near posterior extremity. Acetabulum in anterior half of body. Testes tandem, postequatorial. Cirrus pouch more or less strongly developed between acetabulum and anterior testis; external seminal vesicle posterior, lateral or anterior to cirrus pouch. Genital pore median, submedian, dorsal or ventral, immediately postacetabular. Ovary submedian, intertesticular. Receptaculum seminis present. Laurer's canal? Vitellaria extending whole or almost whole length of ceca. Metraterm strongly developed, muscular. Excretory vesicle Y-shaped, bifurcating just behind cecal ends. Parasitic in freshwater turtles.

Key to genera of Tremarhynchinae

Cirrus pouch and metraterm very strongly developed; esophagus very long, bifurcating immediately in front of acetabulum; genital pore median, ventral; vitellaria commencing behind acetabulum ..... *Enterohaematotrema*

Cirrus pouch not very strongly developed; esophagus moderately long, bifurcating a short distance anterior to acetabulum; genital pore submedian, dorsal; vitellaria extending into forebody ..... *Tremarhynchus*

Tremarhynchus Thapar, 1933

Syn. *Rhynchotrema* Thapar, 1933 [1])

Coeuritrema Mehra, 1933

Generic diagnosis. — Spirorchiidae, Tremarhynchinae: Body lanceolate pointed or rather rounded behind, with smooth or uneven surface. Acetabulum larger than oral sucker about one third of body length from anterior extremity. Oral sucker prominent. Esophagus moderately long. Ceca simple or sinuous, reaching to near posterior extremity. Testes lobed or not, tandem or somewhat diagonal, post-equatorial. Seminal vesicle free in parenchyma, anterior or posterior to cirrus pouch. Cirrus pouch between acetabulum and anterior testis, may not overlap the latter at its base. Cirrus protrusible. Genital pore submedian, dorsal, postacetabular or pretesticular. Ovary lobed or not, a little to pore side, intertesticular. Receptaculum seminis present. Uterus short. Vitellaria extensive. Excretory vesicle Y-shaped, stem short, bufurcating just behind cecal ends. Parasitic in blood vessels or heart of freshwater turtles.

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[1]) This genus, characterized by eight features, agrees well with *Tremarhynchus*, probably because the two genera are described from the same material, so that it is quite certain that *Tremarhynchus* is identical with *Rhynchotrema*, but until the actual date of issue of the Proceedings of the 20th Indian Science Congress held on January 2—7, is ascertained, I prefer to retain the genus *Tremarhynchus*, the description of which appeared in the June issue of the Journal of Helminthology of the same year.

Genotype: ***T. indicum*** **Thapar, 1933** (Pl. 58, Fig. 702), syn. *Hapalorhynchus indicus* (Thapar) Price, 1934, *Coeuritrema indicum* (T.) Mehra, 1934, in larger blood vessels and heart of *Trionyx gangeticus;* India.

Other species:

T. lyssimum (Mehra, 1933), syn. *Coeuritrema lyssimus* Mehra, 1933; in heart of *Lyssemys punctata;* India. Assigned to *Hapalorhynchus* — Byrd (1939).

T. odhnerense (Mehra, 1933), syn. *Coeuritrema odhnerensis* Mehra, 1933, in *Lissemys punctata;* India.

T. yoshidai (Ozaki, 1939), syn. *Hapalorhynchus yoshidai* Ozaki, 1939, in blood vessel of *Ocadia sinensis;* China.

Haemoxenicon Martin et Bamberger, 1952

Generic diagnosis. — Spirorchiidae, Carettacolinae: Body small, slender, not spined except for margins of oral and ventral suckers. Remnants of eye-spots may be present. Oral sucker terminal; esophagus long, provided with glands. Ceca terminating anterior to arms of excretory vesicle. Acetabulum weakly muscular, retractile, about one-sixth of body length from anterior extremity. Testes numerous, postovarian, intercecal, in single or double row. Vesicula seminalis externa saccular, between acetabulum and cirrus pouch. Cirrus pouch well developed,

containing tubular internal seminal vesicle, prostate cells and short cirrus. Genital pore ventral, slightly submedian, about midway between acetabulum and ovary. Ovary immediately posterior to cirrus pouch; expanded portion of germiduct serving as seminal receptacle. Minute pore opening on dorsal surface to left of median line, communicating with short Laurer's canal. Uterus short. Vitellaria extending along ceca between ovary and excretory vesicle; vitelline reservoir near posterior border of ovary. Excretory vesicle Y-shaped. Blood parasites of marine turtles.

Genotype: *H. stunkardi* Martin et Bamberger, 1952 (Pl. 52, Fig. 629a—b), in mesenteric veins of *Chelonia mydas;* Pacific coast, California. Panama.

Other species: *H. chelonenecon* Martin et Bamberger, 1942, in mesenteric veins of *Chelonia mydas;* Pacific coast, California.

DISCUSSION

The genus *Haemoxenicon* appears to be most closely related to *Carettacola* Manter and Larson, 1950, recovered from *Caretta caretta* at the Biological Laboratory of the Carnegie Institution, Tortugas, Florida. The important differences are: a common genital pore, a minute dorsal Laurer's pore, which could be seen only in serial sections, and no vagina in *Haemoxenicon* while *Carettacola* has separate male and female pores and a large thick-walled "vagina" which opens on the surface of the right side of the body. The egg of *Haemoxenicon chelonenecon* seems to be more elongate than that of *Carettacola bifora* but since only one egg was found within *H. chelonenecon* further observations are needed. Many eggs of this type

OBSERVATIONS

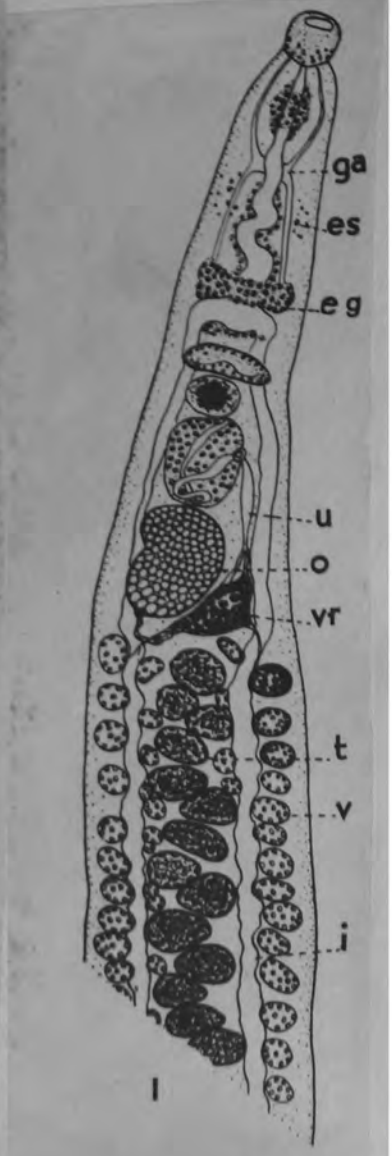
Haemoxenicon n. g. Martin & Bamberger, 1952

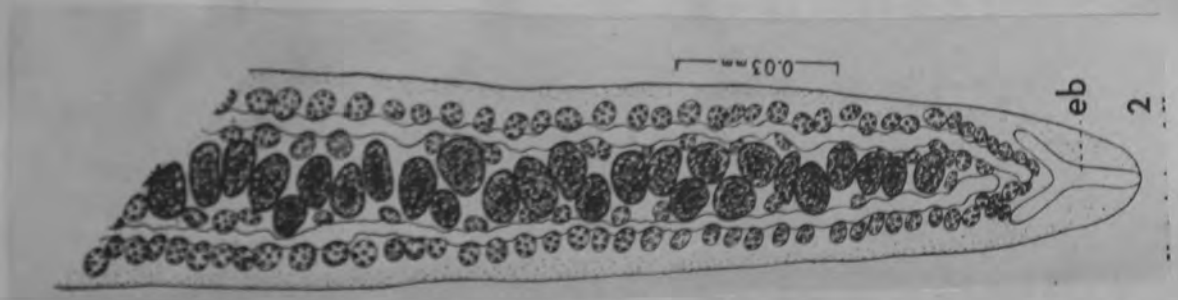
Generic diagnosis: Spirorchidae: Small, slender trematodes. Cuticula unarmed except for small spines on margins of oral and ventral suckers. Oral sucker terminal, ventral sucker weakly muscular, retractable into body. Esophagus slender, provided with glands. Bifurcation of gut at or a short distance anterior to acetabular level. Separate ceca terminate a short distance anterior to arms of excretory bladder. Excretory bladder Y-shaped. Cirrus pouch well-developed, containing a short cirrus, tubular seminal vesicle and prostate cells; external seminal vesicle saccular, anterior to cirrus pouch. Testes postovarial, intercecal, in single or double row; numerous and variable in number. Ovary immediately posterior to cirrus pouch, weakly to conspicuously bilobed. Expanded portion of oviduct serving as a seminal receptacle. Minute pore opening on dorsal surface to left of median sagittal plane communicates with a short Laurer's canal. Uterus short. Vitelline follicles along intestinal ceca from a short distance posterior to ovary to the crura of the excretory bladder. Vitelline reservoir near posterior border of ovary. Common genital pore opens on ventral body surface to the left of median sagittal plane approximately mid-way between acetabulum and ovary. Remnants of eyespots may be present.

Type species: Haemoxenicon stunkardi n. sp.

Haemoxenicon stunkardi n. sp. Martin & Bamberger, 1952

Species diagnosis: With characters of genus. Body elongate, 3.34 to 3.38 mm. long and 0.30 to 0.36 mm. in maximum width. Oral sucker terminal, 0.083 mm. in diameter. Ventral sucker approximately 0.15 mm. in diameter, pedunculated, frequently folded or even retracted into body. Acetabulum 0.55 to 0.58 mm. from anterior end of body. Margins of both suckers armed with short rows of small spines. Mouth leads to tubular esophagus which is lined with villi along most of its length. Glands present along esophagus and especially immediately anterior to bifurcation of gut (Fig. 1). Gut bifurcation a short distance anterior to acetabulum. Thin-walled ceca terminate near the crura of the excretory bladder. The left cecum always a little longer than the right. A conspicuous ganglion, located near the mid-esophagus level, gives off anterior and posterior nerves. Remnants of eyespots are present. Ovary bilobed, 0.17 to 0.21 mm. in length and 0.12 to 0.14 mm. in width. The oviduct arises from the posterior margin of the ovary, coils about, receives a small pouch-like Laurer's canal (whose pore opens dorsally), then proceeds anteriorly on the left side of the body, receiving the duct from the vitelline reservoir at the mid-ovarian level. From this point the uterus proceeds anteriorly to the common genital pore which opens ventrally at a level about mid-way between the acetabulum and the ovary. None of the specimens contained eggs. The vitellaria are spherical to subspherical and extend along the ceca from a short distance posterior to the ovary to slightly posterior to the terminations of the ceca. The vitellaria varied from 0.024 to 0.07 mm. in length and 0.012 to 0.06 mm. in width. The vitellarian products are temporarily stored in a reservoir located near the posterior margin of the ovary. The testes are oval to circular in outline and extend posteriorly and intercecally from a short distance posterior to the vitelline reservoir to a short distance anterior to the terminations of the ceca. Their size varied from 0.036 to 0.14 mm. in length and 0.024 to 0.095 mm. in width. The number of testes varied from 35 to 46. In one specimen the posterior ten testes showed signs of degeneration. They were represented by thin-walled sacs containing small masses of cells suspended in a clear fluid. The seminal vesicle is oval in outline, thin-walled, and is located immediately posterior to the acetabulum. It communicates with a slender tube containing sperm which is enclosed by the cirrus sac. The cirrus sac is well-developed, measuring from 0.17 to 0.24 mm. in length and 0.12 to 0.20 mm. in width, extending from the seminal vesicle to the ovary. It contains "prostate" cells and a cirrus. The cirrus can be extruded a short distance through the common genital pore. The excretory bladder is Y-shaped and moderately thick-walled. The stem measured from 0.08 to 0.13 mm. in length and the crura from 0.07 to 0.08 mm. in length.





Martin & Bamberger, 1952.

Haematoechus chelonaracus n. sp.

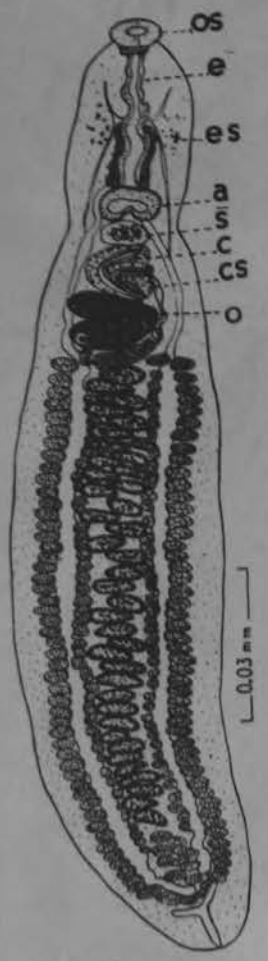
Species diagnosis: With characters of genus. Body elongate, usually exhibiting a slight constriction at or near the acetabular level, 1.38 to 1.90 mm. in length and 0.36 to 0.37 mm. in maximum width. Oral sucker terminal, 0.06 to 0.08 mm. in diameter. Ventral sucker approximately 0.12 mm. in diameter, 0.18 to 0.30 mm. posterior to anterior end of body, pedunculated, capable of being folded and retracted into body (Fig. 4). Margins of both suckers armed with short rows of small spines (Fig. 6). Esophagus tubular, lined with villi along most of its length (Fig. 5), and provided with glands. Bifurcation of gut at or a short distance anterior to acetabular level. Ceca slender, thin-walled, and extending posteriorly to near the crura of the excretory bladder. Right cecum usually slightly longer than the left. A conspicuous ganglion, located near the mid-esophagus level, gives off anterior and posterior nerves. Remnants of eyespots present. Ovary bilobed, 0.08 to 0.14 mm. along one axis and 0.11 to 0.16 mm. along the other axis. Ovary near the posterior end of the anterior one-third of body. Oviduct arises from posterior margin of ovary, slightly convoluted, receives a short pouch-like Laurer's canal (whose pore opens dorsally to the left of the median sagittal plane), then proceeds anteriorly to the left of the ovary where it receives the vitelline duct at the mid-ovarian level. From this point the uterus proceeds anteriorly to the common genital pore located ventrally to the left of the median sagittal plane approximately mid-way between ovary and seminal vesicle. One specimen, which was serially sectioned, contained an egg in the uterus. The egg, including a spine at one end, had an over-all length of 0.146 mm. and a maximum width of 0.037 mm. The spine was 0.022 mm. long. The vitellaria are oval in outline, 0.024 to 0.06 mm. transversely and 0.012 to 0.036 mm. antero-posteriorly, and extend along the ceca from near the ovarian level to a short distance posterior to the cecal terminations. A tubular vitelline reservoir lies close to the posterior margin of the ovary. Testes oval, intercecal, extending from the vitelline reservoir to near, but not reaching, the cecal terminations, and measuring 0.024 to 0.048 mm. in the antero-posterior axis and 0.10 to 0.12 mm. transversely. The number of testes varied from 37 to 44. The saccular, thin-walled seminal vesicle is located immediately posterior to the acetabulum. It communicates with a slender tube containing sperm which is enclosed by the cirrus sac. The well-developed cirrus sac, located between the seminal vesicle and the ovary, measures approximately 0.14 by 0.10 mm. It contains "prostate" cells and a cirrus. The cirrus is covered with villi (Fig. 4). The excretory bladder is Y-shaped with a terminal pore. The crura usually are about the same length as the stem (0.06 mm.).

Host: Chelonia mydas.

Location: Mesenteric veins.

Locality: Pacific Ocean off Baja, California.

Type specimen: Hancock Parasitology Collection No. 4910.



3

HAEMOXENICON

Hapalorhynchinae n. subfam.

Subfamily diagnosis. — Spirorchiidae: Body lanceolate or spatulate. Oral sucker prominent, esophagus moderately long, ceca not reaching posterior extremity. Acetabulum present. Testes tandem, postequatorial, with ovarian complex between. Seminal vesicle large, immediately postacetabular. Prostatic complex strongly developed between anterior testis and seminal vesicle. No cirrus pouch. Genital pore dorsal, near midbody. Receptaculum seminis and Laurer's canal present. Vitellaria extending whole length of ceca. Eggs with polar processes. Excretory vesicle Y-shaped, its stem longer than in other subfamilies.

Hapalorhynchus Stunkard, 1922

Generic diagnosis. — Spirorchiidae, Hapalorhynchinae: Body lanceolate, rather slender or spatulate. Acetabulum about one third of body length from anterior extremity. Oral sucker very prominent. Esophagus of moderate length. Ceca not reaching to posterior extremity. Testes lobed or not, tandem, with ovarian complex between; posterior testis usually at junction of middle with posterior third of body; anterior testis slightly to right of median line or exactly median. Seminal vesicle large, immediately postacetabular. Prostatic complex strongly developed in front of anterior testis. No cirrus pouch. Genital pore sinistral, dorsal, near midbody. Ovary lobed or not, median or slightly to left, intertesticular, postequatorial. Small receptaculum seminis and Laurer's canal present. Vitellaria extensively developed from intestinal bifurcation to cecal ends, especially in pre-acetabular and postovarian regions. Eggs with polar processes. Excretory vesicle Y-shaped. Parasitic in blood vessels of turtles.

Genotype: *H. gracile* Stunkard, 1922 (Pl. 50, Fig. 613), in artery of *Chelydra serpentina;* Indiana.

Other species:

H. evaginatum Byrd, 1939, in mesenteric vessels of *Amyda spinifera;* N. America.

H. reelfooti Byrd, 1939, in blood vessel of *Sternotherus odoratus;* N. America.

H. stunhardi Byrd, 1939, in blood vessel of lung of *Kinosternon carinatum;* N. America. 12 flame cells on each side.

YAMAGUTI, 1958

Stunkard (1923) erected the genus *Hapalorhynchus* for *H. gracilis* from *Chelydra serpentina*, stating that there was no cirrus sac or cirrus present. Mehra (1933) erected the genus *Coeuritrema* for *C. lyssemus* and *C. odhnerensis*, stating that they were generically different from *H. gracilis* because they possessed well-developed cirri. Thapar (1933) erected the genus *Tremarhynchus* for *T. indicus*, but Mehra (1934) pointed out that *T. indicus* possesses a rudimentary cirrus and thus belongs in *Coeuritrema*. Price (1934) considered *Tremarhynchus* a synonym of *Hapalorhynchus*, and Byrd (1939) considered both *Tremarhynchus* and *Coeuritrema* synonyms of *Hapalorhynchus*. Skrjabin (1951) and Yamaguti (1958, 1971) both considered *Coeuritrema* and *Hapalorhynchus* separate genera. Our specimens and the original description of *Hapalorhynchus stunkardi* both show a well-developed cirrus. Additionally, Brooks and Mayes (1975) described *Hapalorhynchus foliorchis* and reported a weakly muscular ductus ejaculatorius leading from the seminal vesicle to the genital pore; examination of the holotype of *H. gracilis* revealed a similar morphology as did Thapar's description of *Tremarhynchus indicus*. Since a weakly-muscular ductus ejaculatorius may be termed a rudimentary or poorly-develop cirrus, the synonymy of *Coeuritrema* and *Tremarhynchus* with *Hapalorhynchus* is justified, and the generic diagnosis is hereby emended for the first time to include species with either a well-developed or poorly-developed cirrus.

Byrd (1939) compiled a key to the species of *Hapalorhynchus*, and based his first couplet on the presence or absence of a body constriction at the level of the acetabulum. He described *H. stunkardi* as lacking such a constriction, but our specimens of *H. stunkardi* (which were fixed without pressure) have the constriction. The diagnosis of *H. stunkardi* is hereby emended to include such a constriction and the use of the presence or absence of such a constriction for distinguishing species eliminated. We have prepared the following new key to the species of *Hapalorhynchus* in light of the new morphological information.

Key to Species of *Hapalorhynchus* Stunkard 1923
Synonyms: *Coeuritrema* Mehra 1933; *Tremarhynchus* Thapar 1933

1a.	Cirrus well-developed	5
1b.	Cirrus poorly developed	2
2a.	Testes smooth	3
2b.	Testes lobed	4
3a.	Esophageal diverticula present	*evaginatus* Byrd 1939
3b.	Esophageal diverticula absent	*gracilis* Stunkard 1923
4a.	Ovary lobed	*indicus* (Thapar 1933) Price 1934
4b.	Ovary smooth	*foliorchis* Brooks and Mayes 1975
5a.	Vitelline follicles extending into forebody	6
5b.	Vitelline follicles not extending into forebody	*lyssemus* (Mehra 1933) Byrd 1939
6a.	Oral sucker smaller than acetabulum	7
6b.	Oral sucker larger than acetabulum	*odhnerensis* (Mehra 1933) Byrd 1939
7a.	Testes lobed, vitelline follicles extending to bifurcation	3
7b.	Testes smooth, vitelline follicles not extending to bifurcation	*yoshidai* Ozaki 1939
8a.	Ovary a narrow transverse band	*reelfooti* Byrd 1939
8b.	Ovary ovoid	*stunkardi* Byrd 1939

BROOKS AND MAYES, 1976

Genus **Hapalorhynchus** Stunkard, 1922

Syn: Cocuritrema Mehra, 1933; *Tremarhynchus* Thapar, 1933.

Generic diagnosis: Spirorchinae. Small distomate blood flukes, with or without hair-like spine covering the integument, usually with constriction in body at level of ventral sucker. Suckers small and protrusible. Esophagus long, with gland cells. Gland cells usually forming compact mass about posterior part of esophagus. Nerve ring small. Caeca simple, with or without undulations, reaching to very near posterior end of body. Testes two in number, separated by ovary. Vesicula seminalis usually large, anterior to anterior testis, outside cirrus sac. Cirrus sac small, weakly to moderately muscular, usually with short cirrus. Genital pore dorsal, to left of midline, on level with or slightly anterior to anterior testis. Ovary between testes. Oviduct, shell gland, receptaculum seminis, and small yolk reservoir usually present. Vitellaria follicular, extensive, mainly along length of caeca. Uterus short, with weakly developed metraterm. Ova spherical or elongated, with or without polar processes, discharged singly. Excretory system with median, terminal bladder, more conspicuous than in *Spirorchis*, with or without reserve vesicle. Cornua reaching to region of oral sucker. Parasitic in blood vascular system of turtles.

Type species: Hapalorhynchus gracilis Stunkard, 1922.

Additional species: H. lyssemus (Mehra, 1933) (= *Cocuritrema lyssemus* Mehra, 1933), *H. odhnerensis* (Mehra, 1933) (=*Cocuritrema odhnerensis* Mehra, 1933), *H. indicus* (Thapar, 1933) (= *Tremarhynchus indicus* Thapar, 1933), *H. stunkardi* n. sp., *H. reelfooti* n. sp., and *H. evaginatus* n. sp.

Reasons for considering the genera *Cocuritrema* Mehra, 1933, and *Tremarhynchus* Thapar, 1933, synonymous with the genus *Hapalorhynchus* Stunkard, 1922, have been discussed above.

Byrd, 1939

Key to the Species of the Genus Hapalorhynchus

1. Body separated into two regions by constriction at level of acetabulum.... 2
   Body not separated into regions by constriction..... 3
2. Ovary round; ventral sucker larger than oral sucker..*lyssemus* (Mehra, 1933).
   Ovary transversely elongated; acetabulum smaller than oral sucker.....*reelfooti* n. sp.
3. Integument simple..... 4
   Integument covered with hair-like spines.....*stunkardi* n. sp.
4. Vitellaria extending in front of acetabulum..... 5
   Vitellaria beginning posterior to acetabulum....*odhnerensis* (Mehra, 1933).
5. Body small, less than 3 mm. in length..... 6
   Body large, more than 3 mm. in length.....*indicus* (Thapar, 1933).
6. Esophagus with 10 to 14 evaginated pouches at posterior end..*evaginatus* n. sp.
   Esophagus simple or with dilations only.....*gracilis* Stunkard, 1922.

BYRD, 1939

On the bases of priority Mehra (1934) considered the genus *Tremarhynchus* Thapar, 1933, synonymous with *Cocuritrema* Mehra, 1933. This consideration was made apparently before Mehra had access to the paper by Price (1934) in which this author showed *Tremarhynchus* to be synonymous with *Hapalorhynchus* Stunkard, 1922. We are in agreement with both Price and Mehra in considering *Tremarhynchus* synonymous with *Hapalorhynchus* and *Tremarhynchus* with *Cocuritrema*. Thus the species assigned to the genera *Tremarhynchus* and *Cocuritrema* are transferred to the genus *Hapalorhynchus*.

BYRD, 1939

HAPALORHYNCHUS STUNKARD, 1922

SYN: THAPAR, 1933

The distinguishing characters of the genus *Tremarhynchus* may be summed up thus :

" Hermaphroditic blood inhabiting distomes with protrusible suckers ; no cuticular spines ; narrow pointed posterior end ; bicornuate excretory bladder ; testes separated by the ovary and divided into follicles ; seminal vesicle and cirrus anterior to the testes ; genital pore dorsal and sinistral ; vitellaria extensively developed ; pharynx absent."

Host :—*Trionyx gangeticus* (the common mud turtle of Northern India).

DISCUSSION.

The subfamily Hapalotreminae, as originally constituted by Stunkard (1921), contained only the genus *Hapalotrema* Looss, 1899. Later, Stunkard (1923) added another genus *Hapalorhynchus* to it and this was distinguished from *Hapalotrema* in " the absence of the body spines, protrusible oral sucker, simple testes not divided into follicles, absence of cirrus and cirrus sac, presence of large prostate glands, the position of the seminal vesicle anterior to the testes and the shape of the eggs." To this must now be added a third genus *Tremarhynchus* described in the present communication.

An examination of the various characters of these three genera indicate that the present form is of great systematic importance in so far as it appears to connect the other two genera together. It bears characters in which it resembles the genus *Hapalotrema*, while it has other features that show its affinity with the genus *Hapalorhynchus*. Thus, in the presence of the follicular testes, lobed ovary and the presence of seminal vesicle outside the cirrus, it resembles the genus *Hapalotrema*. In *Hapalotrema*, however, the posterior end of the body is spatulate, the body is armed with spines and the seminal vesicle and the cirrus, as also the genital pore, are situated besides the ovary on its left side between the testes. In these features, therefore, and particularly in the position of the seminal vesicle, cirrus and the genital pore, in front of the testes, the genus *Tremarhynchus* differs remarkably from *Hapalotrema*. In the protrusible nature of the oral sucker, in the absence of the body spines and in the anterior position of the seminal vesicle and the genital pore, the present form resembles the genus *Hapalorhynchus*. But in this latter genus, the testes are not divided into follicles, the prostate glands are large and the cirrus and cirrus sac are absent. Thus, they can readily be distinguished from each other and the new genus *Tremarhynchus*, in these characters at least, can be identified with *Hapalotrema*, from which it has already been shown to be different in certain important features. It would, thus, appear that the new genus presents features common, partly with one and partly with the other, to the two already known genera of the subfamily, Hapalotreminae and is interesting in so far as it forms a connecting link between the two known genera—*Hapalotrema* and *Hapalorhynchus*. The presence of the cirrus and its position along with that of the seminal vesicle, in front of the two testes in the body is, however, unique in the subfamily. All these characters taken together amply justify the creation of our new genus for these flukes.

HAPALORHYNCHUS STUNKARD, 1922

SYN. **Diagnosis of the Genus Coeuritrema ~~N. G.~~** H.R. MEHRA, 1933

Hapalotreminæ: Hermaphrodite distome blood flukes; delicate musculature. Body elongated, narrow or broad behind ventral sucker; size very small; body wall with or without small papillæ; oral sucker protrusible; ventral sucker protractile and retractile, situated at about one third body length from anterior end. Pharynx absent; œsophagus long surrounded by salivary gland cells which are numerous near its posterior extremity; intestinal bifurcation close in front of ventral sucker; intestinal cæca reaching a little in front of hind end and forming characteristic loops behind ventral sucker in region of genital opening, left cæcal loop more pronounced. Genital opening dorsal, sinistral close behind ventral sucker near middle of body length close outside left cæcum. Testes two in number with ovary between them, situated in third quarter of body, intracæcal and usually lobed; anterior testis lying to the right, immediately behind cirrus sac and close in front of ovary; posterior testis median, immediately behind ovary and receptaculum seminis. Ovary conical or flask-shaped, situated to the left with transverse vitelline ducts close behind it; vitelline reservoir in front of transverse ducts. Receptaculum seminis pear-shaped, rounded or oval situated to the right near right cæcum, immediately in front of posterior testis. Cirrus sac large, muscular and crescent shaped or retort shaped with a concavity in its right wall, situated immediately in front of anterior testis. Vesicula seminalis small, external, and to the right side near right cæcum opposite to the cirrus sac. Cirrus well developed, without spines. Metraterm well developed and muscular, situated in front of ovary and to the left side of anterior testis and cirrus sac Uterus short, indistinguishable from metraterm except by the absence of musculature, containing a single large ovum bearing filaments at ends. Vitellaria well developed lateral, overlapping the cæca, uniting mesially behind ventral sucker in the region between it and genital opening, and behind posterior testis, leaving entirely free the genital field. Excretory bladder small and tubular at hinder end with a short median stem provided with one or two pairs of lateral lobes and dividing near blind ends of cæca into two small but prominent cornua.

Habitat: Ventricle of heart.

Host: Water tortoises, *Lissemys punctata*. Locality: Allahabad, India.

Type species.—*Coeuritrema lyssimus* ~~sp. n.~~ MEHRA, 1933

Hapalorhynchus gracilis, ~~nov. spec.~~ Stunkard, 1932

Figures 1 and 2

The material upon which this description is based consists of over one hundred individuals collected from the washings of the visceral organs, lungs, liver, kidneys, mesenteries, and alimentary tract of turtles from North Judson, Indiana.

Fixed and mounted specimens measure from 1.5 to 1.9 mm. in length and from 0.15 to 0.25 mm. in width. Living specimens in an extended condition are slightly longer and more slender. The worms are fusiform in shape tapering anteriorly and posteriorly in a similar manner. The region of greatest width is near the middle of the body where the reproductive organs are located. Before and behind the limits of the vitellaria the body narrows considerably. In cross-section the body is oval, flattened ventrally.

The cuticula is thin and unarmed. The musculature is weak and poorly developed.

The acetabulum is slightly protrusible but not stalked and is situated near the posterior end of the anterior third of the body. It is cup-shaped, normally circular in outline but sometimes elongated or flattened as a result of pressure or contraction. It measures from 0.061 to 0.069 mm. in diameter and its depth is approximately equal to its diameter.

The oral sucker is slightly subterminal and capable of considerable extension and retraction. In fixed and mounted specimens, usually about one-half of the sucker protrudes from the body. In shape it is ovate, wider anteriorly and measures from 0.073 to 0.084 mm. in length and from 0.054 and 0.058 mm. in extreme width. The esophagus extends posteriorly from the oral sucker to the bifurcation of the alimentary tract midway between the oral and ventral suckers. It is straight in extended specimens, often with two or three dilated portions. The lining is cuticular and it is surrounded by secretion cells. No pharynx is present. The digestive ceca meet anteriorly to form an angle and end blindly about one-fifth of the body length from the posterior end. They are somewhat dorsal in position and the left crus is flexed median and dorsad near the middle of the body, passing on the median side of the genital pore.

The excretory pore is located at the posterior end of the body and a large median collecting vesicle passes forward dividing a short distance behind the intestinal crura to form two lateral collecting ducts.

The testes are situated one behind and the other before the ovary. The posterior testis is the larger; it has an elongated oval form and measures 0.18 to 0.21 mm. in length, 0.05 to 0.06 mm. in width and 0.06 to 0.07 mm. in depth. The anterior testis is situated obliquely, immediately in front and slightly at the right of the ovary. It is ovate to triangular in outline, the widest portion is anterior and median and the organ narrows laterally and posteriorly. The posterior end occupies the right side of the body at the ovarian level. Its long axis measures from 0.064 to 0.084 mm. and its transverse axis 0.04 to 0.05 mm.

There is a large seminal vesicle which extends from the level of the acetabulum about one-half of the distance posterad to the ovary. On the right side it has an indentation and is partially covered by a lobe of the vitellaria. From the median posterior margin of the vesicle the vas deferens emerges as a small tube. It enlarges abruptly immediately and passes posterad, dorsad and sinistrad to the genital pore. The anterior part is often filled with spermatozoa while the terminal part is usually empty. The terminal part is lined with cuticula and contracts to a small duct which opens to the surface just median and anterior to the opening of the uterus. The pore is double, the male and female canals opening separately although the wall separating them is very thin and they appear to discharge through a common orifice. A cirrus sac and cirrus are lacking. The vas deferens and the terminal part of the seminal vesicle are enclosed in a large prostatic gland which occupies most of the body space between the anterior testis and the seminal vesicle.

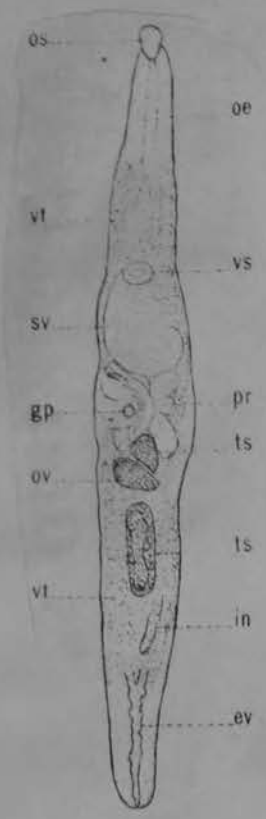


FIG. 2

The ovary is situated slightly at the left of the median line and posterior to the middle of the body. Its long axis is almost at right angles to the long axis of the worm. It measures from 0.1 to 0.12 mm. in length and from 0.06 to 0.08 mm. in extreme width. It is ovoid to pyriform in shape, the wider end is lateral and slightly anterior, and the oviduct arises at the median posterior margin. The oviduct passes posterad almost to the level of the posterior testis. Here is gives off a small seminal receptacle and Laurer's canal passes dorsally opening to the surface near the median line. Immediately following the origin of Laurer's canal, the vitelline duct discharges into the ootype and the canal then passes forward on the dorsal side of the body and leads directly to the genital pore. The vitellaria consist of masses of follicles extending on either side of the body from the bifurcation of the alimentary tract to the bifurcation of the excretory vesicle. They extend to the median line forming a solid mass in front of the acetabulum and behind the ovary except for a small area where the posterior testis overlapping almost all the space between dorsal and ventral walls of the body limits their presence. Between the acetabulum and the ovary they are restricted to narrow tracts at the sides of the body lateral to the intestinal diverticula.

The genital pore is dorsal in position, situated near the middle of the body, slightly at the left of the median line. The diverticulum of the intestine and the vitelline tube of that side are bent mediad at the level of the pore and lie median to it. This condition suggests strongly that the genital pore has migrated from a ventro-lateral or lateral to a dorsal position pushing the intestinal and vitelline structures before it.

The uterus is short and in only one out of many individuals examined has an egg been found in the body. Considering the size of the egg it appears certain that not more than a single egg can be present in the uterus at one time. The egg (Fig. 2) is triangular, the shell is thick and resistant to pressure although almost colorless. In the body the egg lies in the uterus with the single horn forward and the forward tip is often bent or slightly coiled. The eggs reach the outside world with the feces of the host and are often present in large numbers. Eggs in the feces measured 0.27 mm. in length, 0.07 mm. in width at the level of the embryo and 0.2 mm. between the tips of the posterior horns.

Helminthological Laboratory, Department of Tropical Research, Bronx Park, New York City.

Hapalorhynchus gracilis Stunkard, 1922

There are 18 specimens in the present collection that conform to the description of *Hapalorhynchus gracilis* except for a slightly smaller body size (none of our material reach 1 mm. in length and the width is never more than 200 μ), the presence of a well defined constriction in the body at the level of the ventral sucker, and the presence of a fairly well defined cirrus sac. The ova have not been observed. When we are able to observe the ova of this group of worms it may become necessary to establish a new species for its reception. However at the present time we prefer to identify our material with *H. gracilis* Stunkard.

BYRD, 1939

Hapalorhynchus evaginatus n. sp. BYRD, 1939

(Plate III, Fig. 8.)

Specific diagnosis: Hapalorhynchus. Body small, elongated, slender, tapering toward posterior end where it is almost pointed, from 460 to 950 μ long by 110 to 200 μ in maximum width. Integument unarmed. Oral sucker terminal, protrusible, from 40 to 60 μ in diameter. Ventral sucker a little way behind bifurcation, 28 to 35 μ long by 46 to 84 μ wide, from 170 to 220 μ from anterior end of body. Nerve ring conspicuous, at level of union of first and second thirds of esophagus, giving rise to anterior and posterior nerve trunks. Esophagus 90 to 190 μ long, slender tube through first two-thirds of its length, with prominent dilation in posterior third; posterior dilated part with 10 to 14 conspicuous evaginated pouches that form rosette-like mass about esophagus; pouches may attain measurements of 37 μ long by 17 μ wide. Esophageal gland cells present, becoming more pronounced in region of esophageal pouches. Caeca slender tubes, with few irregularities, reaching to within 140 μ of posterior end of body. Testes two in number, separated by ovary; anterior testis squarish, 42 μ in diameter, placed immediately in front of ovary, 130 μ behind acetabulum; posterior testis immediately behind ovary, elongated, 97 μ long by 42 μ wide. Seminal vesicle in midline, curving to left to genital pore, separating anterior testis from acetabulum. Cirrus sac indistinguishable. Genital pore dorsal, outside of left caecum, at level of anterior margin of anterior testis. Ovary squarish, close between testes, 21 to 30 μ long by 42 to 60 μ wide. Genital complex unobserved. Vitellaria follicular; from pouched portion of esophagus to excretory bladder, extensive. Uterus short. Metraterm indistinguishable. Ova unobserved. Excretory vesicle tubular, slightly coiled, reaching to posterior limits of vitellaria, almost to ends of caeca.

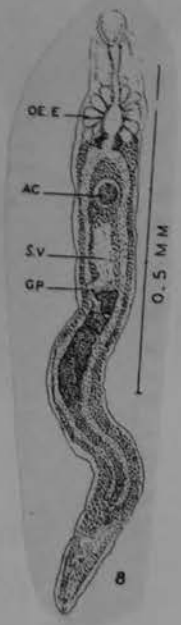
Host: Amyda spinifera (Le Sueur).

Habitat: Mesenteric blood vessels.

Locality: U. S. A. (Reelfoot Lake in Tennessee).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 9227.

Hapalorhynchus evaginatus appears to be distinct from the other members of the genus by the shape and arrangement of the gonads and the characteristic evaginations about the posterior part of the esophagus. In regard to the pouched condition noted for the esophagus the species appears to be closely related to the members of the genus *Vastotrema* Stunkard, 1926. The arrangement of the gonads in our material prevents such an association.



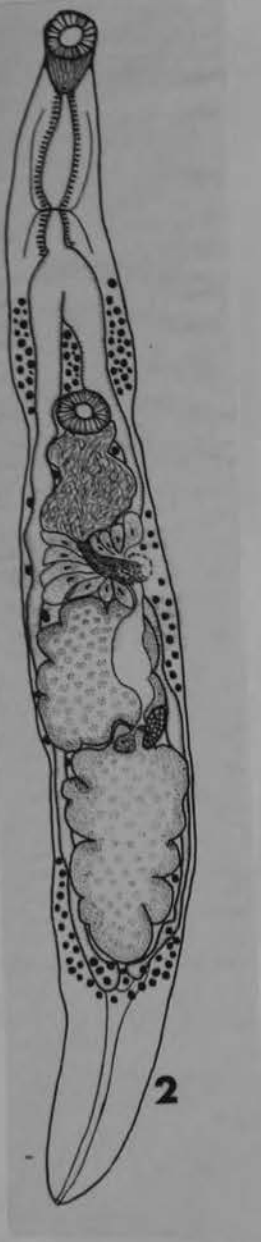
Hapalorhynchus foliorchis sp. n. BROOKS AND MAYES, 1975
(Fig. 2)

Description (measurements based on 24 of 34 specimens): Body smooth, tapering at both ends, widest in posterior half, with a constriction at the level of acetabulum; length 1,560 (1,427 to 1,681), width 200 (164 to 238) near mid-hindbody. Oral sucker subterminal, protrusible, 60 wide (50 to 71); acetabulum one-third body length from anterior end, 71 long (67 to 81) by 77 wide (71 to 85). Esophagus 212 long (182 to 242), dilated and surrounded by gland cells, constricted in posterior third at level of cerebral commissure. Intestinal bifurcation preacetabular, ceca long; postcecal space equal to one-fifth body length. Testes contiguous, irregular; anterior testis 164 (131 to 202) by 145 (111 to 176); posterior testis 233 (182 to 303) by 146 (117 to 172). Seminal vesicle large, abutting posterior margin of acetabulum; with a short, straight duct leading to weakly muscled ductus ejaculatorius, surrounded by large, prominent prostatic gland cells. Genital pore dorsal, 150 to 220 posterior to acetabulum, lateral to sinistral cecum. Cecum indented at level of genital pore. Ovary intertesticular, oval to round, 56 (44 to 67) by 33 (22 to 55), sinistral, abutting left cecum. Seminal receptacle small, posteromedian to ovary. Laurer's canal short, straight; Mehlis' gland cells small. Uterus sinistral, saccular, ventral to anterior testis, opening at genital pore, containing no eggs. Vitelline follicles abundant, extending dorsally from intestinal bifurcation to cecal tips. Excretory pore terminal, bladder Y-shaped, bifurcating at level of cecal tips.

Type host: Chelydra serpentina (Linnaeus), snapping turtle.

Type locality: Missouri River, 1.5 miles south of Brownville, Nebraska.

Type specimens: Holotype and two paratypes USNM Helm. Coll. Nos. 73820, 73821. Paratype series H. W. Manter Coll. No. 20078. Other paratypes in collections of authors.



Discussion

The genus *Hapalorhynchus* Stunkard, 1922, was erected for *H. gracilis* in the circulatory system of *C. serpentina* from Indiana. Byrd (1939) reported *H. gracilis* and described three additional species, *H. evaginatus* in *Trionyx spiniferus*, *H. reelfooti* in *Sternotherus odoratus* (Latreille), and *H. stunkardi* in *Kinosternon* (= *Sternotherus*) *carinatum* (Gray) from Reelfoot Lake in Tennessee. A report by Guilford (1959) of *H. gracilis* in *C. serpentina* from the Menominee River in Michigan is the only other report found by the authors concerning the species of this genus.

Hapalorhynchus foliorchis most closely resembles *H. gracilis*, but differs in possessing a narrower oral sucker and larger acetabulum, and a prominent esophageal constriction. The ovary is extremely small compared to that of *H. gracilis*, the testes are much larger, and highly irregular in outline as opposed to the smooth testes of *H. gracilis*. The postcecal space of *H. foliorchis* is equal to one-sixth the length of the body while that of *H. gracilis* is one-fifth. Finally, the uterus of *H. foliorchis* passes ventrally to the anterior testis while in *H. gracilis* the uterus passes dorsally.

HAPALORHYNCHUS INDICUS (THAPAR, 1933) PRICE, 1934

SYN: TREMARHYNCHUS INDICUS, ~~N.G., N.SP.~~ THAPAR, 1933

The body of the fluke is elongated, cylindrical, and pointed at either end. The length varies from 3·16 mm. to 3·45 mm., and it has its greatest breadth of ·35–·47 mm., at about the level of the posterior testis. The general surface of the body is smooth and does not bear any spines.

The oral sucker is situated at the extreme anterior end of the body and is extremely protrusible. It is smaller than the ventral sucker and measures ·12 mm. by ·15 mm. The ventral sucker is circular and slightly protrusible. It is situated at about one-third the distance from the anterior end of the body and has a diameter of ·2 mm.

The mouth is in the centre of the oral sucker at the anterior end of the body. The excretory pore lies at the posterior extremity, and the genital pore is on the dorsal side behind the position of the acetabulum.

The mouth leads into an elongated straight tube, the oesophagus, that extends for about two thirds the distance between the two suckers from the anterior end. It has a cuticular inner lining of its wall. The pharynx, as in other blood flukes, is absent, and the oesophagus bifurcates in front of the acetabulum into two intestinal cæca that run backwards to the posterior end, as slender straight tubes of a more or less uniform diameter. Before terminating blindly, at about one-eighth of the body length from the posterior end, the two cæca converge for a small distance.

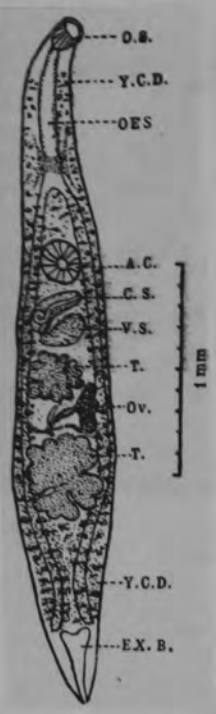
The excretory pore is terminally situated at the posterior end of the body and leads into a large triangular median collecting sac, the excretory bladder. The excretory bladder extends as far forward as the posterior end of the intestinal cæca, where it divides into two narrow lateral ducts one on either side of the median line. The collecting excretory bladder itself is ·2–·3 mm. long and is a very characteristic feature of the group.

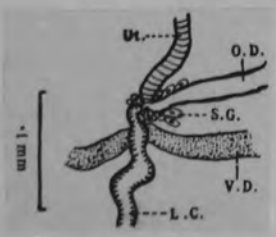
The nervous system is well developed and consists of a distinct œsophageal commissure, situated a little in front of the point of bifurcation of the intestinal cæca, at a distance of ·45–·5 mm. from the anterior end of the body. It appears distinctly X-shaped and runs round the œsophagus. It further sends a pair of nerves towards the anterior end and a pair towards the posterior end of the body.

The female reproductive organs consist of a single ovary situated between the two testes, on the left side of the median line. It is a trilobed organ and leads by a narrow oviduct at about the middle of its right side. The oviduct receives after a short course the common duct of the vitelline glands and thus forms an oötype, at the point of its union. Here Laurer's canal also meets and itself opens on the dorsal surface. The point of union of all these ducts is further marked by the presence of minute unicellular shell glands, shown in Fig. 2 (s.g.).

The vitelline glands are very extensive and irregularly scattered throughout the body. They consist of masses of follicles extending on either side of the median line. In front of the acetabulum and behind the posterior testis they form continuous masses filling up all spaces between the dorsal and ventral walls. In between the acetabulum and the posterior testis they are limited and occupy narrow tracts on either side of the intestinal cæca.

The uterus is very short and arises from the oötype forwards. The eggs have not been observed in any of the specimens so far obtained. The





–OVER–

absence of the eggs is due to the fact that they are discharged as soon as they are formed. There is not sufficient space for them to remain long within the narrow body of the flukes that are migrating in the blood stream from one part to the other of the body of the host. I have, therefore, nothing to add about the structure of the eggs.

There are two testes situated one in front and the other behind the ovary. The testes are divided into a number of distinct lobes that are deeply cleft, showing a varying number of follicles. The posterior testis is the larger of the two and lobulations are very clearly marked.

There is a large seminal vesicle, more or less oval in outline, that lies transversely across in front of the anterior testis and outside the cirrus sac. It is about ·2 mm. long and leads into an elongated, pearshaped cirrus sac in front. This structure (Fig. 3) is obliquely placed in the body and encloses within it an elongated cirrus. The cirrus, in its proximal portion, is a coiled structure forming as a sort of rudimentary ductus ejaculatorius. The distal part is, however, a straight muscular tube with a slight bend. This is the true cirrus and can be protruded out at the genital pore. Within the cirrus sac there are faint glandular cells that represent the prostate glands.

The genital pore is situated on the dorsal side of the body and is on the left side of the median line.

HAPALORHYNCHUS LYSSIMUS (MEHRA, 1933) BYRD, 1939

Syn. **Coeuritrema lyssimus Nov. Gen., Nov. Spec.** H.R. MEHRA, 1933

The trematodes of this species were collected by me in 1931 and 1932 from the ventricle of the heart of soft-shelled turtles *Lyssemys punctata* at Allahabad. In all I examined sixteen turtles, out of which nine were found infected with these parasites. The rate of infection, therefore, seems to be nearly fifty per cent. The number of parasites found in a single host is generally large, more than a dozen. Three hosts were, however, found infected with 5—10 specimens each. In one case only three specimens were obtained. The distomes are more or less firmly attached to the walls of the ventricle and do not come out at once when the ventricle is opened. Some take a few minutes to come out, others a longer time; some took 20 minutes to half-an-hour to come out in the normal salt solution in which the ventricle cut into two halves was kept. When freed in salt solution they do not show any active movements; sometimes they bring their anterior and posterior ends close together and become bent in the form of a loop. They also contract slightly on the application of fixing fluids.

The body is thin and very transparent, and in preserved specimens it is generally hollowed out in the form of a shallow groove. It is somewhat conical in shape, broad and somewhat rounded near the posterior end and narrow in front of the ventral sucker ending to a blunt point at the anterior end. The size is small, 1·33—1·92 mm. in length and 0·46—0·48 mm. in greatest breadth, which lies in the region of the ovary. In the region of the intestinal bifurcation the breadth measures 0·27—0·28 mm., and in that of the ventral sucker 0·23—0·3 mm., behind which it gradually increases, measuring 0·36 mm. in the region of the genital opening and 0·46 mm. in the region of the anterior testis and the ovary, where it reaches the maximum limit. Immediately behind the ovary it slightly diminishes, measuring 0·43 mm. in the region of the posterior testis. In the region of the excretory bladder or the ends of intestinal cæca it measures 0·288 mm. One specimen measured 1·37 mm. in length and 0·35 mm. in maximum breadth. All the above measurements are taken from entire mounts. The hinder end is usually spatulate and flattened depending upon the state of contraction and notched in the centre, where the excretory bladder opens. Some specimens when much contracted show a curiously broad shape of the body with a more or less uniform breadth from behind the ventral sucker to the hinder end. Specimens of smaller size, as a rule, become easily contracted to assume such curious shapes. The body-wall is covered with small conical papillæ or tubercles, which extend from a little distance behind the oral sucker to the hinder end, measuring 0·012 mm. in length and 0·18 mm. in maximum breadth at the base. They are sparse in front of the intestinal bifurcation, but behind the acetabulum they are numerous and more closely situated. Their free ends are somewhat rounded or bluntly pointed and directed straight outwards or upwards, but not backwards like the usual chitinous spines. The small rod-shaped spines characteristic of the blood flukes are present only in the region of the genital pore and cirrus sac. There are hardly any muscle fibres visible in the body-wall, and there is no muscular layer present outside the epithelium lining the intestinal cæca.

The oral sucker is terminal and partly projects out from the anterior end above the general surface of the body, but ordinarily it is not so much protrusible as in the genus *Spirorchis*. It has a circular outline, measuring 0·1—0·12 mm. in diameter; occasionally it is a little longer than broad. The ventral sucker is much larger and stouter, measuring 0·17—0·19 mm. in diameter and 0·14—0·15 mm., in depth, *i.e.*, a little less than twice the size of the oral sucker. In two specimens however, the ventral sucker measured 0·14—0·15 mm. in diameter and the oral sucker 0·112 mm. in length and 0·096 mm. in breadth. The ventral sucker lies close behind the intestinal bifurcation at about one-third body-length from the anterior end, occupying nearly the entire depth and a great portion of

Fig. 1

Dorsal view.

—OVER—

the breadth of the body, and has the form of a deep cup with a short base capable of entire protrusion from the general body surface. It is muscular, having a well-developed layer of radial muscles with an outer layer of longitudinal muscle fibres; the thickness of its wall is about double of that of the oral sucker. The pharynx is absent. The œsophagus is straight and more or less of uniform breadth, measuring 0·195—0·256 mm. in length and 0·045—0·075 mm. in breadth (in one specimen 0·33 mm. long). It is closely surrounded by salivary gland cells, which are found in large numbers forming a bulbous mass before it passes into the intestinal bifurcation; the gland cells are also found in large numbers around its anterior part. The intestinal cæca turn backwards soon after their origin and extend to a little distance in front of the hinder end. They are pressed closely against, or slightly overlapped by the ventral sucker, behind which they converge inwards towards each other mesially, the left curving more deeply than the right, but soon turn outwards to occupy a lateral position. Behind the posterior testis they again undulate twice or thrice but less markedly than before. The cæca undulate so characteristically behind the ventral sucker and the posterior testis that they enclose between them an intracæcal zone, in which the gonads with their associated ducts, vesicula seminalis and cirrus sac lie, and this I propose to call the genital field. The cæca are very narrow around and a little behind the ventral sucker. The genital opening lies dorsally to the left side of the body outside the left intestinal cæcum, half-way between the median line and the left body margin, in the region enclosed by the first characteristic loop of the left cæcum, a little distance, *i.e.*, 0·12 mm. behind the ventral sucker and a little in front of the middle of body. In a contracted specimen the intestinal cæca come so near each other behind the ventral sucker and the posterior testis that they practically meet enclosing the genital field on all sides between them, reminding one of the posterior union of the intestinal cæca in the family Schistosomatidæ. In the region of the genital pore the left cæcum comes to the right side of the median line lying close to the right cæcum (Fig 5). As seen in a transverse section passing through the genital pore the dorsal side of the body in this region is flattened and the ventral side arched.

The testes, two in number, lie in the posterior half of the body in the genital field with the ovary between them (Figs. 1 and 2). The anterior testis lies to the right side pressed against the right intestinal cæcum and close behind the cirrus sac, 0·288 mm. behind the ventral sucker, 1·04 mm behind the anterior end and 0·62 mm. in front of the hinder end. It is roughly triangular or somewhat heart-shaped with a broad flat or slightly concave anterior margin and narrow rounded or somewhat bluntly pointed posterior end, and measures 0·14—0·16 mm. in length, 0·14—0·176 mm. in greatest breadth and 0·144 mm. in depth, occupying the entire depth of the body and touching the dorsal and ventral body walls. In one specimen it measured 0·096 mm. long and 0·1 mm. broad. The ovary lies between the two testes, immediately behind the anterior testis and in front of the posterior testis to the left side of the median line with its outer wall pressed closely inside the left intestinal cæcum. It is not much lobed but has a triangular or somewhat oval form with an inwardly directed process or lobe from which the oviduct arises, measuring 0·12—0·18 mm. in length, 0·05—0·1 mm. in greatest breadth and 0·051—0·11 mm. in depth; the lobe arises from its mesial surface, a little behind or about the middle of its length. The ovary appears as a compact mass of ova of large size of 0·024—0·027 mm. diameter and easily visible under the low power of a microscope. The oviduct lies in the median line and is lined with an epithelium of cubical cells with prominent nuclei. The receptaculum seminis, 0·09 mm in length and 0·033 mm in greatest breadth, is a somewhat spherical or pear-shaped sac filled with sperms, which lies to the right side immediately in front of the posterior testis, close inside the right intestinal cæcum, in the same line with the anterior testis and just behind the level of the posterior margin of the ovary. The Laurer's canal arises from the inner side of the receptaculum seminis, near the point where the latter joins the oviduct and opens to the exterior

continued ⟶

Haplorhynchus lyssimus (Mehra, 1933) Byrd, 1939
Syn: Coeuritrema lyssimus H.R. Mehra, 1933 (continued)

dorsally, slightly to the left of the median line, a little in front of the posterior margin of the ovary where it is lined with a thin layer of cuticle. The transverse vitelline ducts lie between the ovary and posterior testis in front of the receptaculum seminis, near the ventral body-wall. The vitelline reservoir lies in front of the transverse ducts in the median line or slightly to the right side and opens into the oviduct before the receptaculum seminis joins it. Both the vitelline reservoir and transverse ducts are composed of a solid mass of fairly large vitelline cells containing a prominent nucleus and vitelline granules. The oviduct after its junction with the receptaculum seminis passes into a small thin walled uterus, situated between the ovary and the anterior testis. The uterus is small and indistinguishable from the metraterm except by the absence of musculature in its walls. The metraterm is well developed and strongly muscular, measuring 0·27.—0·32 mm. in length; it commences between the ovary and the anterior testis, in front of which it runs parallel to the cirrus sac, crossing the left intestinal cæcum to open to the exterior at the dorsally situated genital opening. It has greatest breadth, 0·03—0·08 mm. in its proximal part, *i.e.*, in the region between the ovary and anterior testis, where the ovum is usually found, while near the genital opening it measures 0·018—0·021 mm. in diameter. It is much more thick-walled in its distel part which lies to the left with the terminal part of the cirrus sac near the median line and the left and right intestinal cæca to the right side (Fig. 5). The posterior testis lies close behind the ovary and receptaculum seminis in the median plane of the body, 0·384 mm. distance in front of the hinder end. It is somewhat lobed, ovoid or rounded in shape, broad in front, and narrow behind, measuring 0·12—0·176 mm. in length, 0·084—0·16 mm. in greatest breadth and 0·075—0·12 mm. in depth, occupying the entire depth of the body and entire space between the laterally situated cæca; immediately behind it the cæca converge inwards coming near each other and joining in contracted specimens so as to mark the hinder limit of the genital field. The genital field, 0·4 mm. in length, occupies the third quarter of the body length.

The cirrus sac is large and thick-walled composed of circular muscle fibres, and is situated obliquely in the median line, in the anterior part of the genital field, with its base in close contact with and pressing the anterior face of the anterior testis near the right intestinal cæcum, and its terminal part near and outside the left intestinal cæcum on its way to the genital opening. It has a characteristic retort-shaped or flask-shaped appearance with a slight concavity anteriorly to the right side, in which lies closely pressed against it the vesicula seminalis. It measures 0·15 - 0·24 mm. in length, 0·045—0·084 mm. in greatest breadth a little in front of the basal end and 0·06 mm. in depth; in front of the middle of its length it measures 0·048—0·06 mm. in breadth. The vesicula seminalis is nearly spherical, pear-shaped or oval in outline, situated outside the cirrus sac and pressed closely against it in the concavity in its right wall, between it and the right intestinal cæcum, in level with and immediately behind the genital pore. It has thin parenchymatous walls and is filled with sperms, measuring 0·048—0·057 mm. in length, 0·024—0·042 mm. in greatest breadth and 0·045 mm. in depth; it becomes narrower near its hinder end, where it enters the cirrus sac. The pars prostatica lies within the cirrus sac as a narrow tube surrounded by a vacuolated mass of prostate gland cells. The cirrus is well developed and easily protrusible. When protruded it is seen to be continuous with, though somewhat constricted off from, the terminal portion of the cirrus sac, which lies within the genital atrium. It is an elongated cylindrical organ, swollen at the free terminal end and narrow

at the base, lying flat on the dorsal surface of the body near the left body margin, and measuring 0·09—0·1 mm. in length, 0·075—0·09 mm. in greatest breadth at the end and 0·033 mm. in breadth at the base (Fig. 5). The cirrus sac opens to the right and the metraterm to the left side in the small genital atrium.

The vitellaria commence behind the acetabulum and terminate near the hind end just behind the blind ends of the intestinal cæca. They lie mainly outside the intestinal cæca covering them dorsally and ventrally, but immediately behind the acetabulum and the posterior testis, *i.e.*, in the region of the cæcal loops they extend inwards uniting mesially, leaving, however, entirely uncovered the genital field and the excretory bladder. The follicles are large in size and closely crowded together. The transverse ducts arise between the ovary and the posterior testis and unite to form in front the vitelline reservoir, which lies ventrally to the oviduct. Only one ovum is contained at a time in the uterus or in the proximal part of the metraterm. The ovum is large, somewhat oval in shape, and produced into a narrow filament at each end, measuring 0·168 mm. in length with filaments, 0·096 mm. without filaments and 0·027—0·03 mm. in greatest breadth. In one specimen the ovum had one end produced into a small bluntly pointed filament and the other end indistinctly curled; in this case the entire ovum measured 0·096 mm. in length.

The excretory bladder is short but prominent, situated at the posterior end of the body in the median plane, behind and a little in front of the blind ends of the intestinal cæca. It consists of a short median stem, which bifurcates anteriorly at about the level of or a little in front of the blind ends of the cæca, into two short cornua or lobes lying near and parallel to each other. The main stem also gives off laterally two lobes behind each other on each side near the bifurcation. The tubular bladder and its diverticula are lined by a layer of columnar epithelial cells with no muscular layer outside. The excretory opening is terminal, situated in the middle of the notch at the posterior end of the body.

Habitat: Ventricle of heart.

Host: *Lissemys punctata* syn. *Emyda granosa*. Locality: Allahabad, India.

Spirorchiidae

HAPALORHYNCHUS MACROTESTICULARIS (RHODE, LEE AND LIM, 1968) BROOKS AND SULLIVAN, 1981

SYN. COEURITREMA MACROTESTICULARIS n. sp. RHODE, LEE AND LIM, 1968

Beschreibung. (Auf 10 Exemplaren beruhend). Lang und flach maximale Breite etwa am Äquator, nach vorne und hinten zu schmaler werdend. Mundsaugnapf terminal oder subterminal, kleiner als das Acetabulum. Acetabulum im ersten Viertel oder Drittel des Körpers. Cirrussack gross, schräg bis quer, hinter dem Acetabulum. Kein Pharynx, doch wulstartige Anhäufung von kleinen Zellkernen am Hinterrande des Mundsaugnapfes. Oesophagus lang, von drüsenartigen Zellen umgeben, die zwei deutliche Anschwellungen bilden. Darmverzweigung vor dem Acetabulum. Darmschenkel wellenförmig, nahe dem hinteren Körperende endigend, ein Darmschenkel auf der Höhe des Cirrussackes deutlich nach innen umbiegend. Exkretionsblase median am Hinterende des Körpers, mit seitlichen Ausbuchtungen, sich am Hinterende der Darmschenkel verzweigend. Dotterstöcke aus grossen Follikeln bestehend, hauptsächlich lateral von den Darmschenkeln, vor dem Acetabulum und hinter dem hinteren Hoden in der Mittellinie zusammenstossend. Zwei Hoden, stark gelappt, intercaecal, hintereinander, in den mittleren zwei Fünfteln des Körpers, durch das Ovar voneinander getrennt. Querverlaufende Dottergänge hinter dem Ovar. Receptaculum seminis vor dem hinteren Hoden. Geschlechtsöffnung dorsolateral. (Abb. 2-4).

Wirt: *Dogania subplana* (Geoffr.).

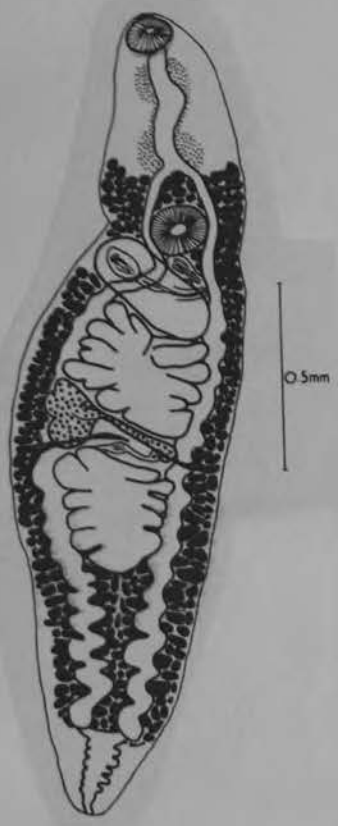
Organ: Herz oder Arterien nahe dem Herzen.

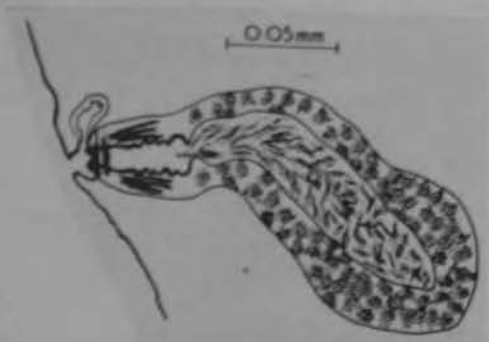
Fundort: Malaya. (Die Schildkröten wurden in einem chinesischen Laden in Kuala Lumpur, Malaya, gekauft).

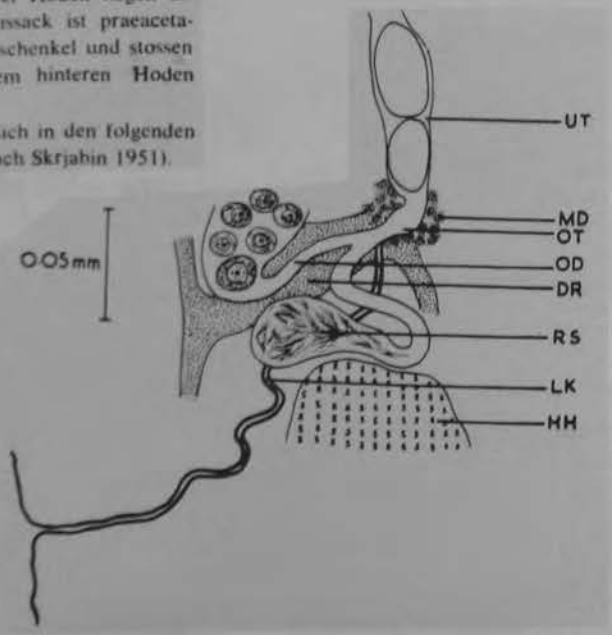
Holotyp: Helminthological Collection No. R. 769. Zoology Dept., University of Malaya, Kuala Lumpur.

Verwandtschaft. (Der Diskussion liegt das System Skrjabins 1951 zugrunde. Die neue Art gehört zur Gattung *Coeuritrema* Mehra, 1933 (Synonym *Tremarhynchus* Thapar, 1933), *Spirorchidae*, *Hapalotrematinae* Stunkard, 1921. Diese Gattung ist charakterisiert durch ein Acetabulum, das grösser als der Mundsaugnapf ist und ein Drittel der Körperlänge hinter dem Vorderende liegt. Der Mundsaugnapf ist ausstülpbar, ein Pharynx fehlt und der Oesophagus ist von Drüsenzellen umgeben und mässig lang. Der Darm verzweigt sich unmittelbar vor dem Acetabulum, er bildet charakteristische Schleifen hinter dem Bauchsaugnapf. Die Geschlechtsöffnung liegt dorsal auf der linken Körperseite hinter dem Acetabulum. Zwei Hoden liegen im dritten Köperviertel, das Ovar liegt zwischen ihnen. Der Cirrussack ist praeacetabular. Die Dotterstöcke liegen lateral und in der Zone der Darmschenkel und stossen in der Mittellinie hinter dem Bauchsaugnapf und hinter dem hinteren Hoden zusammen.

Bisher sind 3 Arten dieser Gattung beschrieben worden, die sich in den folgenden hauptsächlichen Merkmalen von der neuen Art unterscheiden (zit. nach Skrjabin 1951).







-OVER-

MESSERGEBNISSE. In Millimetern. Längs-vor Querdurchmesser:

	1	2	3	4	5	6	7	8
Länge	0.97	1.98	2.11	2.14	2.18	2.50	2.72	2.74
Max. Breite	0.16	0.41	0.56	0.56	0.36	0.59	0.46	0.46
Mundsaugnapf	0.06 × 0.06	0.10 × 0.11	0.11 × 0.14	0.11 × 0.14	0.10 × 0.14	—	0.13 × 0.14	—
Acetabulum	—	0.10 × 0.17	0.14 × 0.17	0.14 × 0.16	0.13 × 0.14	0.13 × 0.16	0.15 × 0.16	0.15 × 0.16
Cirrussack	—	0.24 × 0.10	0.28 × 0.15	0.36 × 0.27	0.29 × 0.09	0.37 × 0.16	0.34 × 0.18	0.33 × 0.15
Vorderer Hoden	0.06 × 0.10	0.18 × 0.27	0.27 × 0.37	0.30 × 0.36	0.25 × 0.32	0.36 × 0.37	0.29 × 0.36	0.30 × 0.36
Hinterer Hoden	0.14 × 0.07	0.26 × 0.21	0.32 × 0.30	0.30 × 0.29	—	0.45 × 0.40	0.47 × 0.36	0.49 × 0.34
Ovar	0.03 × 0.02	0.16 × 0.07	0.19 × 0.11	0.18 × 0.12	0.23 × 0.09	0.20 × 0.12	0.29 × 0.21	0.22 × 0.15

C. lyssinus Mehra, 1933. Indien. 1.53-1.92 mm lang. Mundsaugnapf 0.1-0.12 mm Durchmesser. Acetabulum 0.17-0.19 mm Durchmesser, beide Hoden in der hinteren Körperhälfte, vorderer Hoden rechts von der Medianlinie, hinterer Hoden nur schwach gelappt oder rundlich. Cirrussack 0.15-0.24 × 0.045-0.084 mm.

C. indicus (Thapar, 1933) Mehra, 1934. 3.16-3.45 mm lang, hinterer Hoden grösser als vorderer. Hoden relativ viel kleiner.

C. odhneresis Mehra, 1933. Indien. 1.5 mm lang. Hoden rundlich, deutlich gelappt, in der hinteren Körperhälfte, relativ viel kleiner. Cirrussack 0.18 × 0.054 mm. Yamaguti (1958) nennt die Gattung *Tremarhynchus* Thapar, 1933, Unterfamilie *Tremarhynchinae Yamaguti*, 1958. Er ordnet *Hapalorhynchus yoshidai* Ozaki, 1939, aus China, neben den drei bereits genannten Arten diesem Genus ein. Hauptsächliche Unterschiede zwischen dieser und der neuen Art sind: die Dotterstöcke beginnen hinter der Darmverzweigung, die Geschlechtsöffnung liegt weiter hinten, die Hoden sind nicht gelappt.

HAPALORHYNCHUS ODHNERENSIS (MEHRA, 1933) BYRD, 1939

syn: **Coeuritrema Odhnerensis Nov. Spec.** H.R. MEHRA, 1933

One specimen of this blood fluke was obtained from the ventricle of the heart of *Lissemys punctata* at Allahabad in October 1931. The body is thin, delicate and very transparent, measuring 1·3 mm. in length, 0·224 mm. in maximum breadth in the genital field, *i.e.*, from the genital opening to the hinder limit of the posterior testis, 0·176 mm. in breadth in the region of the ventral sucker and 0·16 mm. in that of the intestinal bifurcation. It is narrow and elongated with bluntly-pointed ends, measuring 0·09 mm in breadth at the anterior end and 0·06 mm. at the posterior end; just behind the oral sucker it slightly broadens attaining a breadth of 0·1 mm. The posterior end is not broad and notched in the middle as in *Coeuritrema lyssimus*, from which this species differs markedly in the shape of its body (Fig. 7). The body-wall is entirely free from tubercles or papillæ, which are well developed in the other species.

The oral sucker is larger than the ventral sucker, measuring 0·087 mm. in length and 0·075 mm. in breadth. It lies terminally at the anterior end and is much protrusible. The ventral sucker is delicate, much smaller and thinner with poorly developed musculature than that of *C. lyssimus*, measuring 0·06 mm. in length and 0·072 mm. in breadth, and lies a little in front of the hinder limit of the first third body length. The pharynx is absent. The œsophagus measures 0·27 mm. in length and 0·08 mm. in maximum breadth, and is surrounded by salivary gland cells, which lie in much larger numbers around the intestinal bifurcation. The intestinal cæca run backwards as soon as they arise, surrounding closely the ventral sucker and terminate a little distance in front of the hind end, just in front of the bifurcation of the short main stem of the excretory bladder. Behind the ventral sucker, at a distance of 0·075 mm. from it, they bend inwards towards the median line, the left more markedly than the right, to form the characteristic, loops, which lie near each other separated by a narrow median region of 0·015 mm. diameter. Behind the genital field, *i.e.*, the posterior margin of the posterior testis they do not undulate to form loops as in the other species, but they run straight near and parallel to each other, ending 0·15 mm distance in front of the hind end.

The excretory opening lies at the hind end of the body. The excretory bladder is narrow and tubular, situated at the hind end just behind the blind ends of the intestinal cæca; the main stem of 0·1 mm. length is a little longer than that of the other species and bifurcates into two short cornua, close behind the blind ends of the cæca. One small rather inconspicuous lateral lobe is given off on each side from the main stem just behind the point of bifurcation.

The genital opening lies dorsally to the left side in the region enclosed by the loop of the left intestinal cæcum, close outside the latter, 0·99 – 0·1 mm. distance behind the ventral sucker and a little in front of the middle of the body; it lies a little more forward than in *C. lyssimus*. The testes, two in number, lie in the posterior half of the body with the ovary between them in the genital field and are distinctly lobed. The anterior testis lies immediately behind the cirrus sac, 0·12 mm. distance behind the genital opening, somewhat in the median line, more to the right than the left side near the right intestinal cæcum by the intervening metraterm. It is irregularly lobed and rounded, measuring 0·105 mm. in diameter. The ovary lies between the testes and has a characteristic flask-shaped outline with the neck part directed mesially and the main body part of an oval shape, 0·081 mm. long and 0·03 mm. broad, situated to the left side with its outer margin in close contact with the left intestinal cæcum and its longitudinal axis parallel to the length of the body. The narrow mesially directed part 0·039 mm. long and 0·027 mm broad, arises from the middle of its length and is continued into the oviduct. The receptaculum seminis filled with sperms lies to the right side close inside the right intestinal cæcum with its narrow anterior part curved mesially, opposite to the ovary immediately in front of the posterior testis, and measures 0·054 mm. in length and 0·036 mm. in greatest breadth near its basal end. The transverse

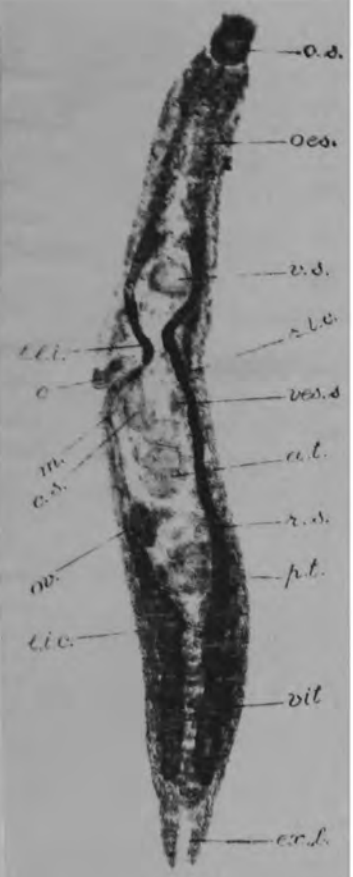


Fig. 7

–over–

vitelline ducts and the vitelline reservoir lie as in the other species close behind the ovary, between it and the posterior testis. The posterior testis lies median, 0·454 mm. in front of the hinder end and immediately behind the ovary and the receptaculum seminis; it is lobed like the anterior testis with nearly equal long and broad diameters, measuring 0·096 mm. in length and 0·102 mm. in greatest breadth, and occupies the entire space between the two cæca. The gonads occupy nearly third quarter of the body length.

The cirrus sac is well developed with stout muscular walls, situated close in front of and pressing behind the anterior testis; it is crescent-shaped with a deep concavity in its right wall, which lies median with the vesicula seminalis opposite to it near the right intestinal cæcum. It is approximately 0·18 mm. long and 0·054 mm. broad in its greatest diameter in the region a little in front of the concavity. It consists of a small basal part of 0·075 mm. length lying transversely and large vertical part lying adjacent to the left intestinal cæcum. The vesicula seminalis of an oval shape lies to the right side touching the right intestinal cæcum opposite to the middle part of the cirrus sac, and measures 0·054 mm. in length and 0·036 mm. in greatest breadth. The cirrus is well developed and protrusible. When protruded it shows a chitinous rugose surface without spines or hooks and has a characteristic stick-shaped form with a stumpy curved handle like terminal portion of 0·033 mm. length and 0·027 mm breadth; the main part measures 0·045 mm. in length and 0·018—0·02 mm. in breadth.

The uterus lies between the mesial neck part of the ovary and the posterior margin of the anterior testis; it is not distinguishable from the metraterm, into which it soon passes. The metraterm is well developed with thick muscular walls, situated to the left side in close contact with the left intestinal cæcum, between it on one side and the cirrus sac and the anterior testis on the other, measuring 0·25 mm. in length and 0·03 mm. in breadth. Near its terminal end it crosses ventrally the left intestinal cæcum to open into the shallow genital atrium. Only one ovum is contained in the uterus or the proximal part of the metraterm, which in consequence is much dilated. The ovum is oval in shape and produced into a coiled filament at one end and indistinctly seen elongated filament at the other, measuring 0·09 mm. in length without filaments and 0·03 mm. in greatest breadth.

The vitellaria are extensive, situated laterally overlapping the intestinal cæca and uniting mesially behind the ventral sucker, in the region between it and the genital pore, and in the intracæcal region behind the posterior testis to the blind ends of the cæca, leaving entirely free the genital field. They commence at the intestinal bifurcation and terminate a little behind the blind ends of the cæca at about the bifurcation of the short stem of the excretory bladder.

Habitat: Ventricle of heart.
Host: *Lissemys punctata* syn. *Emyda granosa*.
Locality: Allahabad, India.

Remarks on the Species of the Genus Coeuritrema

It will be apparent from the foregoing description that *Coeuritrema odhnerensis* and *Coeuritrema lyssimus* resemble each other closely in the anatomy and topography of organs and therefore must be referred to the same genus. Both the species are characterised by the presence of two suckers, a long œsophagus surrounded by gland cells, intestinal bifurcation close in front of ventral sucker, intestinal cæca reaching near the hind end and forming characteristic loops behind the ventral sucker, dorsal sinistral position of the genital opening behind the acetabulum near or a little in front of the middle of body length, testes two in number with the ovary between them, well developed cirrus sac situated in front of the anterior testis with the vesicula seminalis outside it near the right intestinal cæcum, a stout eversible cirrus, well developed muscular metraterm and short uterus containing a single large ovum with one or two polar filaments situated in front of the ovary, strongly developed vitellaria overlapping the cæca and uniting mesially behind the acetabulum and posterior testis leaving free the genital field, and a small but prominent excretory bladder with a short median stem, two anterior cornua and lateral lobes, situated at the hind end.

The important features in which *C. odhnerensis* differs from *C. lyssimus* and which entitle it to the rank of a different species are:—

(1) Shape of the body; elongated and narrow in *C. odhnerensis*, much broader behind ventral sucker with a broad posterior end in *C. lyssimus*.
(2) Absence of papillæ in the body wall.
(3) Oral sucker larger than ventral sucker; reverse condition in *C. lyssimus*.
(4) Intestinal cæca not undulating behind posterior testis.
(5) Testes irregularly lobed.
(6) Characteristic shape of ovary; flask-shaped in *C. odhnerensis*, somewhat triangular or conical in *C. lyssimus*.
(7) Crescentic shape of cirrus sac; retort shaped in *C. lyssimus*.
(8) Shape of protruded cirrus; stick-shaped in *C. odhnerensis*, broad and flattened with a narrow base in *C. lyssimus*.
(9) Anterior limit of vitellaria, intestinal bifurcation in *C. odhnerensis*, posterior border of acetabulum in *C. lyssimus*.
(10) Character of the ovum.
(11) Main stem of excretory bladder a little longer, with one pair of small, rather inconspicuous lateral lobes.

Hapalochynchus reelfooti — Byrd, 1939

(Plate III, Fig. 7.)

Specific diagnosis: Hapalochynchus. Body small, from 420 to 550 μ long by 120 to 170 μ wide, with prominent constriction in region of acetabulum. Integument unarmed. Oral sucker protrusible, 34 to 46 μ long by 30 to 42 μ wide, half exposed at anterior end of body. Ventral sucker smaller, 17 to 30 μ long by 30 to 42 μ wide, located about 170 μ from anterior end of body. Nerve ring conspicuous, at middle of esophagus, with anterior and posterior nerve trunks. Esophagus about 80 μ long, constricted into two regions at nerve ring, with gland cells. Gland cells more compact behind nerve ring. Caeca slender tubes, irregular in width and course, reaching to excretory bladder. Testes two in number, separated by ovary; anterior testis between ovary and cirrus pouch, lying transversely across body with heavy end to right of midline, from 42 to 50 μ long by 108 μ wide; posterior testis close behind yolk reservoir, deeply indented, 54 μ long by 104 μ wide. Seminal vesicle large, lying diagonally across body between cirrus sac and acetabulum, mainly outside cirrus sac. Cirrus sac slightly muscular, about 80 μ long by 35 μ wide, containing small part of seminal vesicle, short ejaculatory duct which terminates in slightly muscular cirrus, and numerous prostatic gland cells. Genital pore dorsal, just inside left caecum, on level with anterior margin of anterior testis. Ovary between testes, transversely elongated mass of cells reaching from caecum to caecum, 16 to 21 μ long by 71 to 120 μ wide. Oviduct, ootype, seminal receptaculum, Laurer's canal, and shell gland present. Vitellaria follicular, from nerve ring to middle of excretory bladder, occupying all available space in body not occupied by other organs. Uterus short. Metraterm not distinguishable. Ova unobserved. Excretory system essentially like that described for *H. stunkardi*.

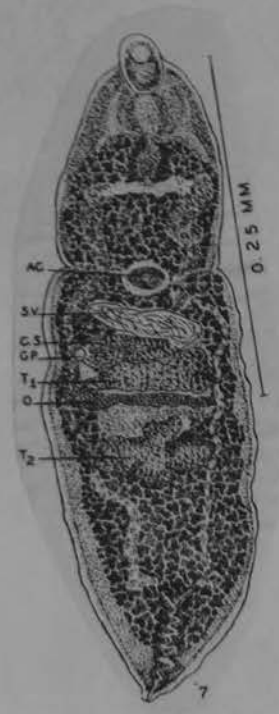
Host: Sternotherus odoratus (Latreille).

Habitat: Blood vascular system.

Locality: U. S. A. (Reelfoot Lake in Tennessee).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 9226.

Hapalochynchus reelfooti is considered distinct from all other members of the genus by the prominent constriction in the region of the ventral sucker, the small size of the suckers, and the very thin, transversely elongated ovary.



Hapalorhynchus stunkardi Byrd, 1939

Hapalorchynchus stunkardi ~~n. sp.~~ Byrd, 1939

(Plate II, Fig. 5.)

Specific diagnosis: Hapalorhynchus. Body delicate, weakly muscular, with rounded to slightly attenuated extremities and almost parallel sides, from 0.72 to 1.44 mm. long by 350 to 420 μ wide. Cuticula sparsely beset with hair-like spines. Nerve ring small. Oral sucker protrusible, 80 to 104 μ in diameter. Ventral sucker protractile, same size as oral sucker, located from 220 to 360 μ behind anterior end of body. Esophagus from 130 to 220 μ long, separated into two regions by constriction at about beginning of posterior third, each region dilated, with gland cells. Gland cells form two clusters, one about each dilation, posterior cluster more pronounced. Caeca long, extending to within 110 μ of posterior end of body, with irregular course, tending to be turned in toward midline at posterior end; left caecum with prominent loop in region of genital pore. Genital pore dorsal, outside left caecum, just anterior to anterior testis. Testes two in number; anterior testis transversely oval to triangular in shape, lying mainly to right of midline between genital pore and ovary, from 95 to 160 μ long by 110 to 170 μ wide; posterior testis deeply notched, lying in midline behind ovary and from 170 to 290 μ in front of posterior end of body, from 120 to 220 μ long by 140 to 170 μ wide. Seminal vesicle large, in intercaecal space between acetabulum and anterior testis, mainly outside cirrus sac. Cirrus sac thin walled and nonmuscular, extending from genital pore across body to near right caecum, surrounded by large mass of fairly large prostatic gland cells. Cirrus short, slightly muscular. Ovary irregular in outline, lying close to left caecum, from 200 to 330 μ behind acetabulum, measuring 52 to 140 μ long by 100 to 130 μ wide. Oviduct, ootype, Laurer's canal, small receptaculum seminis, and yolk reservoir present. Vitellaria follicular, from middle of esophagus to excretory bladder, occupying all available space in body except region of acetabulum and genital field. Uterus short, with slightly muscular metraterm, containing single egg. Egg oval, 87 to 95 μ long by 48 to 52 μ wide, without polar filaments or coenia. Excretory bladder reaching to ends of caeca, transversely looped to give pouched appearance, with slightly muscular wall, giving rise to two lateral collecting tubules. Collecting tubules reaching to oral sucker region, giving rise to capillary tubules which terminate in flame cells (Plate III, Fig. 6).

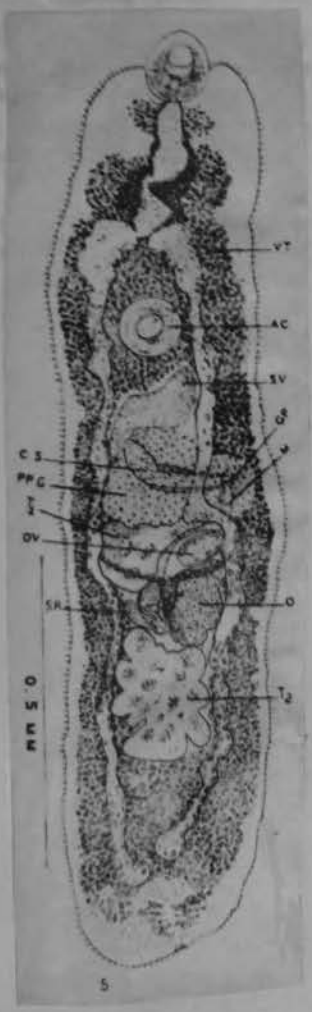
Host: Kinosternum carinatum (Gray).

Habitat: Blood vessels of the lung.

Locality: U. S. A. (Athens, Georgia).

Type specimen: U. S. Natl. Mus. Helm. Col. No. 9225.

Hapalorhynchus stunkardi resembles *H. gracilis* Stunkard, its nearest relative in the genus, in the shape of the body and arrangement of the internal organs, but can be separated from this species and the other members of the genus by the nature of the cirrus sac, the large cluster of prostatic gland cells about the outside of the cirrus sac, the presence of hair-like spines over the body, and the nature and extent of the caeca.



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Hapalorhynchus stunkardi Byrd 1939

Host: *Chelydra serpentina* L. (4 worms in 1 host).
Site: Blood vessels of lungs.
Specimens: 2, Univ. Neb. State Mus., H. W. Manter Lab. No. 20217.

BROOKS AND MAYES, 1976

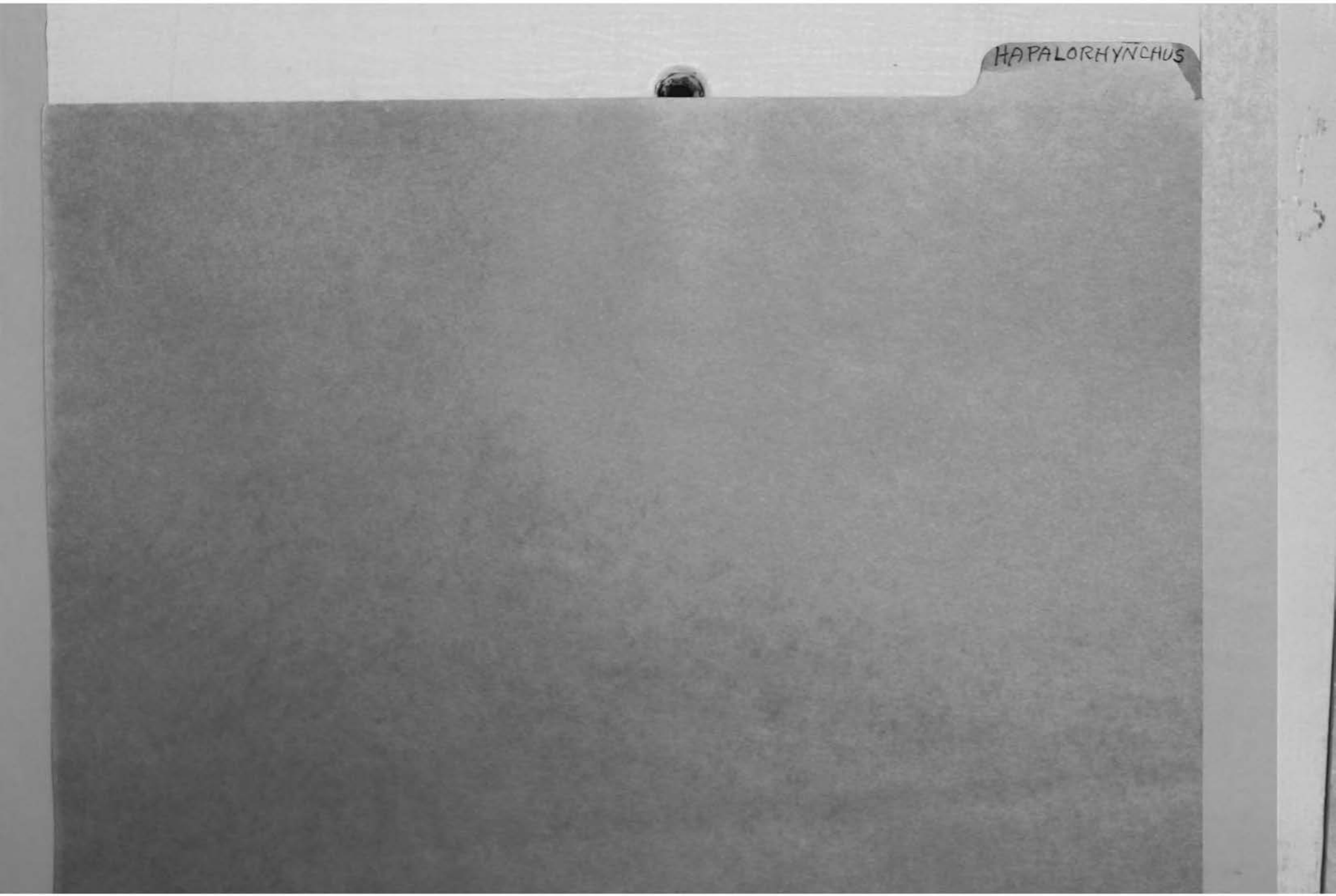
Byrd (1939) described *H. stunkardi* from the blood vessels of the lungs of *Kinosternon* (= *Sternotherus*) *carinatum* (Gray) in Tennessee. Since this is the first report of the species since its description, both the host and locality are new.

See also comments in generic discussion by these authors.

Hapalorhynchus yoshidai Ozaki, 1939

Host: Ocadia sinensis Gray
Locality: Japan
Site: Blood vessels

From Skrjabin
"after Ozaki, 1939"


HAPALORHYNCHUS

Hapalotrematinae Poche, 1926

Subfamily diagnosis. — Spirorchiidae: Body elongate, spinose. Esophagus moderately long; ceca simple, reaching posterior extremity. Acetabulum discoid, in anterior half of body. Testes numerous, intercecal, divided into two groups by ovary and terminal genitalia. Seminal vesicle between anterior group of testes and ovary. Cirrus pouch small, containing ejaculatory duct and cirrus only. Genital pore sinistral to ovary. Ovary postequatorial. No receptaculum seminis, Laurer's canal present. Vitellaria extending for whole postacetabular portion of ceca. Uterus proper lacking, metraterm muscular. Eggs filamented. Excretory vesicle Y-shaped, with short stem. Parasitic in marine turtles.

Hapalotrema Looss, 1899

Generic diagnosis. — Spirorchiidae, Hapalotrematinae: Body elongate, spinulate. Acetabulum discoid, larger than oral sucker, in anterior half of body. Esophagus wide, long. No pharynx. Ceca simple, reaching to posterior extremity. Testes numerous and divided into two groups, one of which lies between the acetabulum and the seminal vesicle, and the other behind the ovary. Seminal vesicle more or less elongated pyriform, free in parenchyma between anterior group of testes and ovary. Cirrus pouch containing ejaculatory duct and cirrus. Pars prostatica not differentiated. Genital pore sinistral to ovary. Ovary lobed, intertesticular, in middle third of body or at its junction with posterior third. No receptaculum seminis. Laurer's canal present. Vitellaria occupying whole lateral fields of hindbody. Uterus proper lacking, metraterm muscular. Eggs with polar filaments. Excretory vesicle Y-shaped, with short stem. Parasitic in blood vessels of marine turtles.

Genotype: *H. constrictum* (Leared, 1862) Looss, 1899 (Pl. 58, Fig. 704), syn. *Learedius europaeus* Price, 1934; *H. mistroides* (Montic, 1876), in edible turtle. Also in heart of *Thalassochelys corticata;* Egypt, Europe, Okinawa.

Other species:

H. loossi Price, 1934, for *H. constrictum* (Leared) of Looss, 1899, not of Montic., in *Caretta caretta;* Egypt.

H. orientale Takeuti, 1942, in *Eretmochelys squamosa;* Itoman, Okinawa.

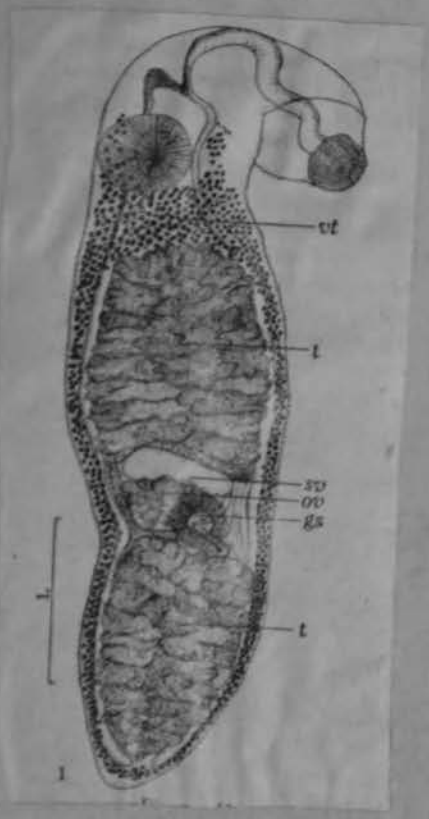
H. synorchis Luhman, 1935, in heart of *Caretta caretta;* Florida.

Luhman, 1935

Hapalotrema synorchis n. sp. (Fig. 1)

Diagnosis of *Hapalotrema synorchis*:

Size 6 by 1.5 mm. Body covered with spines. Oral sucker 383 μ in diameter. Ventral sucker 583 μ in diameter and located one-third body length from anterior end. No pharynx; esophagus a long, wide tube, narrowing toward bifurcation of ceca. Ceca extend to posterior end of body. Testes numerous, in two large, compactly massed groups, one anterior, the other posterior to the ovary. Seminal vesicle well developed, horizontally placed, immediately anterior to ovary, and not incloased in cirrus sac. Cirrus present. Genital pore surrounded by well developed genital sucker to the left of, and ventral to the ovary. Deeply lobed ovary lies almost median between two groups of testes, a little more than two-thirds body length from anterior end. Seminal receptacle small, posterior to ovary. Laurer's canal present. Uterus short, opens at genital sucker. Vitelline ducts



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HAPALOTREMA

Hemotosoma, new genus Stunkard, 1922

This genus is characterized by the small oral sucker and relatively short esophagus; absence of pharynx; terminal excretory pore and excretory vesicle which divides almost immediately to form lateral collecting ducts; testes usually ten in number, irregularly lobate or sinuate, arranged in [illegible] rows anterior to the ovary but situated in the posterior half of the worm; seminal vesicle posterior to the testes with only the terminal part of the vas deferens enclosed in a small cirrus sac; genital pore ventral, sinistral, near the posterior end of the body; vitellaria numerous, extending from the bifurcation of the alimentary tract almost to the posterior end of the body; ovary oval, lobed, on the right side of the body; small seminal vesicle and Laurer's canal. The uterus is short and contains a single oval egg.

Hæmatosoma hæmatobium, ~~n. sp.~~ Stunkard, 1922

Figure 3

The first specimen of this form was found December 1, 1914, in the lung of a large turtle collected near Raleigh, North Carolina. In the fall of 1916, six specimens were removed from the left subclavian artery of another turtle from the same locality. Since that time other specimens have been removed from the heart and larger arteries of turtles collected in New York and New Jersey. In November, 1921, a shipment of turtles was received from North Judson, Indiana, seventy-five per cent of which harboured the parasite. Records of dissection show one turtle in which twelve specimens were found in the lungs, four in the pulmonary arteries, two in each auricle, sixteen in the ventricle, eight in the mesenteric arteries and twenty eight at the posterior end of the aorta. Where several worms were found together, they were often entangled and very hard to separate. Those found in the ventricle frequently were partially embedded in the muscular wall.

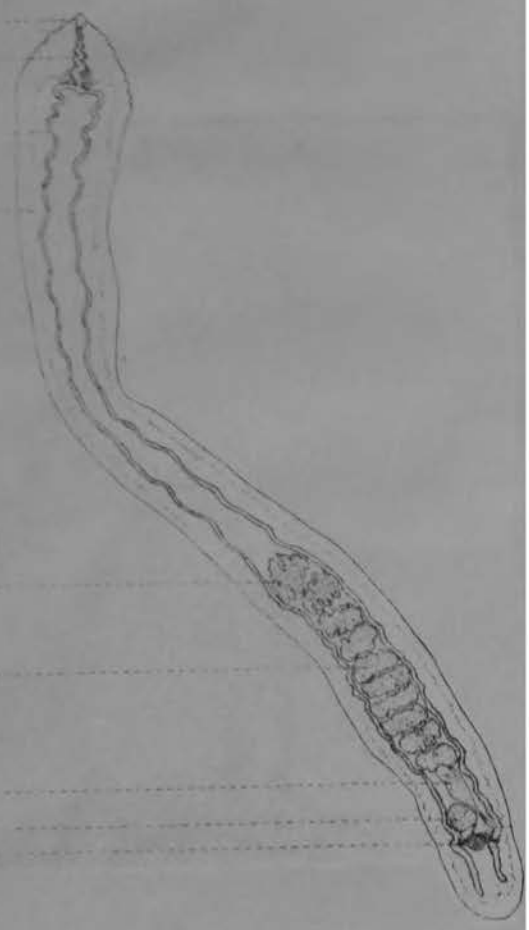
Those worms are elongate, flattened nematodes with almost parallel sides, rounded posterior and pointed anterior ends. The anterior end in extended oesophagus narrows uniformly to the tip and when contracted becomes broad and blunt with crenated margins. Extended individuals are widest in the region occupied by the testes and have a narrow zone in the ventral part of the body. On contraction, the body anterior to the testes becomes approximately the width at their level. Living worms may extend to a length of 12.5 mm. and contract to less than 6 mm. Fixed and stained specimens measure from 5 to 9 mm. in length and from 0.48 to 0.75 mm. in width. The width is from two to three times the dorso-ventral measurement.

The cuticula is thin and smooth, lacking spines or other modifications. The musculature is light and delicate.

The oral sucker is the only organ of attachment. It is situated at the anterior tip and in extended specimens slightly protrudes from the body. It is ovoid in shape, rather muscular and measures from 0.077 to 0.1 mm. in length and from 0.071 to 0.084 mm. in width. The mouth opening is subterminal. Depending on the amount of contraction in the anterior region of the body, the esophagus is slightly or exceedingly sinuous, the sinuosity varying with the extent of contraction. In length it measures from 0.39 to 0.77 mm. It increases in diameter posteriorly although the size of the lumen is not uniform, frequently having one or more dilated portions. The lining is muscular and throughout its length the esophagus is surrounded by secretive cells. At the posterior end for about one-fifth of its length the gland cells become more numerous forming a conspicuous enlarged portion. No pharynx is present. The intestinal diverticula arise just before the posterior end of the esophagus and pass laterad about one-half of the distance to the body wall where they turn sharply posterad and extend almost to the end of the body. Their course is notably sinuous and they are spaced further apart in the region occupied by the reproductive organs, passing laterad to the testes and ovary. They have an almost uniform diameter and are filled with decomposing blood which gives them a black appearance.

The excretory pore is situated at the posterior end of the body and the vesicle divides almost immediately to form two lateral collecting ducts which pass anteriorly.

The reproductive organs resemble in many respects those of *Spirorchis*. The testes number ten in mature individuals although after a time certain testes degenerate. They are arranged one before the other in the intercecal area in the posterior half of the body. The most anterior testis is about three-fifths of the body length from the anterior end and the posterior testis is separated from the posterior end of the body by slightly less than one-half the distance between the anterior and posterior testes. The testes are irregularly lobed, contiguous structures. In the anterior testes the lobes are deep and the testes are distinctly separated, while in the middle of the group the lobulations are smaller, less conspicuous, and the organs closer together. The testes are flattened antero-posteriorly, and this is particularly noticeable at the



center of the group where the pressure is greatest. In the testicular area they occupy practically all the space between the vasa but do not extend laterally beyond the intestinal diverticula. Because of their shape it is difficult to make satisfactory measurements of the testes but they vary in size from 0.12 by 0.27 mm. to 0.27 mm. by 0.43 mm. The posterior testis opens directly into a large ovoid or pyriform seminal vesicle. The broader end is anterior and the posterior end tapers to a duct which passes on the left side of the body and near the mid-ovarian level enters the cirrus sac. The cirrus sac is small and the muscular wall slightly developed. It is pyriform in shape, wider anteriorly, and the prostate if present is represented by only a few cells. The cirrus sac varies in length from 0.154 to 0.22 mm. and in width from 0.05 to 0.077 mm. The genital pore is ventral, just posterior to the level of the ovary, and situated between the cecum of the left side. The opening of the cirrus is anterior to that of the uterus.

The ovary is a lobed oval structure situated on the right side of the body between the seminal vesicle and the genital pore. It measures from 0.154 by 0.22 mm. to 0.23 by .28 mm. The smallest arises at the median posterior margin and passes dextrad and posteriad. After continuing a short distance it turns mediad where Laurer's canal is given off and the common vitelline duct is received. The ootype region is short and the tube then passes dorsad, lateral and ventral to the genital pore. The vitellaria are extensively developed and consist of masses of follicles extending from the bifurcation of the alimentary tract almost to the posterior end of the body. They are not segmented into lobes but form a continuous sheet of cells extending on the lateral side of the cecum throughout their length and filling the intervesical area anterior to the testes and posterior to the vitelline receptacle. Just behind the level of the genital pore vitelline ducts pass mediad on the ventral side of the body and unite to form a large reservoir, the vitelline receptacle which opens into the ootype through the common vitelline duct.

The uterine portion of the female canal is short and contains a single oval egg. A metraterm is present although not strongly developed. The eggs are thick shelled, brown in color and are discharged into the vessels. The smallest egg measured in the uterus was 0.77 mm. in length and 0.05 mm. in width, the largest 0.086 mm. in length and 0.065 mm. in width. Eggs in the tissue of the host and found in the feces have an average measurement of 0.115 mm. in length and 0.081 mm. in width. The eggs increase in size after deposition and usually become darker in color. They are provided with a cap which opens to allow the escape of the embryo.

Henotosoma

Part III

K. Spirorchidae Stunkard (1921)

Haplotreminae Stunkard (1921)

Hepatohaemotrema n. g. Sinha, 1958

Generic diagnosis: Haplotreminae having a very narrow and elongata body, tapering towards both ends, more so towards the front end. Body surface smooth and devoid of any armature. Oral sucker cup-like and protrusile. Acetabulum located immediately in frontof the junction of anterior and middle thirds of body. Excretory pore median and terminal, situated at the hind end of the body. Pharynx absent; oesophagus long and slender; intestinal bifurcation anterior to acetabulum; caeca extend considerably behind posterior testis, terminating at about 1/7th of body length from tail end.

The gonads are located posterior to the middle of the body; the smooth and oval testes lie one behind the other with the ovary wedged in between them; vesicula seminalis externa and interna present, the former lying within a long and somewhat "S"-shaped cirrus-sac extending between the front testis and the acetabulum; pars prostatica well defined; cirrus protusible and armed with three distinct processes. Genital pore median, located posterior to acetabulum. Ovary transversely elongated and pyriform; metraterm lying parallel to cirrus-sac on the left hand side.

Vitellaria are restricted to posterior portion of the body, extending from the level of anterior testis to the ends of the caeca; uterus contains at a time a single elongate egg possessing a distinct lateral spine. Adult flukes parasitic in the liver of fresh water turtles.

Type species: ***Hepatohaemotrema hepaticum*** n. sp., parasitic in the liver of *Kachuga kachuga*.

Sinha, 1958

***Hepatohaemotrema hepaticum* n. sp.** This fluke was recovered on several occasions from the fresh water turtles obtained locally. The worms were found lodged in the liver, usually in small numbers, not more than three flukes being obtained from a single host at any time.

The body of the fluke is very slender and elongate with attenuated ends. It measures 2.69—2.73 mm. in length and 0.187—0.252 mm. in maximum width attained in the region of the gonads. The protusible oral sucker is terminal and cup-shaped, measuring 0.07—0.083 × 0.025 to 0.065 mm. The acetabulum is located immediately in front of the junction of middle and anterior thirds of the body, at about 0.35—0.72 mm. from the anterior end; it is more or less rounded, measuring 0.07—0.073 mm. in diameter. A pharynx is lacking as in other blood flukes. The oesophagus runs in a straight course and is fairly large, measuring 0.34—0.71 mm. in length. The bifurcation of the intestine is located fairly close to the acetabulum and is about 0.4 to 1.3 mm. from the anterior end. The caeca run along the lateral margins of the body to terminate posteriorly at a distance of 0.273 to 0.275 mm., i.e., roughly at 1/7th of the body length from the posterior end. The excretory bladder is "Y"-shaped and opens to the exterior at the hind end by means of a terminal and median excretory pore.

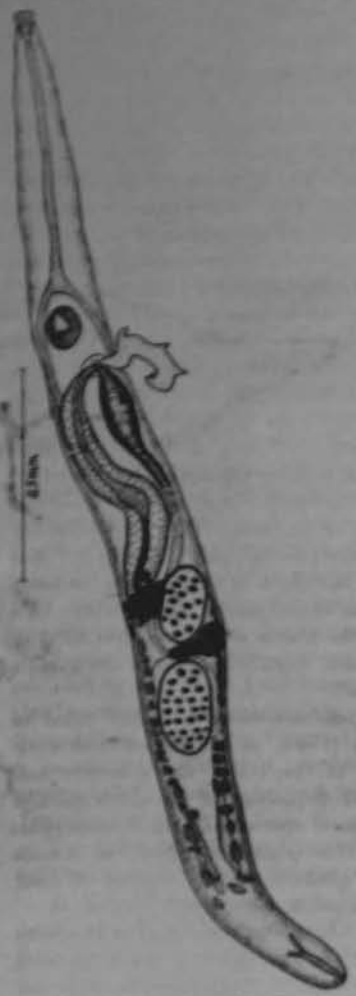


Fig. 13. *Hepatohaemotrema hepaticum* n. g. et n. sp. (Ventral view)

Fig. 14. *Hepatohaemotrema hepaticum* — Egg

The testes lie one behind the other, distinctly posterior to the middle of the body; they are oval in shape and possess entire margins. The anterior testis is slightly smaller than the posterior one, the two measuring 0.135—0.187 × 0.071—0.116 mm. and 0.152—0.211 × 0.089 to 0.145 mm. respectively. The common vas deferens formed by the union of the two vasa efferentia from the testes opens into an external seminal vesicle lying on the right side of the front testis. By means of a short duct entering into the cirrus-sac it is connected to the internal seminal vesicle lying within the sac. The cirrus-sac is an elongated —S— shaped structure lying to the right of the median line; it measures 0.58 × 0.68 mm. in length and extends from the mid level of the front testis to the genital pore in front. It contains in addition to the internal seminal vesicle a pars prostatica and a protusible cirrus which is characterized by the presence of three distinct processes.

The ovary 0.07—0.096 × 0065.—0.11 mm;. is transversely elongated and fits in between the two testes. Posterior to the ovary, a small pear-shaped receptaculum seminis is discernible in the live condition. The uterus emerging from the ootype runs parallel to the cirrus-sac to open in front at the genital aperture. It lies close tothe left hand margin of the body, whilst its terminal portion, the metraterm, is slightly swollen. The vitellaria are poorly developed and have a restricted distribution in the posterior portion of the body. They start from the level of the anterior testis and extend as far backwards as the end of the caeca. The follicles on each side form a linear series covering the caecum and lie quite close to the lateral margin of the body. At a time only a single egg is found in the uterus which measures 0.041 × 0.006 mm.; it is much elongated and slightly curved in the middle and possesses a distinct lateral spine.

Systematics. The new genus *Hepatohaemotrema* is closely allied to the genus *Enterohaemotrema* MEHRA (1940), as is evident from their resemblance in general appearance of the body, the structure and location of gonads, the structure and disposition of the cirrus-sac and the metraterm, the position of the genital aperture and the characteristic features of the digestive system. A close comparison, however, reveals the fact that the newly established genus is sharply marked off from *Enterohaemotrema* on the following grounds:

1. The vitellaria are confined to the posterior portion of the body in the new genus, whilst in their anterior extent they reach the level of the acetabulum in *Enterohaemotrema*. — 2. In the new form the cirrus possesses distinct processes which have not so far been observed in *Enterohaemotrema*. — 3. The oesophagus is almost straight in the new worm, whereas it is sinuous in the earlier genus. — 4. The location of the parasite also differs in the two cases. *Enterohaemotrema* is parasitic in the intestine, whilst the new parasite occurs in the liver.

In view of the sharp differences the writer has felt justified in establishing a new genus for the reception of the newly found fluke.

Specific diagnosis of Hepatohaemotrema hepaticum n. sp. With the characters of the genus and the following measurement of the body:

Principal measurements: Length, 2.09—2.735 mm.; breadth, 0.187 to 0.252 mm. oral sucker, 0.0709—0.0837 × 0.025—0.065 mm.; ventral sucker, 0.0709—0.073 mm. in diameter; oesophagus, 0.34—0.71 mm. long. Testes, 0.135—0.187 × 0.071—0.116 mm. and 0.152—0.211 × 0.089—0.145 mm.; ovary measuring 0.07—0.096 by 0.065—0.11 mm. Ovum measuring 0.041 × 0.006 mm.

Host: *Kachuga kachuga*. — Habitat: Liver. — Locality: Hyderabad, India. — Type specimens are deposited in the museum of the Zoology Department, Osmania University, Hyderabad.

HEPATOHAEMOTREMA

Learedius Price, 1934

Generic diagnosis. — Spirorchiidae, Spirorchiinae, Spirhapalini: Body elongate, slightly constricted at level of acetabulum. Oral sucker well

[4] Syn. of *Hapalotrema* Looss, 1899—Byrd (1939).

developed. Esophagus long, surrounded by gland cells. Ceca slender, reaching to near posterior extremity. Acetabulum pedunculated, larger than oral sucker, equatorial or pre-equatorial. Testes numerous, massed together in intercecal field anterior to external seminal vesicle. Cirrus pouch somewhat elongated sigmoid, containing part of seminal vesicle, numerous prostate cells and protrusible cirrus. Genital pore median or slightly to left, postovarian, near posterior end of body. Ovary deeply lobed or dendritic, posttesticular. Laurer's canal present. Vitelline follicles extending from intestinal bifurcation to level of ovary or cecal ends, chiefly extracecal or circumcecal, confluent in median field anterior and posterior to acetabulum. Uterus short, containing fusiform eggs with polar prolongations. Parasitic in circulatory system of marine turtles.

Genotype: *L. leardi* Price, 1934 (Pl. 51, Fig. 622), in *Chelone mydas;* U.S.A.

Other species:

L. orientalis Mehra, 1939, in *Chelonia mydas;* India.

L. loochooensis Takeuti, 1942, in *Chelone japonica;* Itoman, Loochoo Isl.

LEAREDIUS

Monticellius Mehra, 1939

Generic diagnosis. — Spirorchidae, Spirorchiinae, Spirhapalini: Body very much elongated. Oral sucker terminal, very prominent, followed by small pharynx. Esophagus long, without esophageal vesicle, bifurcating about midway between suckers. Ceca not running forward at commencement in contrast with *Plasmiorchis* Mehra, 1934, terminating near posterior extremity. Acetabulum prominent, larger than oral sucker, in second quarter of body. Testes 5, in linear series behind acetabulum. External seminal vesicle elongate, between posteriormost testis and cirrus pouch; latter elongated claviform; its curved proximal half situated between external seminal vesicle and ovary, and its distal half dorsal to ovary. Genital pore ventral, practically median, postovarian. Ovary indented, overlapping ceca laterally in posterior third of body. Vitellaria extending from intestinal bifurcation to behind ovary, filling entire intercecal field between intestinal bifurcation and anterior testis; vitelline reservoir large, median, immediately behind genital pore. Uterus behind vitelline reservoir, containing single egg. Parasites of chelonians.

Genotype: ***M. indicus*** **Mehra, 1939 (Pl. 60, Fig. 724)**, in *Chelonia mydas;* India.

Other species: ***M. similis*** **(Price, 1934)** Mehra, 1939, syn. *Learedius* s. P., in *Chelonia mydas;* U.S.A.

MONTICELLO 5

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 _____

Neospirorchiinae n. subfam.

Subfamily diagnosis. — Spirorchiidae: Body long, filiform. Oral sucker moderately developed, esophagus rather long. Ceca united at about midbody into a long unpaired duct reaching posterior extremity. No acetabulum. Testes single, tubular, winding backward from behind cecal union. Cirrus pouch weakly developed. Genital pore lateral, in posterior part of body. Ovary tubular, winding backward from posterior portion of testis to beyond genital pore. Vitellaria chiefly dorsal, extending whole length of intestine. Parasitic in marine turtles.

Neospirorchis Price, 1934

Generic diagnosis. — Spirorchiidae, Neospirorchiinae: Body greatly elongated, thread-like, subcylindrical. Cuticle provided with fine transverse ridges but without spines. No acetabulum. Oral sucker moderately developed; esophagus long, surrounded by gland cells at its posterior half. Ceca united at about midbody into a long unpaired duct reaching posterior extremity. Testes single, tubular, slender, winding backward from behind cecal union. Cirrus pouch weakly developed. Genital pore lateral, in posterior third of body. Ovary slender, winding backward from posterior portion of testis to beyond genital pore. Seminal receptacle and Laurer's canal absent. Germiduct joining vitelline duct near posterior extremity. Vitelline follicles extending from intestinal bifurcation to near level of genital pore chiefly in dorsal area. Uterus slightly tortuous, containing a number of eggs; eggs oval, without polar prolongations. Parasitic in blood vessels of marine turtles.

Genotype: *N. schistosomatoides* Price, 1934 (Pl. 53, Fig. 645a—b), in visceral blood vessels of *Chelone mydas;* U.S.A. Other species: *N. pricei* Manter et Larson, 1950, in ventricle of heart of *Caretta caretta;* Florida.

SPIRORCHIDAE

Neospirorchis pricei Manter & Larson, 1950

Description (Based on two complete specimens and portions of two others. Figures 1 and 2 were drawn from a specimen which was later accidentally broken in remounting. Although all pieces are still on a single slide, it was decided to consider this specimen a paratype): Body long and slender, apparently more or less flattened (although probably killed under a coverglass), 6.100 to 8.100 mm. long by 0.360 to 0.540 mm. wide; unspined but with very fine transverse ridges. Oral sucker rudimentary, subterminal, 0.052 to 0.057 mm. in diameter; acetabulum lacking. Esophagus slightly sinuous, thick-walled, 0.32 to 0.34 mm. in length; gland cells surrounding its posterior half. Ceca at first with irregular swellings or outpocketings, soon becoming narrow, uniting a little past midbody; common cecum ending blindly near posterior end of body. Excretory pore terminal; excretory vesicle Y-shaped with short spherical median stem.

Genital pore 0.9 to 1.1 mm. from posterior end of body between cecum and gravid uterus, apparently ventral in position, near midline just to the left of the intestinal cecum. Testis long, compactly and spirally coiled, its anterior end near midbody and somewhat anterior to union of the ceca; its posterior end about ⅓ body length from posterior end of body; to the left of the common cecum. Loops of the coiled testis sometimes appear to be distinct branches when the coils are superimposed. Vas deferens short. Cirrus sac slightly sinuous, slender, thick-walled, 0.423 mm. long by 0.076 mm. wide, its wall up to 23 μ thick. External seminal vesicle lacking; internal seminal vesicle a narrow elongated sac 0.224 mm. in length or about half the length of the cirrus sac; cirrus muscular, protrusible, about 0.20 mm. long. Ovary a coiled tube; its anterior end overlaps the posterior portion of the testis slightly; its posterior end is a little posterior to the genital pore. The oviduct arises from the posterior end of the ovary. It is at first thin-walled and coiled but soon becomes sinuous and thicker-walled. It extends posteriorly alongside the intestinal cecum almost to the posterior end of the body where it joins the posterior end of the oötype close to the entrance of the vitelline duct. The length of this portion of the oviduct not counting its curvature is about 0.513 mm. Vitelline follicles small and close together, extensive, extending from bifurcation of the ceca to slightly posterior to genital pore; anterior to the cecal union they are extracecal, intercecal, and ventral but not dorsal to the ceca; posterior to the cecal union they are to the right and ventral to the common cecum. A very long, single yolk duct extends posteriorly along the side of the cecum to join the yolk reservoir not far from the posterior end of the body. Yolk reservoir a large irregularly shaped sac, measuring 0.190 by 0.152 mm., with a short anterior duct connecting with the oötype. Oötype extending anteriorly, surrounded by Mehlis' gland which is approximately the same size as the yolk reservoir. A Laurers' canal and a seminal receptacle are lacking. Anterior to the oötype a straight tube, which can still be considered the oviduct, extends forward about the same distance as the length of Mehlis' gland. It then becomes the thin-walled uterus which immediately forms a single, short, close spiral evident only when not more than a few eggs occur in it. As eggs accumulate in this short spiral it appears as a very characteristic, spherical, egg-filled sac. It leads through a narrow constriction to the anterior portion of the uterus, an elongate almost straight sac which, when egg-filled extends slightly anterior to the genital pore. It contains up to an estimated 200 or more eggs. A metraterm is lacking. Eggs are ovoid, yellowish, without filaments or processes, and measure 36 to 40 by 23 to 24μ.

1

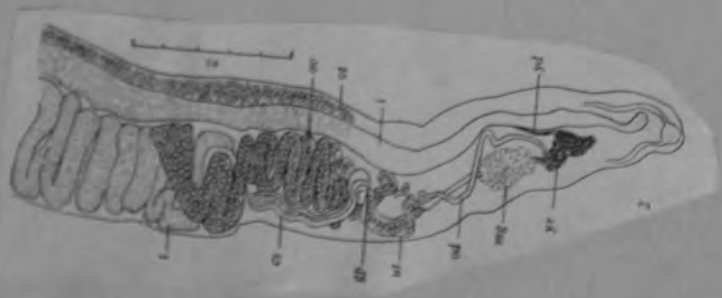
Discussion: Only one other species is known in the genus *Neospirorchis*, *N. schistosomatoides* Price, 1934, from the heart of *Chelone mydas*, a marine turtle, which died in the National Zoological Park. *N. pricei* differs from this species in possessing (1) a shorter esophagus; (2) more anterior extent of testis; (3) longer, more slender, thicker-walled cirrus sac; (4) a short, inconspicuous vas deferens; (5) a distinct, tightly spiraled posterior portion of the uterus separated from an anterior sac-like portion; (6) ventral genital pore. The seemingly ventral position of the genital pore could possibly be due to compression of the worm when killed under a cover glass. However, there is no evidence of a half twist in the body.

The species is named in honor of Dr. E. W. Price.

Host: Caretta caretta, loggerhead turtle

Location: ventricle of the heart

Locality: Tortugas, Florida



NEOSPIRORCHIS

Plasmiorchis Mehra, 1934 [1])
Syn. *Gomtiotrema* Sinha, 1934
Hemiorchis Mehra, 1939

Generic diagnosis. — Spirorchiidae, Spirorchiinae, Spirhapalini: Body spatulate or lanceolate, spinose. Acetabulum larger than oral sucker, about one-third of body length from anterior extremity. Oral sucker longer than broad; esophagus long, sinuous, esophageal vesicle present. Ceca running forward a short distance along esophagus and then turning backward, terminating near posterior extremity. Testes lobed or not, arranged in linear series between acetabulum and ovary. External seminal vesicle sinistral or dorsal to ovary. Cirrus pouch large, muscular, posttesticular, opposite ovary, enclosing long coiled internal seminal vesicle, prostate complex and short cirrus. Genital pore sinistral, ventral, postovarian. Ovary on the right of median line or practically median at or near middle of posterior third of body. Receptaculum seminis present. Vitellaria extending from intestinal bifurcation or a little in front of it to cecal ends, outside or around, or exclusively inside, ceca. Uterus short, containing a single, large, oval egg. Excretory vesicle V-shaped. Parasitic in heart or arteries of turtles.

Genotype: *P. orientalis* Mehra, 1934 (Pl. 50, Fig. 618), syn. *P. pellucidus* Mehra, 1934 — Byrd, 1939, in ventricle of heart of *Kachuga dhongoka;* India.

Key to species — Skrjabin (1951).

Other species:

P. bengalensis (Mehra, 1940) in *Hardella thurgi;* Bengal.

P. hardellii Mehra, 1934 (Pl. 60, Fig. 728), syn. *P. obscurum* Mehra, 1934 — Byrd, 1939; *Hemiorchis hardelii* (Mehra, 1934), in ventricle of heart apd aortic arches of *Hardella thurgi;* India. Also in *Kachuga dhongoka;* India.

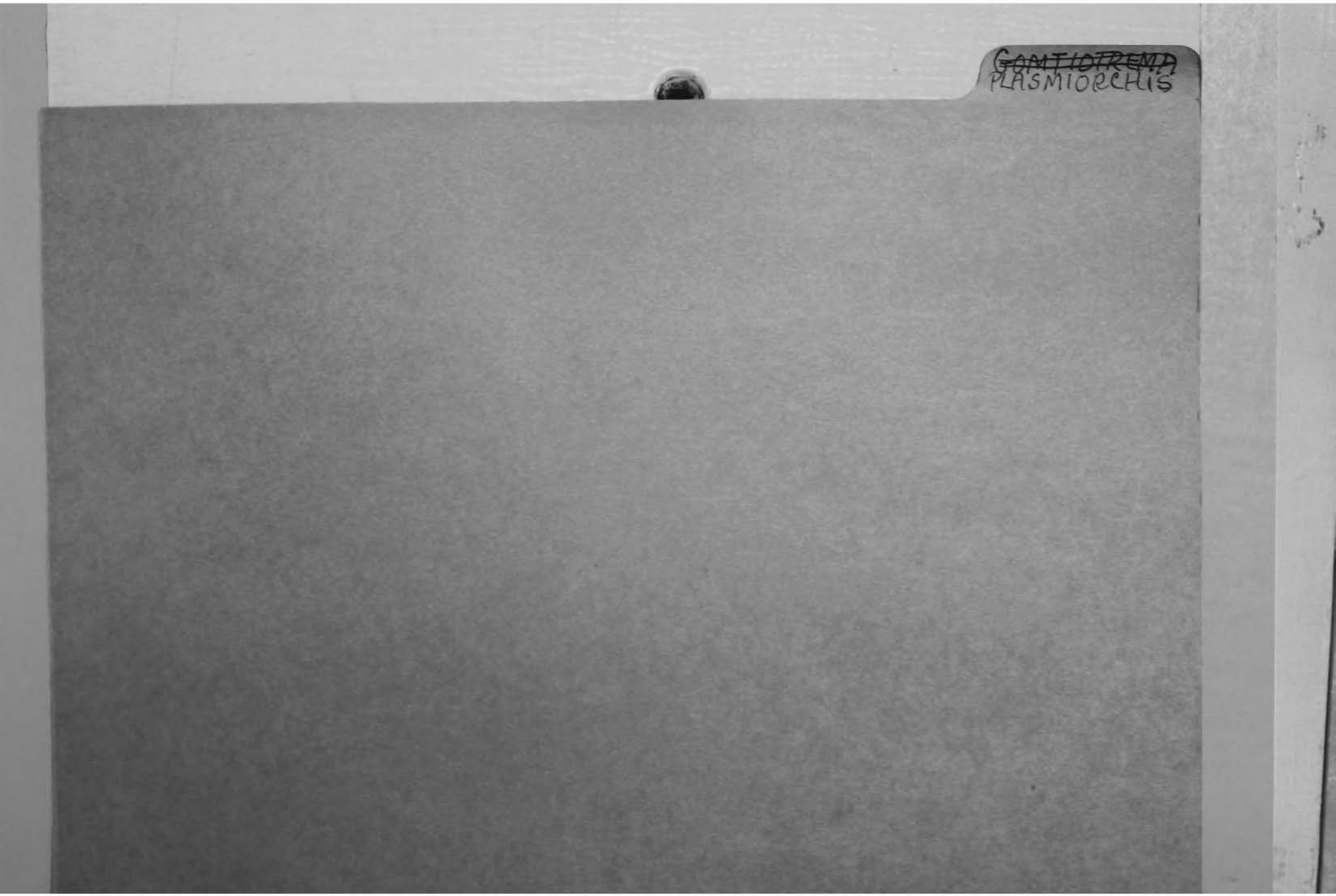
P. pellucidus Mehra, 1934, in ventricle of heart of *Kachuga dhongoka;* India. Listed by Hughes et al. as a synonym of *S. orientalis* Mehra, 1934.

P. sanguineus (Sinha, 1934), syn. *Gomtiotrema s.* S., in larger blood vessels of *Hardella thurgi;* River Gomti, India.

GOMTIOTREMA Sinha, 1934

Hermaphroditic, blood-inhabiting distomes, with protrusible suckers; no cuticular spines; relatively large oesophagus; a loop in the intestinal ceca at their origin from the oesophagus. Testes twelve, oval to spherical, preovarial, arranged in linear series, intercaecal; vesicula seminalis continued into a narrow ejaculatory duct; genital pore lateral and posterior. Ovary dome-shaped, trilobed posteriorly, anterior to the genital pore; vitellaria extensive; receptaculum seminis and Laurer's canal present. Uterus short, with a single large egg, which is knobbed.

Host: Hardella thurgi (Gray)
Locality: Lucknow, River Gomti, India


~~GOMIOTREMA~~
PLASMIORCHIS

Spirhapalini n. trib.

Tribe diagnosis. — Spirorchiinae: Acetabulum present. Posterior

testes (1—2) may be postovarian. Cirrus pouch more or less well developed. Genital pore nearly median, submedian or submarginal. Vitellaria extracecal or cecal.

Key to genera of Spirhapalini

1. Acetabulum large, prominent, small pharynx may be present; genital pore nearly median 2
   Acetabulum small, not prominent; pharynx absent; genital pore submedian or submarginal 3
2. Testes numerous, massed together behind acetabulum; ovary deeply lobed or dendritic ..... *Loaredius*
   Testes less numerous (about 5), arranged in linear series behind acetabulum; ovary not deeply lobed; small pharynx present ..... *Monticellius*
3. Posterior testes (1—2) separated from the rest by ovary and terminal genitalia ..... *Spirhapalum*
   Testes entirely provarian ..... *Plasmiorchis*

Spirhapalum Ejsmont, 1927 [1])

Generic diagnosis. — Spirorchiidae, Spirorchiinae, Spirhapalini: Body elongate and fairly broad. Acetabulum rather small, pre-equatorial. Oral sucker prominent, a little smaller than acetabulum. Esophagus sinuous, surrounded by gland cells. Ceca reaching to near posterior extremity. Testes divided by ovary into an anterior and a posterior group; anterior testes several, arranged in zigzag line between acetabulum and seminal vesicle, posterior testes one or two, closely packed together. Seminal vesicle transversely elongated immediately behind anterior group of testes. Cirrus pouch elliptical, to left of ovary. Genital pore sinistral, ventral, at or near level of posterior end of ovary. Ovary lobed, to right of median line behind seminal vesicle. Germiduct widened to form receptaculum seminis, giving off Laurer's canal before joining vitelline duct. Uterus short; eggs oval, without polar prolongations. Vitellaria extending on both sides of ceca from intestinal bifurcation to cecal ends. Excretory vesicle with sigmoid stem. Parasitic in turtles.

Genotype: *S. polesianum* Ejsmont, 1927 (Pl. 44, Fig. 537), in heart of *Emys orbicularis*; Poland.

SPIRHAPALUM ELONGATUM ~~n. sp.~~ RHODE, LEE AND LIM, 1968

Beschreibung. (Auf 26 Exemplaren beruhend).

Flach und lang, grösste Breite hinter dem Äquator, nach vorne und hinten zu schmaler werdend. Mundsaugnapf rudimentär. Oesophagus quergestreift, lang, wellenförmig, von drüsenartigen Zellen umgeben. Acetabulum am Anfang des zweiten Körperdrittels. Darmblindsäcke endigen nahe dem Hinterende. 6 Hoden praeovarial, 1 Hoden postovarial, stark gelappt, intercaecal, median. Ovar submedian, stark gelappt, im hinteren Körperviertel. Uterus kurz, mit 1 Ei. Vordere Samenblase dreigeteilt, latero-frontal vor dem Ovar. Die beiden hinteren Teile in Cirrusbeutel, der auch ausstülpbaren Cirrus enthält. Hintere Samenblase hinter dem Ovar. Dotterstöcke von der Darmverzweigung bis zum hinteren Körperende, hauptsächlich lateral von den Darmschenkeln und in der Zone der Darmschenkel, vor den vorderen Hoden auch intercaecal, nur einen schmalen Raum in der Mittellinie freilassend, hinter der Darmverzweigung und am Hinterende des Körpers in der Mittellinie zusammenstossend, einige grosse Follikel intercaecal auf der Höhe des Ovars und vor dem hinteren Hoden. Geschlechtsöffnung ventrolateral. (Abb. 5-8).

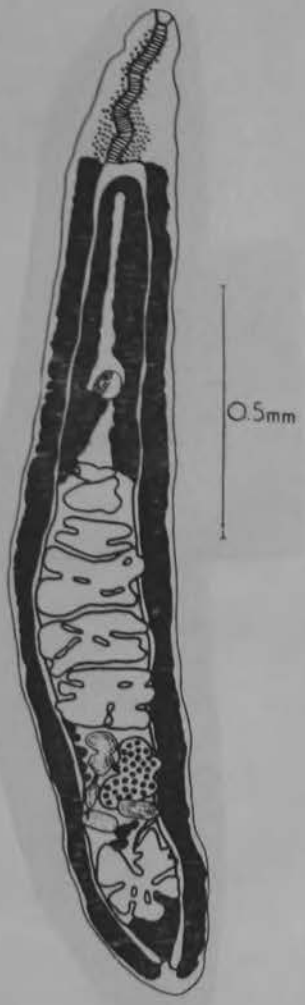
Wirt : *Cyclemys amboinensis* (Daud.)

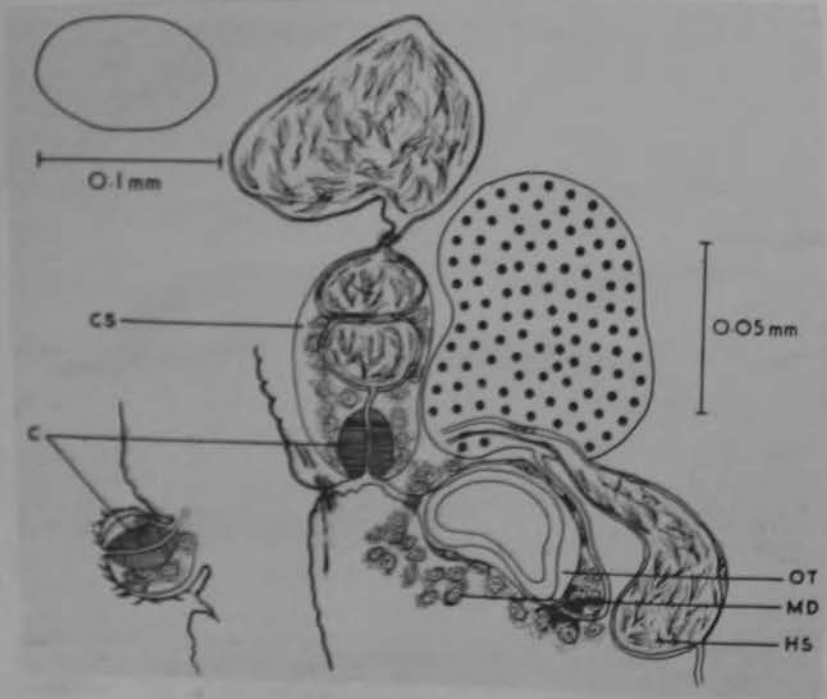
Organ : Arterien des Mesenteriums.

Fundort : Tanjong Karang, Malaya (Typlokalität) ; Jesselton, Nordborneo.

Syntypen : Helminthological Collection No. R. 779-785, Zoology Department, University of Malaya, Kuala Lumpur.

Verwandtschaft. Die Gattung *Spirhapalum*, Ejsmont, 1925, *Spirorchinae*, Stunkard, 1921, zu der die neue Art gehört, hat die folgenden hauptsächlichen Kennzeichen : kein Pharynx, Oesophagus von drüsenartigen Zellen umgeben, Darmschenkel bis zum Körperhinterende. Hoden in 2 Gruppen, einer vorderen und einer hinteren, voneinander durch das Ovar und die Geschlechtsgänge getrennt. Vordere Gruppe der Hoden besteht aus kleinen Teilhoden (6), die hintere Gruppe aus 1-2 Teilen. Mit mächtig entwickeltem Cirrussack, männliche Geschlechtsöffnung ventral nahe dem linken Darmschenkel ; gelapptes Ovar hinter der vorderen Gruppe von Hoden auf der rechten





—OVER

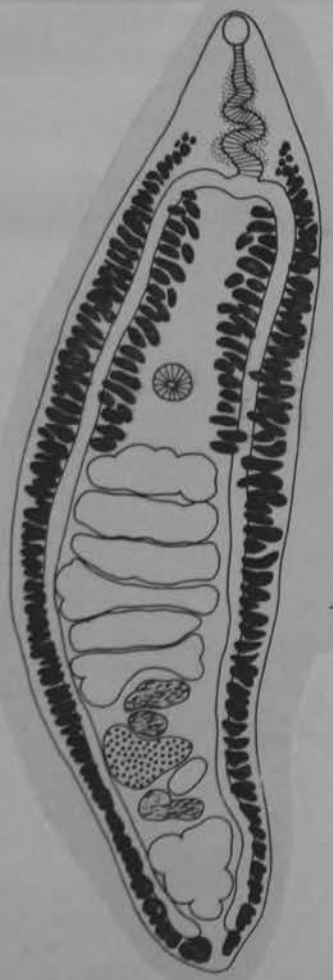
Messergebnisse. (In Millimetern, Längs — vor dem Querdurchmesser):

	1	2	3	4	5	6	7	8	9	11
Länge	1.22	1.23	1.28	1.33	1.55	1.55	1.62	1.68	1.78	2.08
Max. Breite	0.31	0.22	0.57	0.52	0.34	0.49	0.50	0.50	0.35	0.34
Mundsaugnapf	0.05 × 0.04	0.05 × 0.03	0.06 × 0.04	—	0.05 × 0.05	—	0.05 × 0.05	0.06 × 0.04	0.05 × 0.04	—
Acetabulum	0.06 × 0.07	0.04 × 0.05	0.04 × 0.07	0.05 × 0.06	0.05 × 0.06	0.04 × 0.06	0.06 × 0.08	0.06 × 0.07	0.04 × 0.05	0.05 × 0.05
1) Hoden	0.04 × 0.07	—	0.08 × 0.24	0.08 × 0.25	0.05 × 0.08	0.12 × 0.25	0.08 × 0.29	0.16 × 0.21	0.07 × 0.08	0.16 × 0.16
2) »	0.04 × 0.08	—	0.05 × 0.27	0.07 × 0.27	—	0.09 × 0.25	0.05 × 0.26	0.10 × 0.20	0.05 × 0.07	0.10 × 0.11
3) »	0.05 × 0.08	—	0.05 × 0.29	0.08 × 0.29	0.05 × 0.07	0.09 × 0.25	0.05 × 0.27	0.09 × 0.22	0.05 × 0.07	—
4) »	—	—	0.05 × 0.31	0.07 × 0.29	0.05 × 0.09	0.10 × 0.25	0.07 × 0.29	0.07 × 0.22	0.05 × 0.08	—
5) »	0.03 × 0.09	—	0.06 × 0.30	0.08 × 0.30	0.05 × 0.09	0.08 × 0.26	0.07 × 0.25	0.06 × 0.21	0.09 × 0.10	—
6) »	0.06 × 0.09	—	—	0.09 × 0.27	0.10 × 0.11	0.07 × 0.25	—	0.08 × 0.21	—	0.10 × 0.16
7) »	0.05 × 0.04	—	0.15 × 0.19	0.13 × 0.21	0.07 × 0.09	—	—	—	—	0.13 × 0.14
Ovar	0.07 × 0.13	0.06 × 0.10	0.07 × 0.17	0.09 × 0.19	0.10 × 0.10	0.10 × 0.18	0.10 × 0.17	0.08 × 0.19	0.10 × 0.12	—
Ei	0.083 - 0.042	—	0.072 - 0.041	0.083 - 0.042	0.083 - 0.042	0.083 - 0.042	0.073 - 0.052	0.083 - 0.047	0.083 - 0.036	0.068 - 0.036

(Exemplare 1 und 2 aus Borneo).

Körperseite. Laurerscher Kanal vorhanden. Uterus besteht nur aus einem ovalen Ootyp, der in einen Metraterm übergeht und sich nahe der männlichen Geschlechtsöffnung nach aussen öffnet. Zahlreiche Dotterfollikel zwischen der Darmverzweigung und dem hinteren Körperende, sowohl zwischen als auch lateral von den Darmschenkeln. Im Gebiet der hinteren Hoden gehen die rechten Dotterstöcke in die linken über. Parasiten des Blutgefässystems von Süsswasser-Schildkröten.

Die einzige bisher beschriebene Art, *S. polesianum* Ejsmont, 1927 aus *Emys orbicularis* in Polen ist in den folgenden Merkmalen von der neuen Art verschieden. 1.18-2.3 × 0.38-0.65 mm gross, Mundsaugnapf 0.069-0.076 × 0.060-0.085 mm, Acetabulum 0.074-0.123 mm Durchmesser. Das Ovar ist grösser als die Teilhoden, die Vesicula seminalis liegt hauptsächlich vor dem Ovar, der Körper ist gedrungener.



SPIRHAPALUM

Unicaecinae nom. emend. for
Unicaecuminae Mehra, 1934

Subfamily diagnosis. — Spirorchiidae: Body elongate, tapered toward both extremities. Oral sucker small, esophagus moderately long. Ceca

[4]) "They were more or less intimately attached to the intestinal wall and took about half an hour to come out when the intestine was opened in salt solution . . ."

single, median, reaching posterior extremity. No acetabulum. Testes forming a lobed longitudinal column in greater middle portion of body. Vas deferens arising from anterior end of testis and winding backward. Cirrus pouch present. Genital pore sinistroventral, near posterior end of testis. Ovary long, coiled in posterior third of body. Vitellaria extending from level of esophagus to ootype. Parasitic in freshwater turtles.

Unicaecum Stunkard, 1925

Generic diagnosis. — Spirorchiidae, Unicaecinae: Body elongate, tapered toward extremities. No acetabulum. Oral sucker small, esophagus of moderate length, surrounded by gland cells. Ceca single, median, simple or sinuous, reaching posterior extremity. Testes forming a continuous lobed column in center of body. Vas deferens arising from anterior end of testis and winding backward. Cirrus pouch present. Genital pore ventral, sinistral, near posterior level of testis. Ovary long, coiled, in posterior third of body. Seminal receptacle and Laurer's canal absent. Uterus short; eggs large, spherical. Vitelline follicles irregularly distributed, extending from level of esophagus to ootype. Parasitic in blood vessels of freshwater turtles.

Genotype: *U. ruszkowskii* Stunkard, 1925 (Pl. 55, Fig. 675), in *Pseudemys scripta*, and *Graptemys pseudogeographica pseudogeographica;* N. America.

Other species: *U. dissimile* Byrd, 1939, in blood vessels about heart of *Pseudemys troosti;* Tennessee.

Unicaecum ruszkowskii Stunkard, 1925

Length: 4 to 9 mm.

Width: 0.5 to 0.96 mm.

Oral sucker: 0.12 to 0.15 mm. in diameter.

Acetabulum: (size:) Absent.
(position):

Sucker ratio:

Esophagus: Present, surrounded by secreting cells, esp. in posterir half.
Pharynx: Absent

Genital pore (location): About 1/5 body length from posterior end. Ventrally and to left, at middle of ovarian zone.
Testes, shape: Testis long and very ramified, forming a continuous spiral. Ventral and median, from a short distance post.
location: to post.ext. of esophagus to about middle of ovarian zone.
Cirrus sac (extent): 0.13 to 0.16 mm. in diameter.
Ovary, shape: A very winding chaplet of cells.

location: In posterior third of body, its anterior level is at ant. of post. third of body and extends about 1/8 body length towards post. end.
Vitellaria: Form numerous disseminated follicles which reach from the esophagus to the region of the germigene. Mostly lateral.
Eggs: Have a thin colorless shell.

Other features: Only one caecum.

Host: Pseudemys scripta

Locality: South-eastern United Sta

Reference: Ann. de Parasitologie,

Comparisons: Genus Spirorchi6.

Life cycle:

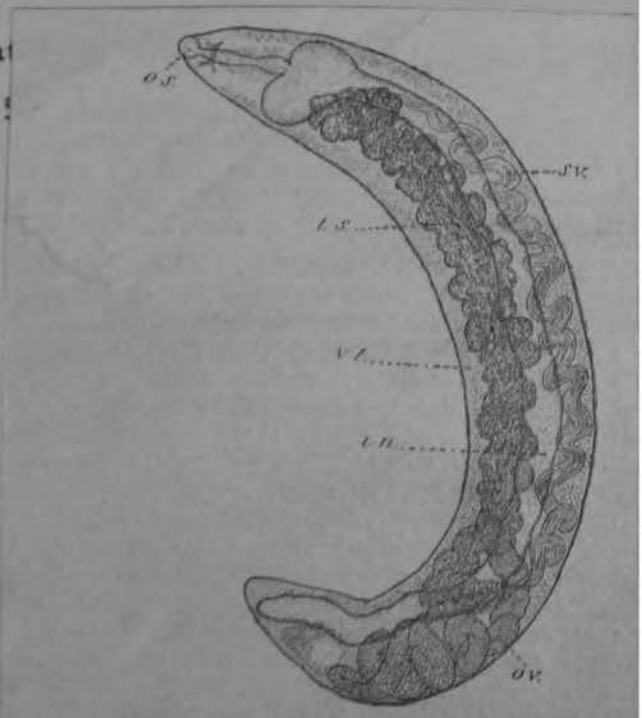


Fig. 1. — *Unicœcum ruszkowskii*, spécimen type monté en entier, × 21.

UNICAECUM

Vasotrematinae n. subfam.

Subfamily diagnosis. — Spirorchiidae: Body lanceolate. Oral sucker prominent; esophagus long, bifurcating just in front of acetabulum; ceca not reaching to posterior extremity. Acetabulum small, at about middle of anterior half of body. Testes spirally coiled in posterior intercecal field. External seminal vesicle large or winding. Cirrus pouch small. Genital pore ventral, at level of ovary or between ovary and acetabulum. Ovary submedian, between anterior testis and seminal vesicle. Vitellaria extending along greater posterior part of ceca. Parasitic in freshwater turtles.

Vasotrema Stunkard, 1928

(*Vasatrema* Stunkard, 1926, renamed)

Generic diagnosis. — Spirorchiidae, Vasotrematinae: Body lanceolate with delicate musculature. Acetabulum and oral sucker prominent, former in anterior half of body. No pharynx. Esophagus bifurcating just

in front of acetabulum. Ceca terminating near posterior extremity. Testes coiled in long spirals, occupying whole posterior intercecal field. Seminal vesicle large or winding, cirrus pouch small. Genital pore ventral, sinistral, at level of ovary or between ovary and acetabulum. Ovary pretesticular, to right of median line. Vitellaria extending along posterior part of ceca, commencing at level of ovary or more anteriorly. Eggs oval, large; miracidia oculate. Excretory vesicle? Parasitic in circulatory system of freshwater turtles.

Key to species — Skrjabin (1951).

Genotype: *V. amydae* (Stunkard, 1926) Stunkard, 1928 (Pl. 52, Fig. 640), in *Amyda ferox* and *A. spinifera;* N. America.

Other species:

V. attenuatum Stunkard, 1928, in *Amyda spinifera;* U.S.A.

V. longitestis Byrd, 1939, in artery of *Amyda spinifera;* Tennessee.

V. robustum Stunkard, 1928, in *Amyda spinifera;* U.S.A.

Cercaria with dorsal crest, 6 pairs of penetration glands and finfolded tail furcae develops in *Physa gyrina* and *P. integra*, penetrates young turtles, *Amyda spinifera*, *A. ferox* and *A. mutica*, in which it attains full maturity in 10 to 12 months — Wall (1951).

Vasotrema amydae (Stunkard, 1926)

Length: 1 to 1.32 mm.

Width: 0.093 to 0.142 mm.

Oral sucker: 0.04 to 0.055 mm. in diameter.

Acetabulum: (size:) 0.045 to 0.055 mm. in diameter.
(position): At the level of the union of the anterior 1/4 and the posterior three fourths of the body.

Sucker ratio: 1:1

Esophagus: Present, with a series of large diverticula in its posterior fourth.
Pharynx: Absent.

Genital pore (location): Ventral and lateral, below the left caecum, 0.02 mm. from the acetabulum.

Testes, shape: Testis is a spiral organ.
location: Extends longitudinally between the two caeca. Anterior extremity a little ant. to mid. body, post. extremity a little ant. to extremity of caeca.

Cirrus sac (extent): Obliquely from g.p. to s.v.

Ovary, shape: Spherical or ovoid.
location: To left or right of median line, at body length from anterior end.

Vitellaria: Consist of small follicles disseminated al
Do not form separate lobes. Extend from ca
caeca to a point slightly anterior to the

Eggs: Only mentioned as being large.

Other features:

Host: Amyda ferox and Amyda spinifera.

Locality: Florida and Indiana.

Reference: Ann. de Parasitologie, 6(3):303-320, 1928

Comparisons: V. attenuatum and V. robustum.

Life cycle:

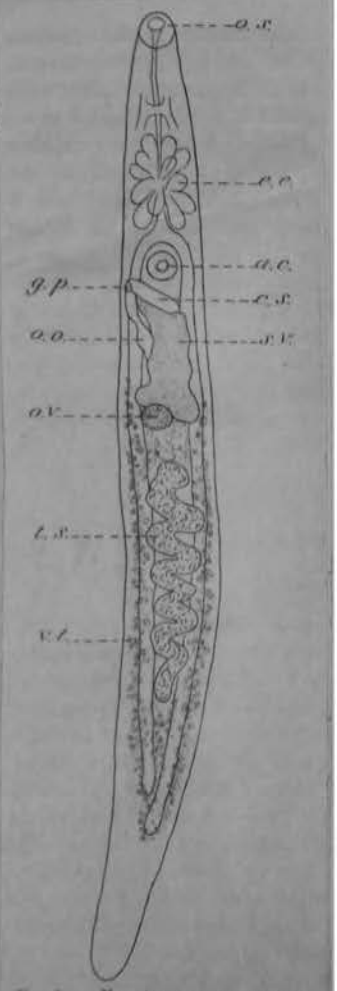


FIG. 1. — *Vasotrema amydæ* : spécimen type, entièrement monté, vu par la face dorsale, × 105 (1).

Spirorchidae

Vasotrema attenuatum Stunkard, 1928

Length: 1.4 to 1.76 mm.

Width: 0.08 to 0.13 mm.

Oral sucker: 0.033 to 0.048 by 0.028 to 0.033

Acetabulum: (size:) 0.038 to 0.048 in diameter.
(position): At 2/7 body lenghh from anterior end.

Sucker ratio:

Esophagus: Relatively short and the the diverticula very small as com-
Pharynx: Absent pared to Spirorchis (Stunkard 1923, figs. 14, 15, 16)

Genital pore (location): A short distance posterior and to the left of the acetabulum.
Testes, shape: A large, elongate testis.

location: Behind the ovary.
Cirrus sac (extent): Occupies same position as seminal vesicle of V. amydae
Ovary, shape: Circular, entire.

location: Immediately posterior to the sac whic
terminal portion of the spermatic car
Vitellaria: Transverse vitelline canals at level of ant
testis and behind ovary. Their union gives
common canal which passes anteriorly, to th
Eggs: Not mentioned. of the seminal vesicle, fr
the ootype.
Other features:

Host: Amyda ferox and Amyda spinifera

Locality: Florida and Indiana.

Reference: Ann. de Parasitologie, 6(3):303-320, 1928.

Comparisons: V. amyda and V. robustum.

Life cycle:

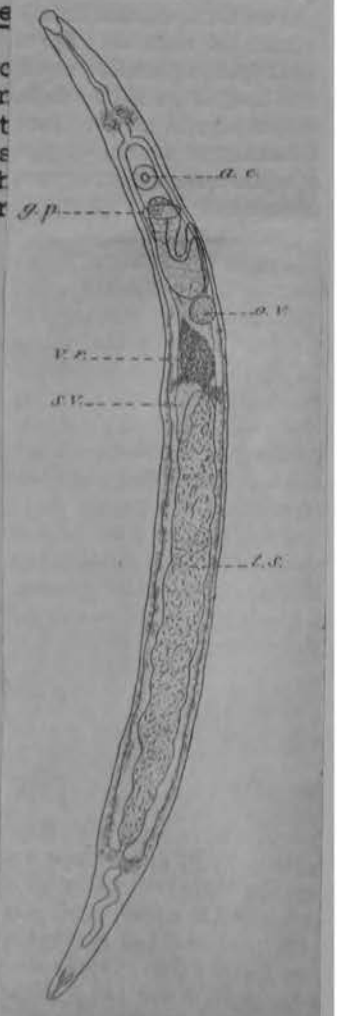


Fig. 4. — *Vasotrema attenuatum*. Spécimen type, entièrement monté, vu par la face dorsale, × 95.

Vasotrema brevitestis sp. n. BROOKS AND MAYES, 1975
(Fig. 1)

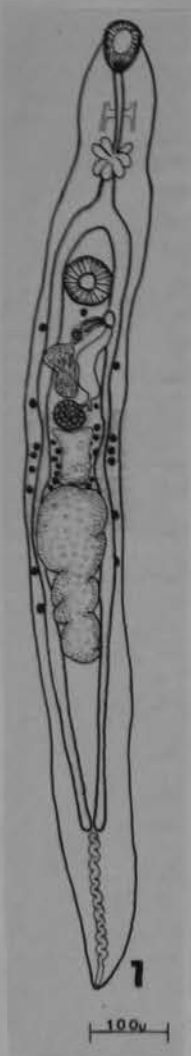
Description (measurements based on 20 of 34 specimens): Body spindle-shaped, weakly muscled, length 1,300 (1,240 to 1,628), width 115 (108 to 124). Small spines present on anterior end of body, most conspicuous on oral sucker. Oral sucker subterminal, oval, diameter 50 (40 to 56); acetabulum at anterior end of second third of body, round, diameter 50 (38 to 52). Esophagus 190 long, with ring of prominent diverticula at beginning of posterior third of esophagus. Intestinal bifurcation preacetabular, ceca relatively long; postcecal space one-fifth body length. Testis relatively short, compact, exhibiting some degree of torsion; intercecal at mid-hindbody; 260 (231 to 310) by 90 (70 to 100); ratio of testis length to body length 1:5. Vas deferens straight, passing lateral or dorsal to ovary. Seminal vesicle external, saccular, connected to cirrus sac by short duct. Cirrus sac short, diagonal, not extending to opposite cecum, 72 (66 to 78) by 12 (11 to 12); containing pars prostatica and straight cirrus. Genital pore ventral, posterosinistral to acetabulum. Ovary pretesticular, round to slightly irregular, 40 by 38 (34 to 40). Seminal receptacle postovarian, large, filling intercecal space between ovary and testis. Laurer's canal short; Mehlis' gland composed of very small cells. Uterus saccular, preovarian, sinistral, opening at genital pore. Vitelline follicles discrete, 20 to 40 in number, 12 in diameter; most numerous in region of seminal receptacle, extending dorsally from testicular to acetabular region. Single mature egg 20 by 16; single immature egg 36 by 30. Excretory pore terminal, vesicle convoluted in postcecal region.

Type host: *Trionyx muticus* (LeSueur), smooth soft-shelled turtle.

Type locality: Missouri River, 1.5 miles south of Blair, Nebraska.

Another host and locality: *T. spiniferus* (LeSueur), spiny soft-shelled turtle, Atkinson State Recreation Area, 0.5 mile west of Atkinson, Nebraska.

Type specimens: Holotype and two paratypes USNM Helm. Coll. Nos. 73817–73819. Paratype series H. W. Manter Laboratory Nos. 20076, 20077. Other paratypes in collections of authors.



Discussion

The genus *Vasotrema* Stunkard, 1926, was erected for *V. amydae* in the circulatory system of *Amyda* (=*Trionyx*) *spinifera* from Illinois and *A. ferox* (Schneider) from Florida. Stunkard (1928) subsequently described *V. attenuatum* and *V. robustum* from the same hosts and localities. Byrd (1939) reported *V. robustum* and a new species *V. longitestis* in *T. spiniferus* from Reelfoot Lake, Tennessee. Wall (1951) described the life cycle of *V. robustum* in *T. spiniferus* and *T. ferox*.

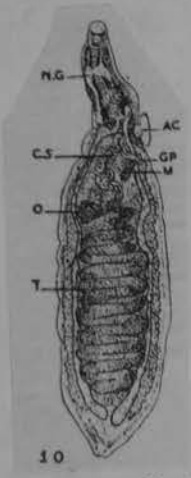
Vasotrema brevitestis most closely resembles *V. amydae* from which it differs in possessing a relatively shorter, more compact testis, and postcecal space equal to one-fifth the body length as opposed to one-sixth; a cirrus sac which does not extend to the opposite cecum; and vitellaria composed of relatively few, large, discrete follicles not extending posterior to the testis as opposed to the abundant, dispersed follicles extending to the cecal tips in *V. amydae*. In recognizing a fifth species of the genus, the authors have prepared the following key:

Key to species of *Vasotrema* Stunkard, 1926 (syn. *Vasotrema* Stunkard, 1926)

1	a) Vitelline follicles small	2
	b) Vitelline follicles large	3
2	a) Testis elongate, unspiraled or slightly torqued	*attenuatum*
	b) Testis a loose spiral	*amydae*
	c) Testis a tight spiral of many coils	*longitestis*
3	a) Genital pore some distance from acetabulum, acetabulum much larger than oral sucker	*robustum*
	b) Genital pore immediately postacetabular, acetabulum and oral sucker subequal	*brevitestis*

Vasotrema longitestis Byrd, 1939

Host: Amyda spinifera



Figs. from Byrd, 1939

Vasotrema robustum Stunkard, 1928

Length: 1.4 to 3 mm.

Width: 0.24 to 0.36 mm.

Oral sucker: 0.075 to 0.11 mm. in diameter.

Acetabulum: (size:) 0.12 to 0.19 mm. in diameter.
(position): At 1/3 body length from anterior end.

Sucker ratio:

Esophagus: Has diverticula whose size is intermediate between those of V. amydae and those of V. attenuatum.
Pharynx: Absent.

Genital pore (location): At level of ovary under the left caecum.

Testes, shape: Voluminous, in the form of a spiral.

location: In the intercaecal space, in posterior half of body.
Cirrus sac (extent): Laterally and ventrally from s.v. to g.p.
Ovary, shape: Spherical or ovoid.

location: On the right side, at the mid-body level.

Vitellaria: Consist of small follicles which reach fro
extremity of the caeca to the acetabular l

Eggs: In one specimen there was an egg in the ootype
be measured accurately.
Other features:

Host: Amyda ferox and Amyda spinifera.

Locality: Florida and Indiana.

Reference: Ann. de Parasitologie, 6(3):303-320, 1928

Comparisons: V. amydae and V. attenuatum.

Life cycle:

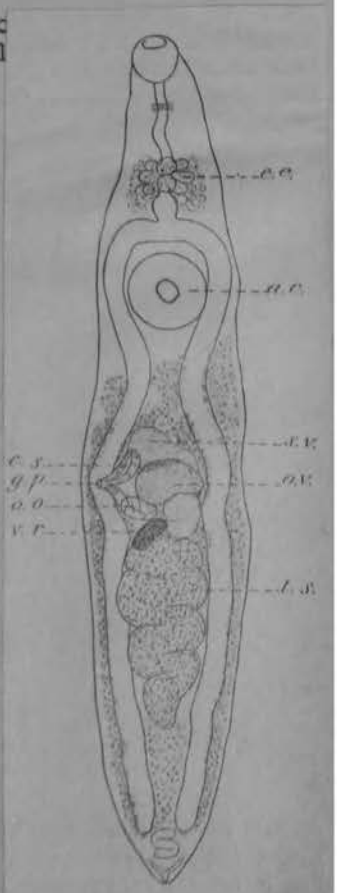
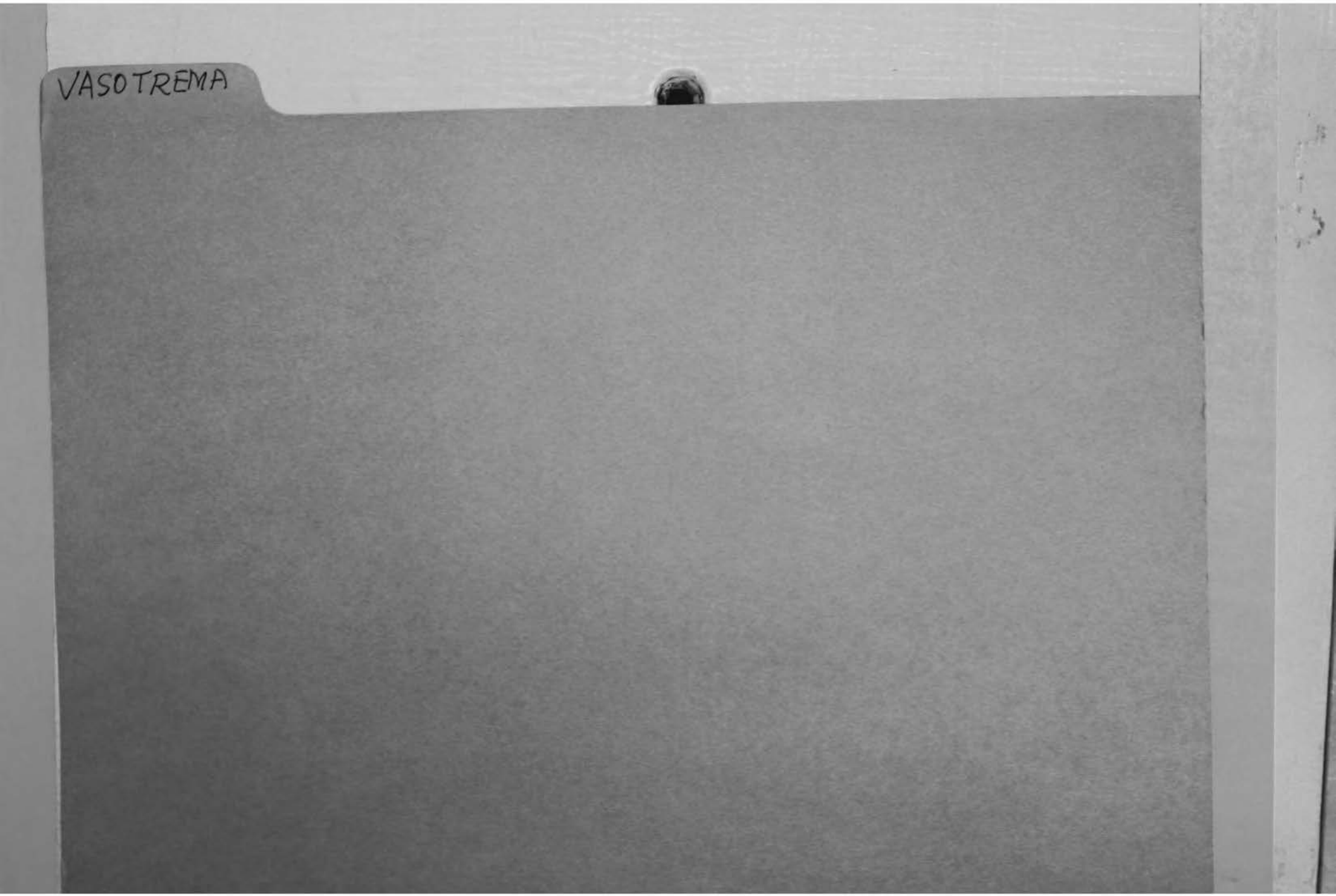


Fig. 7. — *Vasotrema robustum*. Spécimen type, entièrement monté, vue dorsale, × 60.


VASO TREMA