

PARC NATIONAL DE L'UPEMBA
I. MISSION G. F. DE WITTE

en collaboration avec
W. ADAM, A. JANSSENS, L. VAN MEEL
et R. VERHEYEN (1946-1949).

Fascicule 48

NATIONAAL UPEMBA PARK
I. ZENDING G. F. DE WITTE

met medewerking van
W. ADAM, A. JANSSENS, L. VAN MEEL
en R. VERHEYEN (1946-1949).

Aflevering 48

TREMATODA ⁽¹⁾

BY

STEPHEN PRUDHOE (London).

The collection of Trematodes mentioned below was obtained during the Expedition of G. F. DE WITTE in the National Upemba Park and kindly entrusted to the writer for study and determination by Professor V. VAN STRAELEN. As the Trematodes of the Belgian Congo become better known, it becomes increasingly clear that this region of Africa possesses a rich and varied Trematode-fauna and has much to contribute to our knowledge of the biology of this group of parasites.

The collection is composed mainly of several hundreds of specimens of amphistomes from various *Artiodactyla*. Although the collection is small in the number of species present, it is not without special interest. For instance, it contains a member of the family *Gyrodactylidae*, the first Monogenetic Trematode to be recorded from a freshwater fish in Africa. Furthermore, it is now possible to partially elucidate the life-histories of two species of Trematodes, of which only the adults have been known hitherto.

The following is a list of the hosts and their Trematode parasites :

MOLLUSCA.

Lanistes sp. [probably *L. procera* (v. MARTENS)].
Thapariella sp. (*metacercaria*).

(1) All the localities between [] are within the Park's boundaries.

FISHES.

- Clarias lazera* CUVIER & VALENCIENNES.
Neogrodactylus congolensis n. gen., n. sp.
Clinostomoides brieni DOLLFUS, 1950 (*metacercaria*).

AMPHIBIANS.

- Bufo regularis* REUSS.
Mesocoelium monodi DOLLFUS, 1929.
Rana mascareniensis DUMÉRIL & BIBRON.
Mesocoelium monodi DOLLFUS, 1929.

BIRDS.

- Kaupifalco monogrammicus meridionalis* (HARTLAUB).
Nephrostomum ramosum (SONSINO, 1895).

MAMMALS.**Artiodactyla.**

- Phacochoerus aethiopicus* (PALLÁS).
Gastrodiscus aegyptiacus COBBOLD, 1876.
Adenota vardoni (LIVINGSTONE).
Paramphistomum microbothrium FISCHOEDER, 1901.
Cotylophoron cotylophorum (FISCHOEDER, 1901).
Hippotragus equinus (DESMAREST).
Paramphistomum microbothrium FISCHOEDER, 1901.
Carmyerius mancupatus (FISCHOEDER, 1901).
Bubalus caffer (SPARRMAN).
Paramphistomum microbothrium FISCHOEDER, 1901.
Cotylophoron cotylophorum (FISCHOEDER, 1901).
Carmyerius exoporus MAPLESTONE, 1923.
Taurotragus oryx (PALLÁS).
Paramphistomum microbothrium FISCHOEDER, 1901.
Cotylophoron cotylophorum (FISCHOEDER, 1901).
Carmyerius mancupatus (FISCHOEDER, 1901).
Kobus defassa crawshayi P. L. SCLATER.
Paramphistomum microbothrium FISCHOEDER, 1901.
Cotylophoron cotylophorum (FISCHOEDER, 1901).
Tragelaphus scriptus (PALLÁS).
Cotylophoron cotylophorum (FISCHOEDER, 1901).
Ourebia ourebi (ZIMMERMANN).
Paramphistomum microbothrium FISCHOEDER, 1901.

Carnivora.

- Aonyx capensis* (SCHINZ).
Clinostomum pyriforme n. sp.

Order MONOGENEA.

Family GYRODACTYLIDAE COBBOLD, 1864.

Neogyrodactylus congolensis n. gen.; n. sp.

(Figs. 1 and 2.)

Host and locality :

On skin of *Clarias lazera*. Mabwe, 585 m, 3.XII.1948 (1571); 6.XII.1948 (1590); 8.XII.1948 (1602).

In specimens without embryos the body, excluding the opisthaptor, is more or less cylindrical. It varies between 1,2 mm and 2,1 mm in length and 0,22 mm and 0,5 mm in maximum width. The posterior adhesive organ or opisthaptor is distinctly marked off from the body of the worm and is somewhat trapezoidal in outline. It measures 0,52 to 0,60 mm in length and 0,46 to 0,58 mm in maximum width, which usually occurs in the anterior region. The armature of the opisthaptor consists of a pair of large central hooks, supported by a somewhat U-shaped ventral bar (fig. 2) and a simple dorsal bar. Lying between the large central hooks, and articulating with the ventral bar, there is a pair of delicate cuticular hook-like structures which extend to the posterior margin of the opisthaptor. These delicate structures are provided with alae along their inner surfaces, and they articulate with a further pair of elongate structures which appear to be spatulate at their extremities. The ventral surface of the opisthaptor appears to be provided with rather indistinct rugae, while the margins are invested with long delicate filaments of cuticle. On the antero-lateral borders of the opisthaptor there is a pair of small lobes, each armed with a small bifid hook. In addition, the opisthaptor is provided on its dorsal surface with a posteriorly-directed, fan-shaped, cuticular membrane, armed with fourteen hooklets, as shown in figure 2.

The anterior end of the body is notched to form two lobes, from which arise papilla-like outgrowths or head-organs. Through these organs pass the ducts of many large unicellular glands. These gland-cells or head-glands are disposed in four clearly-defined groups, two on either side of the body in the anterior region. The cerebral organ is large and situated close behind the indentation at the anterior end of the body. The mouth occurs behind the cerebral organ and leads into a rather spacious cavity which opens into a well-developed pharynx, lying between the groups of head-glands. In the mature worms the pharynx measures 0,12-0,15 mm in diameter. As in *Gyrodactylus*, according to KATHERINER (1895), the pharynx is divided into two sections. The outer section appears as a

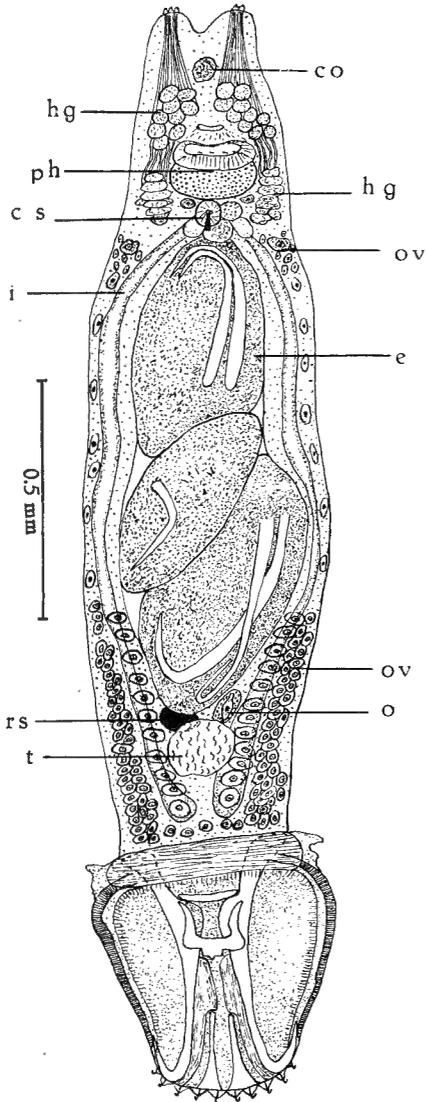


FIG. 1.

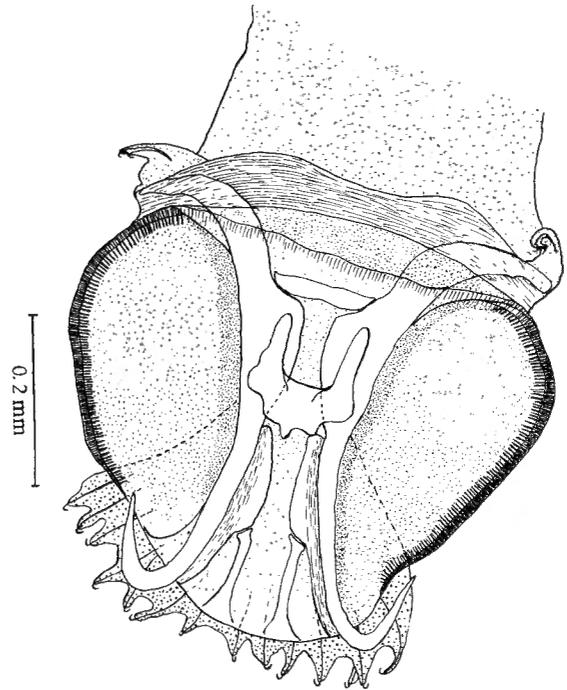


FIG. 2.

FIGS 1-2. — *Neogyrodactylus congolensis* n. gen., n. sp.

Fig. 1. — Ventral view of adult.

co, cerebral organ; cs, cirrus-sac; e, embryo; hg, head-glands;
i, intestinal caecum; o, oötype; ov, ovocyte; ph, pharynx;
rs, receptaculum seminis; t, testis.

Fig. 2. — Ventral view of opisthaptor.

muscular ringlike structure, from the inner surface of which arise six stout processes. Each of these processes has a narrow duct passing through it. The second or inner section of the pharynx is a large globular body with a less compact musculature, lying among the fibres of which there are six large gland-cells. Although ducts from these gland-cells have not been observed, it seems possible that their products issue through the papillae in the first section of the pharynx. From the pharynx a short oesophagus opens into a pair of intestinal caeca, which extend to near the posterior end of the body.

The testis is globular, measuring 0,06 mm to 0,15 mm in diameter. It is situated between the intestinal caeca, near the middle of the body, but as the uterus becomes larger so the testis is moved posteriorly, and in one case where the uterus contains three embryos the testis lies near the ends of the caeca. The cirrus-bulb occurs more or less in the median line, immediately behind the pharynx. Around its aperture there is a crown of about fifteen delicate spines, while attached to the inner posterior wall of the bulb is a large spine, measuring up to 0,027 mm in length. From a comparatively large seminal vesicle the ejaculatory duct opens into the base of the cirrus-bulb. Opening into the latter, side by side with the ejaculatory duct, are the ducts of two prostate organs, which lie on either side of the seminal vesicle. In addition, there is a well-developed pyriform glandular organ lying in front of the seminal vesicle and also opening into the cirrus-bulb.

The female genital system appears to be very complex and bears some resemblance to that found in acoelous Turbellaria. The female gonads consist of two lateral rows of ovocytes, apparently not enclosed in a definite wall but embedded in the parenchyma. Laterally, immediately behind the level of the intestinal bifurcation, there is on either side of the body a relatively large gland-cell, from which the ovocytes seemingly originate, for the smallest ovocytes occur in the vicinity of these gland-cells and become progressively larger as they pass posteriorly. On reaching the hinder region of the body, the rows of ovocytes turn sharply and, running conversely, extend to the level of the testis or beyond. At this point the rows turn posteriorly and run, dorsally to the intestinal caeca, to the hinder end of the body, where they again turn sharply and, ventrally to the caeca, extend anteriorly to the testis. Here the ovocytes pass into a large oötype, which lies to the left of the median line, between the testis and uterus. Surrounding the larger ovocytes it is sometimes possible to observe a thin coating of yolk-material. A large rounded receptaculum seminis, measuring up to 0,075 mm in diameter, is situated to the right of the oötype, into which it opens. The large oval uterus, measuring up to about 0,12 mm in length, occupies the middle region of the body between the intestinal caeca and contains several embryos in various stages of development.

From KATHERINER's (1895) account of the anatomy of *Gyrodactylus* there seems to be some indication of a germovitellarium being present in this

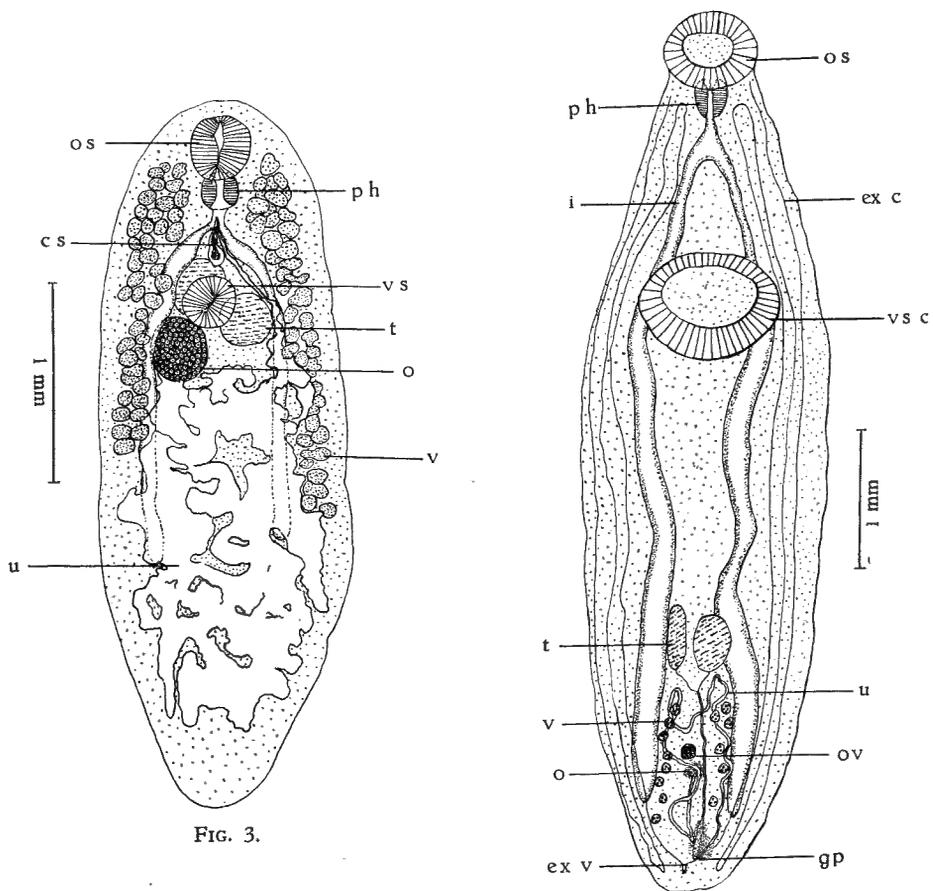


FIG. 3.

FIG. 4.

FIG. 3. — *Mesocoelium monodi* DOLLFUS. Ventral view of adult (eggs omitted).
 cs, cirrus-sac; o, ovary; os, oral sucker; ph, pharynx; t, testis;
 u, uterus; v, vitelline follicle; vs, ventral sucker.

FIG. 4. — *Thapariella* sp. Ventral view of metacercaria.
 ex c, excretory canal; ex v, excretory vesicle; gp, genital pore; i, intestinal
 caecum; o, oötype; os, oral sucker; ov, ovary; ph, pharynx; t, testis,
 u, uterus; v, vitelline follicle; vs, ventral sucker.

genus, but some subsequent writers appear to reject KATHERINER's interpretation of the female complex and recognize distinct vitellaria and a separate ovary. Since no definite vitellaria have been observed in the present form, it seems possible that KATHERINER's interpretation might be correct, and the question should be reopened. But such a study should be based on the examination of sectioned material, selectively stained, and not solely on whole mounts.

Neogyrodactylus is undoubtedly related to the genera *Gyrodactylus* and *Gyrodactyloides*, but may be readily distinguished from these in the structure of the opisthaptor and in the organization of the female genital system. The following definition may now be given for the new genus :

NEOGYRODACTYLUS n. gen.

Gyrodactylidae. Opisthaptor somewhat trapezoidal in outline, provided with a pair of large hooks, but without marginal hooklets. A fan-shaped membrane armed with 14 hooklets is attached to the dorsal surface of the opisthaptor. Female genital system including a receptaculum seminis and a pair of germovitellaria. Parasites of freshwater fishes.

Genotype : *N. congolensis* n. sp.

Order DIGENEA.

Family DICROCOELIIDAE ODHNER, 1910.

Mesocoelium monodi DOLLFUS, 1929.

(Fig. 3.)

Hosts and locality :

Bufo regularis; *Rana mascareniensis*. Mabwe, 585 m (1611c, 1612c).

This species appears to be widely distributed among anurans and saurians in West Africa. It was originally described by DOLLFUS (1929) from *Chamaeleon gracilis* in the Cameroons. SZIDAT (1932) later recorded *M. monodi* from *Rana mascareniensis*, *Bufo regularis*, *Agama planiceps*, *Agama colonorum*, *Lygosoma fernandi* and *Mabuia maculilabris* in Liberia, while BAYLIS (1936) recorded it from *Chamaeleon etiennei* in the Belgian Congo.

The following description is based solely upon specimens in the present collection. The worms are dorso-ventrally flattened and elongate oval in outline. They measure 2,5-3,5 mm in length and 0,75-1 mm in maximum width. The cuticle is provided with closely-set rows of minute spines, extending posteriorly as far as the hinder limit of the vitelline follicles. The subterminal oral sucker has an elongate opening. It is rounded (0,33 mm in diameter) or oval (0,3-0,33 mm in length and 0,25-0,30 mm in width). The ventral sucker is situated at about the junction of the first and second thirds of the total length of the body and measures 0,18 mm to 0,27 mm in diameter. The oral sucker appears to open into a well-developed pharynx which is more or less transversely oval, measuring 0,10-0,15 × 0,13-0,20 mm. When an oesophagus is apparent, it is very

short. The intestinal caeca are relatively wide and extend to a little beyond the middle of the body. The genital pore occurs immediately behind the pharynx, in the region of the intestinal bifurcation. The thin-walled cirrus-sac is pyriform or flask-shaped and extends to near the ventral sucker. It contains a well-developed seminal vesicle, apparently constricted into two portions, opening into a coiled ejaculatory duct, which shows no differentiation of a pars prostatica nor of a cirrus. As in other members of the genus *Mesocoelium*, the testes are arranged symmetrically or somewhat obliquely in the region of the ventral sucker. They are rounded and measure 0,20-0,30 mm in diameter. The ovary lies to the right or to the left of the median line, immediately behind and contiguous with the testis of that side. It is more or less rounded and sometimes a little larger than the testes, measuring 0,22-0,33 mm in diameter. The vitellaria consist of numerous rounded follicles situated at the sides of the body, extending from the region of the oral sucker to near the posterior ends of the intestinal caeca. The follicles lying on the same side of the body as the ovary seldom extend posteriorly as far as those in the opposite field. The uterus is voluminous and thrown into a large number of coils, which occupy most of the body behind the ventral sucker. The eggs are very numerous and measure 0,035-0,038 × 0,020-0,023 mm.

DOLLFUS (1950) has described a new species, *Mesocoelium schwetzi*, from *Rana mascareniensis* and *Bufo regularis* in the Belgian Congo. This species bears a very close resemblance to *M. monodi*, and merely appears to be a smaller form, with a comparatively larger pharynx. The validity of the differences enumerated by DOLLFUS for distinguishing *M. schwetzi* from *M. monodi* is doubtful, since, according to DOLLFUS (1929), SZIDAT (1932) and the present description, *M. monodi* is an exceedingly variable form.

Family ECHINOSTOMATIDAE Looss, 1902.

[*Nephrostomum ramosum* (SONSINO, 1895).]

Host and locality :

Kaupifalco monogrammicus meridionalis. [Kabenga, près Kaziba, 1.240-1.300 m, 8.IV.1949 (2241).]

N. ramosum has been hitherto known to occur as an adult only in Ciconiiform birds, and the occurrence of three mature specimens of this species in a Falconiform bird is of special interest, since it is again shown that, generally speaking, the degree of specificity in the adaptation of echinostome trematodes to particular hosts or even orders of hosts is rather low.

Family BRACHYLAEMIDAE JOYEUX and FOLEY, 1930.

Thapariella sp. (*metacercaria*).

(Fig. 4.)

Host and locality :

Lanistes sp. (*Mollusca*). Mabwe, 585 m, 20.I.1949 (1805 c, 1808 c); 23.II.1949 (1995 c); 5.IV.1949 (2179 c).

Many specimens of an immature brachylaemid trematode were found by Dr. W. ADAM on the surface of the body beneath the shell of *Lanistes* (probably *L. procera*).

The elongate body of the immature worms is smooth and measures 5-7,5 mm in length and 1-2 mm in maximum width. The more or less rounded oral sucker is subterminal and has a diameter of 0,46-0,75 mm. It opens directly into a well-developed spherical pharynx, which measures 0,16-0,27 mm in diameter. A short oesophagus is apparent only in the larger specimens. The intestinal caeca are relatively wide and extend to near the posterior end of the body. The ventral sucker occurs at about the junction of the first and middle thirds of the total length of the body. It is rounded (0,63-0,93 mm in diameter) or transversely oval (0,78 × 0,9 mm to 0,94 × 1,12 mm). The excretory pore is situated dorsally in the median line in the posterior region of the body. The bladder is short and narrow, and into it opens the main excretory canals. These canals extend to the lateral regions of the body and forward to the level of the pharynx, where they recurve and return to the region of the main bladder, and recurving again extend anteriorly to terminate in the region of the oral sucker.

The genital pore is situated in the median line near the posterior end of the body. It leads into a fairly wide atrium, at the base of which lie the openings of the genital ducts. The testes are obliquely or symmetrically arranged and situated between the intestinal caeca in the middle of the posterior half of the body. From the testes the vasa efferentia converge towards the median line, where they unite to form a vas deferens. From the union of the vasa efferentia the male duct extends posteriorly to the genital pore. Throughout its length this duct does not show any modifications of its walls, but its hinder portion is enveloped by a dense mass of extracapsular gland-cells.

About midway between the testes and the genital pore lies the ovary, and immediately behind this the « shell »-gland complex. From this complex the uterine canal extends to the diffusion of the gland-cells surrounding the distal portion of the male canal and there turns to run forward as far as the hinder margin of the left testis. At this point it crosses to the right testis, where it turns posteriorly and takes an undulating course to the genital pore. The vitelline glands are disposed in distinct follicles lying between the intestinal caeca, behind the testes.

The follicles are well developed, and there are constantly six follicles lying on the left side of the median line and eight on the right, but one instance has been found where the numbers are reversed.

BRIEN (1955) has described thread-like sporocysts waving their free ends in the mantle-cavity of *Lanistes procerus* in the Belgian Congo. These sporocysts contained furcocercous cercariae and since larvae of this type are, according to ALLISON (1943), known to occur in the brachylaemid *Leucochloridiomorpha constantiae* (MUELLER) it seemed possible that BRIEN's cercariae represented an earlier stage of the present form. But no evidence of this has been found, for about twelve specimens of the snail were dissected by Dr. C. A. WRIGHT and the writer and, while several snails had superficial lesions on the surface of the body, no indications of trematode infestation were found among the internal organs.

Dr. ADAM kindly informed the writer that he thought the openbilled stork (*Anastomus lamelligerus* TEMMINCK) was the probable final host of this parasite, because he had seen storks take the snails out of the water, bring them on land and pick the animals out of their shells. This opinion is substantiated by SRIVASTAVA (1955), who describes from *Anastomus oscitans* in India a new Trematode, *Thapariella anastomusa*, which is clearly very closely related to the larval form from *Lanistes*. In fact, except for two noticeable differences, both forms would appear to belong to the same species. With regard to the differences, firstly, in *T. anastomusa* the excretory pore is said to be terminal, but in SRIVASTAVA's figure 2 it is shown to be subterminal and ventral, closely adjacent to the genital pore, while in the African form the excretory pore is subterminal but quite definitely dorsal. Secondly, the cirrus in *T. anastomusa* possesses well-developed spines, but in the larval forms cirrus-spines have not been detected in whole mounts, nor in serial sections. Cirrus-spines may, of course, develop at a later stage, but it would at the moment be speculative to regard the form from *Lanistes* as the larva of *Thapariella anastomusa*.

SRIVASTAVA regards *Thapariella* as a form intermediate between the families *Hemiuridae* and *Brachylaemidae* and erects for it a new family, *Thapariellidae*. In the present writer's opinion any resemblance *Thapariella* might bear to the Hemiurids is purely superficial, but its resemblance to the Brachylaemids is very close. Morphologically, *Thapariellidae* is said to differ from *Brachylaemidae* in the following characters: in the absence of a cirrus-sac; in the position of the ovary in relation to the testes; in the distribution of the uterine coils; and in the shape of the excretory vesicle. To these might be added the paucity of the vitelline follicles. With regard to the latter difference, figures given by SINTZIN (1931) show that in *Panopristis* — a form closely related to *Thapariella* — the vitelline follicles are exceedingly few in the metacercaria, but apparently break up into numerous smaller follicles in the adult worm. The distribution of the uterine coils and the shape of the excretory vesicle in *Thapariella* are fundamentally similar in the subfamily *Brachylaeminae*. In the writer's

opinion the absence of a cirrus-sac and the position of the ovary in relation to the testes are, in this instance, taxonomically no more important than generic characters, and *Thapariellidae* should therefore be regarded as a synonym of *Brachylaemidae*.

Family CLINOSTOMATIDAE LÜHE, 1901.

Clinostomum pyriforme n. sp.

(Fig 5.)

Host and locality :

From mouth of *Aonyx capensis*. Ganza, 860 m, 14.VI.1949 (2497 c).

The body is pyriform but appears to be rather contracted in all specimens. It is smooth and measures 2,5-3,5 mm in length and 1,2-1,7 mm in width. The oral sucker is subterminal, poorly developed and measures 0,22-0,35 mm in diameter. Close behind the opening of the oral sucker the body-wall is thrown into a well-developed collar. A pharynx is apparently absent, and the oral sucker opens directly into a short oesophagus, measuring about 0,25 mm in length and lined with cuticle. The hinder region of the oesophagus is enlarged and provided with a relatively thick circular musculature. The intestinal caeca are simple, undulating dorso-ventrally and extending to the posterior end of the body. The undulation is so profuse that the anterior portions of the caeca appear to be moniliform. The caeca terminate near the base of the excretory vesicle, into which they do not appear to open, as in some other species of the genus *Clinostomum*. The ventral sucker, situated in the middle region of the body, is comparatively large, measuring 0,6-0,8 mm in diameter. The excretory pore is more or less dorsally situated near the posterior end of the body. It opens into a V-shaped excretory vesicle. The genital pore lies in the median line, near the anterior margin of the foremost testis. It leads into a narrow atrium, into which open the cirrus-sac and the metraterm. The cirrus-sac is pyriform, with its longitudinal axis disposed more or less dorso-ventrally. It lies on the anterior margin of the foremost testis and measures about 0,5 mm in length and 0,25 mm in maximum width in its proximal region, and contains a much coiled ejaculatory duct and a bipartite seminal vesicle. The ejaculatory duct is muscular and seems to be lined with a thin cuticle which may have a corrugated appearance. No pars prostatica has been observed. The testes are arranged one behind the other in the hinder quarter of the body. They are transversely-elongate organs, with the hinder margin slightly convex and the anterior margin concave, sometimes rather deeply. In all the specimens examined, the foremost testis, measuring 0,75-1 mm in transverse diameter, is shaped rather like a boomerang and constantly larger than the hinder testis, which measures 0,50-0,75 mm transversely. The ovary is situated to the right of the median line, on the

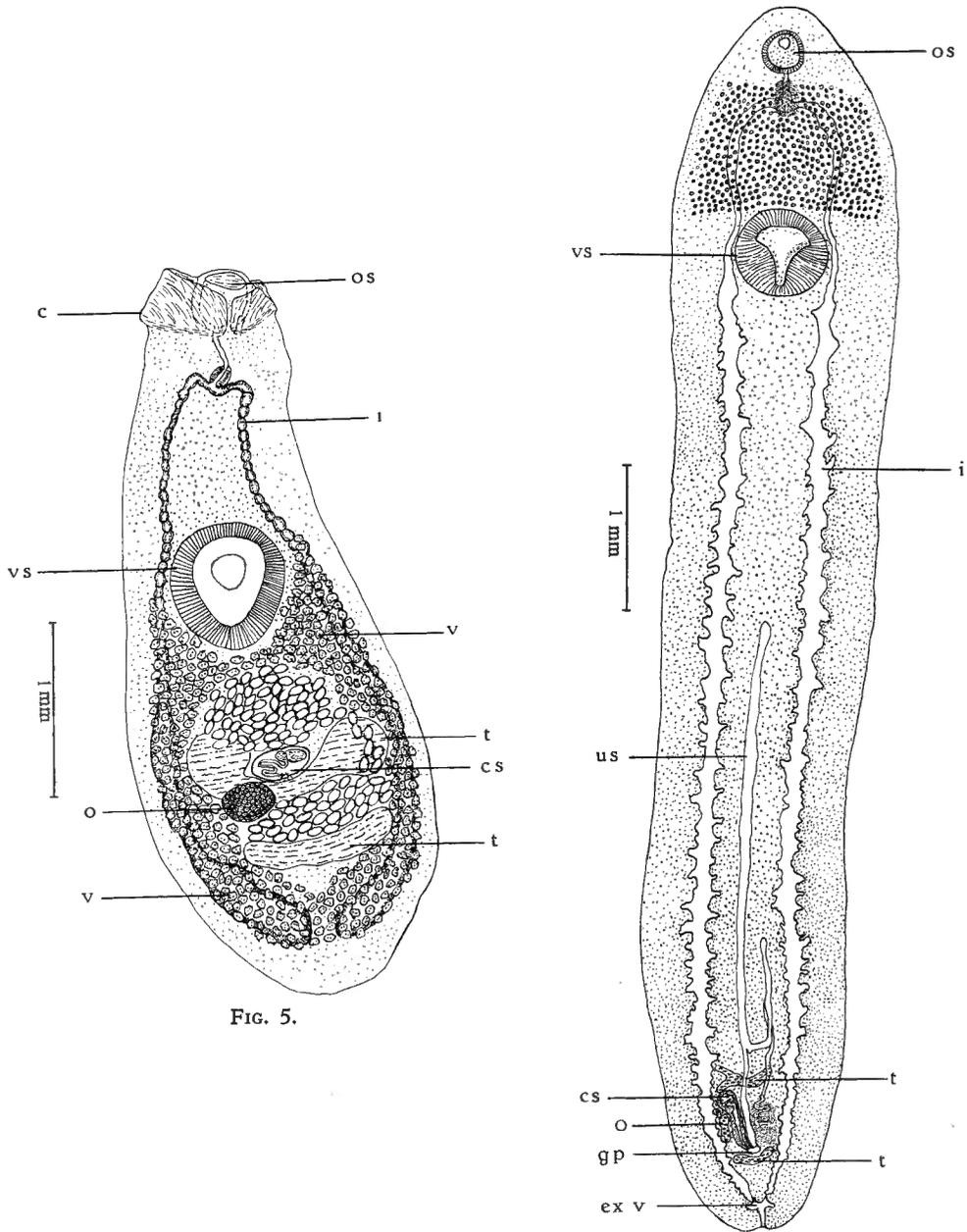


FIG. 5.

FIG. 6.

FIG. 5. — *Clinostomum pyriforme* n. sp. Ventral view of adult.
 c, cephalic collar; cs, cirrus-sac; i, intestinal caecum; o, ovary;
 os, oral sucker; t, testis; v, vitellaria; vs, ventral sucker.

FIG. 6. — *Clinostomoides brieni* DOLLFUS. Ventral view of metacercaria.
 cs, cirrus-sac; ex v, excretory vesicle; gp, genital pore; i, intestinal
 caecum; o, ovary; os, oral sucker; t, testis; us, uterine sac; vs, ventral sucker.

posterior margin of the anterior testis. It is transversely oval and measures 0,22-0,25 × 0,15 mm. A receptaculum seminis has not been observed, but sometimes a mass of spermatozoa may be seen in the proximal region of the uterus. Laurer's canal opens in the mid-dorsal line, posteriorly to the ovary. The oviduct is much convoluted, while the oötype is a narrow elongate structure, not very well differentiated. The ascending limb of the uterus crosses the anterior testis on the left side to open into a spacious uterine sac lying between the anterior testis and the ventral sucker. The vitellaria consist of well-developed follicles situated laterally and extending from the hinder end of the body to about the middle of the ventral sucker. Posteriorly, and often immediately behind the ventral sucker, the follicles are confluent in the median line. In specimens stained with Mayer's paracarmine and mounted in Canada balsam the eggs are collapsed and measure about 0,110 × 0,082 mm while eggs taken from unstained specimens and mounted in formalin measure 0,117-0,125 × 0,067-0,072 mm.

The form described above differs from other known species of *Clinostomum* not only in its small size, but also in the position of the cirrus-sac in relation to the anterior testis. The latter character might be regarded as generically important, but since the position of the cirrus-sac varies in different species of *Clinostomum* the writer feels that the erection of a new genus for the present form is unnecessary.

Another interesting feature of the new form is that it is the only species of *Clinostomum* so far known to occur naturally in a wild mammal. It is true that *C. complanatum* (RUD.) has been found in the pharynx of man in Japan (YAMASHITA, 1938) and in Tiberias (WITENBERG, 1944), while *Clinostomum abdoni* TUBANGUI and GARCIA, 1939, *Clinostomum kalappahi* BHALLERAO, 1947, and *Clinostomum* sp. of BELLIAPPA, 1944, have been recorded from under the tongue of domestic cats in the East Indies, but these infestations may be justifiably regarded as accidental and are presumed to have been derived through the consumption of raw or improperly cooked fish.

***Clinostomoides brieni* DOLLFUS, 1950.**

(Fig. 6.)

Host and locality :

Clarias lazera. Mabwe, 585 m (1538, 1551, 1603).

Many immature examples of this trematode were found on three occasions encysted on the gills of *Clarias lazera* from a lake at Mabwe during August and September, 1947. A very similar form from *Clarias* sp. in Lake Nyasa is present in the collections of the British Museum (Natural History).

The body is somewhat boat-shaped in preserved specimens, being concave ventrally and convex dorsally, with margins somewhat inflexed ventrally. It measures 6 mm to 9 mm in length and 1,25 mm to 1,65 mm

in maximum width, which occurs usually in the anterior region of the body, although the width is nearly uniform throughout. The cuticle is provided with very minute spines densely arranged over the entire surface of the body.

The oral sucker is subterminal. It is more or less rounded and measures 0,25-0,35 mm in diameter, and its musculature does not appear to be very well developed. The ventral sucker, however, is very muscular and measures 0,60-0,65 mm in longitudinal diameter and 0,70-0,75 mm in transverse diameter. Though a true pharynx is apparently absent the hinder portion of the oesophagus seems to be invested with loose muscle-fibres and a vast number of gland-cells. This region of the alimentary system probably represents the degenerated pharynx described in *Clinostomum phalacrocoracis* by DUBOIS (1931). The intestinal caeca extend to near the posterior end of the body, and behind the ventral sucker they are provided with small marginal pockets. The excretory vesicle is more or less V-shaped, the limbs being lateral to the intestinal caeca and extending anteriorly to near the ventral sucker.

The testes are arranged tandem between the intestinal caeca in the posterior region of the body. They are transversely elongate and slightly arched, measuring about $0,15 \times 0,06$ mm, the hinder testis invariably being a little smaller than the foremost. In the median line or somewhat to the right, between the testes, an elongate cirrus-sac is situated. This measures between 0,30-0,50 mm in length and 0,12-0,15 mm in width. It contains a well-developed seminal vesicle and a long, muscular, ejaculatory duct, and opens into a genital atrium situated in the median line on the anterior border of the posterior testis. A pars prostatica does not appear to be differentiated, at least not in the juvenile stage.

The ovary is elongate, measuring about 0,25 mm in length and 0,05 mm in diameter. It lies between the testes, and between the cirrus-sac and the right intestinal caecum. The oviduct passes dorsally to the cirrus-sac to open into the « shell »-gland which lies to the left of the median line between the testes. From the « shell »-gland the uterine canal runs anteriorly, forming a number of loops to a point between 0,5 mm and 1 mm in front of the anterior testis, where it turns dorsally to run conversely to near the foremost testis, where it forms a right-angled bend to extend to the median line. In the median line, the uterine canal opens into the main uterine trunk, which extends anteriorly to about the middle of the body and posteriorly to the genital atrium.

The present form so closely resembles *Clinostomum brieni*, recorded by DOLLFUS (1950) from the oesophagus of *Ardea goliath* at Kadia, Belgian Congo, that the writer has no hesitation in regarding it as the metacercaria of this species.

Family **PARAMPHISTOMATIDAE** FISCHÖEDER, 1901.

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

Subfamily **PARAMPHISTOMATINAE** FISCHÖEDER, 1901.**Paramphistomum microbothrium** FISCHÖEDER, 1901.

(Fig. 7, a-c.)

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

Hosts and localities :

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

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

Hippotragus equinus. [Kafwe, 1.780-1.830 m, 18.IV.1947 (61 c, 63 c, 64 c)]; [riv. Kafwe (329 c)]; riv. Muye (330 c).

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

Ourebia ourebi. Buye-Bala, 1.750 m, 26.III.1948 (678 c); Kalumengongo, 1.780-1.830 m, 16.I.1948.

Taurotragus oryx. Piste Mubale, 1.480-1.780 m, 21.XI.1947 (331 c).

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

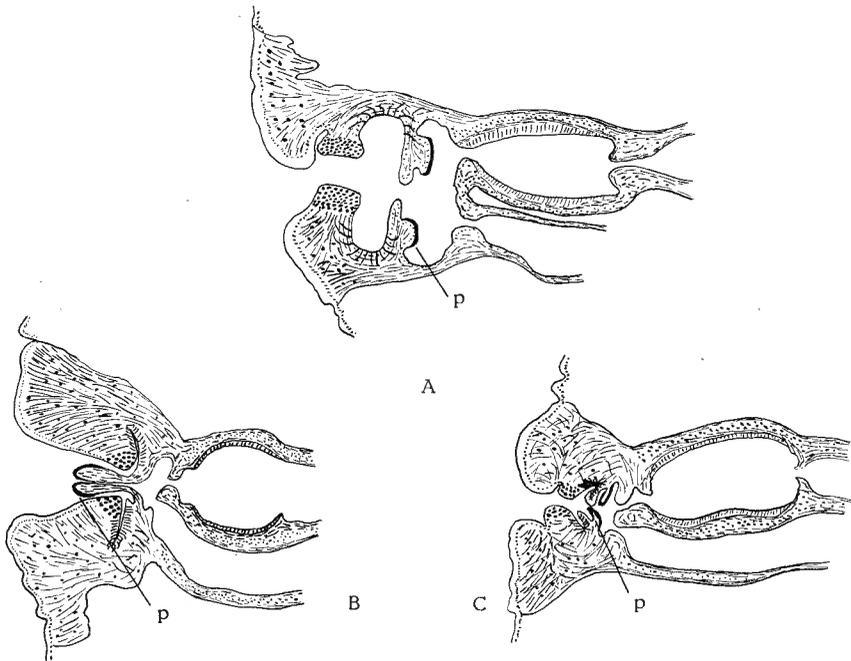


FIG. 7. — *Paramphistomum microbothrium* FISCHÖEDER.

Copulatory apparatus (semi-diagrammatic).

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

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

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

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

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

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

***Cotylophoron cotylophorum* (FISCHOEDER, 1901).**

Hosts and localities :

Adenota vardoni. Mabwe, 585 m, 28.VIII.1947 (226 c).

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

Kobus defassa crawshayi. Kaswabilenga, 680 m, 14.X.1947 (281 c).

Taurotragus oryx. Piste Mubale, 1.480-1.780 m, 21.XI.1947 (331 c).

Tragelaphus scriptus. Kaswabilenga, 680 m, 3.XI.1947 (290 c).

This species was originally assigned by FISCHOEDER to the genus *Paramphistomum*, but as it was considered by STILES and GOLDBERGER (1910) to possess a well-developed genital sucker they erected the genus *Cotylophoron* for its reception, adding at the same time a second species, *C. indicum* STILES and GOLDBERGER. NÄSMARK (1936), in describing two new species — *C. fülleborni* and *C. jacksoni* — states that in addition to the well-developed genital sucker all the species of the genus *Cotylophoron* possess a posterior sucker with a circular musculature « which is distinct from all other Paramphistomides ». To this posterior sucker he gave the name « *Cotylophoron*-type ». Later, PRICE and MCINTOSH (1953) state that a re-examination of the type-specimens of *C. indicum* has shown that the posterior sucker in this species is not of the « *Cotylophoron*-type » but of

the « *Paramphistomum*-type », and these writers transfer the species to the genus *Paramphistomum*, renaming it *P. thapari*. It is implicit by their action that PRICE and McINTOSH do not regard the presence of a well-developed genital sucker to be generically important, as did STILES and GOLDBERGER, and that the disposition of the circular muscle-fibres in the posterior sucker is the only character by which *Cotylophoron* can be differentiated from *Paramphistomum*. In this instance, there appears to be justification for disregarding the well-developed genital sucker as a generic character, because a similar structure also occurs in *Paramphistomum*, but in this genus its development is very variable.

NÄSMARK has also reviewed the genus *Cotylophoron* and recognised the four species mentioned above. This author places considerable emphasis upon the ratios of certain organs as specific criteria, but the accompanying table (from which *C. indicum* is omitted) will show how unreliable these ratios can be for systematic purposes.

MAPLESTONE (1923) and DOLLFUS (1950) have pointed out that the thickness of the circular musculature of the oesophagus in *C. cotylophoron* is subject to considerable variation, but NÄSMARK and some subsequent writers have persisted in regarding the thickness of this musculature as a specific character. For instance, *C. cotylophoron* is said to possess an oesophageal bulb, which enables this species to be readily separated from other members of the genus. In the present material the musculature of the oesophagus is well developed and normally it gradually increases in thickness posteriorly. In some specimens, however, the thickness of the musculature increases suddenly in the posterior region of the oesophagus, and might give the impression of the existence of an oesophageal bulb. In other specimens the lumen of the oesophagus appears to be much swollen and the muscular walls are correspondingly thin. For this reason the writer is inclined to regard the sudden thickening of the musculature in the hinder region of the oesophagus in *C. cotylophorum* as an artificial condition arising from contraction, but in any case this thickening is not comparable with the oesophageal bulb occurring in *Chiorchis* and some other amphistome genera.

A further point that needs to be discussed is the disposition of the testes. In the majority of the numerous specimens examined by the writer the testes are disposed in tandem, but in very contracted specimens they may be arranged diagonally one behind the other or even symmetrically. NÄSMARK, as well as PRICE and McINTOSH (1953), appear to regard the different arrangements of the testes as specific criteria, but the opinion here held is that the testes in *C. cotylophorum* are normally arranged in tandem, but with the contraction of the body they are gradually moved into a symmetrical arrangement. This observation agrees with the opinions expressed by STUNKARD (1929) and by DOLLFUS (1950).

To sum up, there appears to be little justification for considering that *Cotylophoron fülleborni* NÄSMARK, *C. jacksoni* NÄSMARK, *C. novaboracensis* PRICE and McINTOSH and *C. panamensis* PRICE and McINTOSH are, as at

present defined, distinct from *C. cotylophorum* (FISCHÖEDER). It seems therefore necessary to re-examine the type-specimens of these doubtful forms thoroughly in the light of the considerable amount of morphological variation known to occur in *C. cotylophorum*.

Finally, *C. cotylophorum* has been adequately described by FISCHÖEDER (1903) and by STUNKARD (1929), and the present material permits nothing to be added to these descriptions.

Ratios of certain Organs in the Genus *Cotylophoron*.

Species	<i>Cotylophorum</i>		<i>Fülleborni</i>	<i>Jacksoni</i>	<i>Cotylophorum</i>			
	FISCHÖEDER	NÄSMARK	NÄSMARK	NÄSMARK	Present material			
Posterior sucker (diam) : body-length	1 : 2.5-4	1 : 2.7	1 : 2.9	1 : 4.9	1 : 3-4	1 : 4	1 : 2.5-3	1 : 4.5
Pharynx (length) : body-length	1 : 8-10	1 : 9.5	1 : 7	1 : 9	1 : 7-9	1 : 10	1 : 10	1 : 9
Genital sucker (diam) : pharynx (length) (*)	ca. 1 : 1	1 : 1.27	1 : 1	1 : 1	1 : 1-1.2	1 : 1.2	1 : 1.2-1.5	1 : 1

(*) Several specimens in the present collection show the diameter of the genital sucker to be a little greater than the length of the pharynx.

Subfamily GASTROTHYLACINAE STILES and GOLDBERGER, 1910.

The writer here follows MAPLESTONE's (1923) classification of the *Gastrothylacinae* and accepts *Carmyerius* STILES and GOLDBERGER as a valid genus.

***Carmyerius exporus* MAPLESTONE, 1923.**

Host and locality :

Bubalus caffer. Mabwe, 585 m, 29.XII.1949 (1714 c).

As in other species of the genus *Carmyerius*, the body of the present form is more or less spindle-shaped with a truncated hinder extremity. It varies between 11 mm and 13 mm in length and between 3 mm and 6 mm in maximum width. In cross-section the body is circular or occasionally somewhat triangular. The surface of the body is provided with very small papillae, which are numerous and better developed in the anterior region.

The opening of the ventral pouch occurs at 1,5-2 mm behind the mouth. In many specimens cut transversely through the middle of the body, the ventral pouch appears to form several variations of a hexagon, as shown in MAPLESTONE's (1923) figures 23 and 24 and in some instances the pouch is, in this aspect, to be seen merely as a dorso-ventral slit, but even here slight indications of a six-sided figure are apparent.

The mouth is terminal and opens directly into a well-developed pharynx, which is more or less pyriform, measuring 0,8-1,3 mm long and 0,62-0,87 mm wide. The oesophagus is about as long as the pharynx, and it is invested with numerous well-developed extracapsular gland-cells. The intestinal caeca are simple and run an undulating course posteriorly to near the anterior margins of the testes. The posterior sucker measures 1,7 mm to 2 mm in diameter and its ratio with the body-length is 1 : 5,7-6,2. In the present material the genital pore is always apparent from the exterior and situated usually well in front of the opening of the ventral pouch or occasionally level with the opening. It is surrounded by a raised muscular thickening of the body-wall. This thickening may function as a genital sucker, and, contrary to MAPLESTONE's observation, it seems to be well differentiated from the parenchyma. At the base of the shallow genital atrium lies a small papilla.

The testes are large lobed organs situated on either side of the median line, immediately in front of the posterior sucker. The vasa efferentia extend anteriorly and converge near the middle of the body, where they form the vas deferens. This duct is differentiated into the three portions usually found in amphistomes, the seminal vesicle, the pars musculosa and the pars prostatica. The seminal vesicle and the pars musculosa are convoluted structures, while the pars prostatica is relatively straight, being about as long as the oesophagus, and opening into the genital atrium through the small papilla.

The ovary is a rounded (0,60 mm) or an oval (0,56 × 0,32 mm) organ lying in the median line between the testes. Situated dorsally to it is the smaller, but well-developed, oötype. As described by MAPLESTONE, Laurer's canal runs dorsally from the oötype and opens in the mid-dorsal line, well in front of the excretory pore. The vitellaria are well developed and confined to the ventro-lateral regions of the body. They form a sheet of well-developed follicles, limited to the lateral fields of the body by the intestinal caeca and extending from close behind the genital pore to the anterior margin of the testes. From the ovary the uterus pursues a winding course along the mid-dorsal line and terminates by opening into the genital atrium through the small genital papilla. Numerous eggs dissected from several specimens have been mounted in formalin and found to measure 0,127-0,135 × 0,067-0,075 mm.

The above description agrees well with that given by MAPLESTONE, except in one respect concerning the vitelline follicles. He states that in a few of his specimens the « follicles were found close to the posterior end

of the worm, and surrounding the opening of the posterior sucker ». In the many specimens examined by the present writer this condition was never observed, in fact, the posterior limit of the vitelline follicles appears to be constantly at the anterior margin of the testes.

Carmyerius mancupatus (FISCHOEDER, 1901).

Synonym : *Gastrothylax minutus* FISCHOEDER, 1901.

Hosts and localities :

Hippotragus equinus. [Kafwe, 1.780-1.830 m, 18.IV.1947 (61 c)]; [riv. Kafwe, 1.780-1.830 m, 20.VIII.1947 (329 c)]; riv. Muye, 1.400 m, 28.VIII.1947 (330 c).

Taurotragus oryx. Piste Mubale, 1.480-1.780 m, 21.XI.1947 (331 c).

The body is variable in outline, but mainly either broadly pyriform, or somewhat elongate with a truncate posterior extremity. In cross-section the body is more or less rounded. The adult specimens vary considerably in size, measuring from 5 to 11 mm in length and 2 to 4,5 mm in maximum width. The body is smooth, except in the anterior region, where numerous well-developed papillae are to be seen, particularly round the opening of the ventral pouch. The latter opening occurs at about 1 mm behind the mouth in uncontracted specimens. The ventral pouch, as seen in transverse section, is very variable in outline. In the majority of the specimens examined it is more or less triangular, but in some it is circular or somewhat pentagonal, while other specimens show the intergradations between these three conditions, and in one instance the pouch appeared as a narrow dorso-ventral slit, with a bifurcation at each end. Nevertheless, in nearly all instances it seems possible to trace a five-sided figure.

The mouth is, as usual in *Carmyerius*, terminal and leads directly into a highly-muscular pharynx. The shape of the latter appears to depend entirely upon the amount of contraction or extension of the anterior end of the body, as it varies from elongate oval ($1,2 \times 0,47$ mm) to rounded (0,20 mm). The oesophagus is about as long as the pharynx and invested with gland-cells. The intestinal caeca undulate posteriorly to about the middle of the testes. The posterior sucker measures 1 mm to 2 mm in diameter, and its ratio with the body-length is 1:5,4-6,6. In a few instances the sucker is wide and flattened, and in such cases the ratio of the sucker and body-length is about 1:4.

The genital pore is usually situated well inside the ventral pouch, but may occasionally be seen at the opening of the pouch — the latter condition apparently occurring only in well-extended specimens. The genital pore is surrounded by a muscular thickening of the body-wall forming a pair of lips and corresponding to the « Hervorragung » described by FISCHOEDER (1903) for several species of *Gastrothylax*. The pore opens into a muscular atrium, which appears to be rather small. At the base of the atrium lies

a well-developed genital papilla. The testes are two much-lobed organs situated symmetrically immediately in front of the posterior sucker. They measure 1,6-1,8 mm in length and 1-1,4 mm in width. The male ducts are comparable with those described above for *C. exoporus*.

The ovary is relatively small and oval, measuring about $0,56 \times 0,4$ mm. Mehlis' gland lies dorsally to the ovary. The vitellaria are composed of large follicles extending from about the level of the genital pore to about the middle of the testes. From the ovary, the uterus takes a winding course along the mid-dorsal line to the genital papilla. The eggs measure $0,120-0,137 \times 0,067-0,075$ mm.

C. mancupatus and *C. spatiosus* (BRANDES, 1898) are regarded as synonyms by MAPLESTONE (1923), but FISCHOEDER (1903) originally separated these two primarily on the shape of the ventral pouch, as seen in cross section. In *C. spatiosus* the pouch is said to be circular, while in *C. mancupatus* it is triangular. In the material described above both conditions, with all the intermediate gradations, have been observed. Thus the shape of the ventral pouch appears to be of no value as a means for distinguishing these two species. Nevertheless, from existing descriptions *C. spatiosus* appears to be distinguishable by the remarkable capaciousness of the ventral pouch and the consequent thinness of its walls. Moreover, according to BRANDES (1898) and to FISCHOEDER (1903), the intestinal caeca are relatively slender and extend posteriorly only to about the junction of the middle and hinder thirds of the total length of the body. Another feature worthy of note is the relative smallness of the testes, which are entire or slightly lobed, but this may be due merely to age. At the moment there seems to be no conclusive evidence that *C. spatiosus* and *S. mancupatus* are synonymous.

The latter form is also very closely related to *Carmyerius synethes*, and DAWES (1936) considers them to be identical. There is, however, one point of difference between them which should not be passed over without serious consideration. In *C. synethes* the genital ducts open into a very spacious atrium while in *C. mancupatus* the genital atrium is relatively very small. The question of whether or not the spacious atrium in *C. synethes* is really no more than an artifact can apparently only be satisfactorily answered by the examination of further material from the Indian buffalo.

Finally, FISCHOEDER separated *C. minutus* from *C. mancupatus* principally on alleged differences in the shape of the ventral pouch. In *C. minutus* the pouch is said to be also triangular in cross section, but the dorsally situated basal angles of the triangle are bifurcated. In the present material, which has been preserved in formalin, it has been noticed that when the body shows indications of shrinkage, the ventral pouch is almost invariably collapsed, and the angles tend to indicate bifurcations. Otherwise, the writer can find no justifiable evidence in FISCHOEDER's descriptions to warrant the recognition of *C. minutus* as a valid species, and for this reason *C. minutus* is here regarded as a synonym of *C. mancupatus*.

Subfamily GASTRODISCINAE MONTICELLI, 1892.

Gastrodiscus aegyptiacus COBBOLD, 1876.

Host and locality :

Phacochoerus aethiopicus. Mabwe, 585 m, VIII-IX.1947 (209 c, 230 c, 233 c, 239 c).

Several specimens from each of the four lots available have been cleared in beechwood creosote and found, with one exception, to be immature in so far as eggs are not present and the vitelline follicles appear to be undeveloped. The size of the body varies between 8×4 mm and 15×10 mm. The mature specimen, in which eggs are numerous, measures about 11 mm in length and 7 mm in maximum width. It agrees well with the descriptions given by LOOSS (1896) and by STUNKARD (1929). There is however, a noticeable difference in the size of the eggs, which in the present specimen measure $0,136-0,16 \times 0,075-0,09$ mm, as against $0,17-0,19 \times 0,11$ mm given by LOOSS. The size of the eggs is undoubtedly exceedingly variable, for eggs seen by the writer in a specimen of *G. aegyptiacus* from *Equus caballus* in Cairo measure $0,135-0,175 \times 0,09-0,10$ mm.

COBBOLD originally described this form from a horse in Egypt, and since that time *G. aegyptiacus* has become known as a very widely-distributed helminth of African equines. It has also been recorded from wart-hogs in the Valley of the Niger (DOLLFUS, 1932), Dohamey (JOYEUX, GENDRE and BAER, 1928) and N.E. Rhodesia (MAPLESTONE, 1923). Moreover, STUNKARD (1929) records the species from « *Phacochoerus africanus* » at Faradje in the Congo Basin, where the parasite was also found in *Diceros simus cottoni*. In view of the immaturity of the vast majority of the several hundreds of specimens in the present collection, it is worthy of a note that all the specimens, about five hundred of them, recorded by STUNKARD from the wart-hog were also immature.

LEIPER (1913) erected the name *Gastrodiscus minor* for specimens from pigs in Uganda and Nigeria, but gave no recognizable description. Possibly MAPLESTONE (1923) is justified in regarding *G. minor* as a synonym of *G. aegyptiacus*.

Looss (1896) records the cercaria of *G. aegyptiacus* from the operculate snails *Cleopatra bulimoides* and *C. cyclostomoides* in Egypt, while FAUST (1926) has provisionally referred to this species cercariae found in *Planorbis* sp. in South Africa.

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