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Systematic Studies on Limnic *Macrostomum* Species (Turbellaria, Macrostomida) from East Africa

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Abstract

Young, J. O. (Department of Zoology, University of Liverpool, Liverpool L69 3BX, U.K.). *Systematic studies on limnic* Macrostomum *species (Turbellaria, Macrostomida) from East Africa.* Zool. Scr. 5 (2): 49–60, 1976. — Descriptions of nine new species of *Macrostomum* from Kenya, Tanzania and Uganda are given: *M. coxi* sp.n. from Lake Naivasha, two dams and one pond in Kenya; *M. baringoense* sp.n. from Lake Baringo; *M. reynoldsoni* sp.n. from the River Mwena and a canal near Mombasa; *M. nairobiense* sp.n. from a dam at Nairobi; *M. christinae* sp.n. from the River Kitenkela/Athi, Kenya and Lake Amani, Tanzania; *M. thingithuense* sp.n. from the River Thingithu, Mt. Kenya; *M. amaniense* sp.n. from Lake Amani, Tanzania; *M. georgeense* sp.n. from Lake George, Uganda; and *M. sinyaense* sp.n. from six streams/rivers, two dams and five pools in Kenya. Their similarities to known species are discussed.

Recorded for the first time from E. Africa are *M. orthostylum* (M. Braun, 1885) from two rivers near Mombasa, *M. rostratum* (Papi, 1951) from a dam near Nairobi, and *M. tuba* (Graff, 1882) from four rivers, four dams and two ponds in Kenya and, tentatively, Lake Edward.

1. Introduction

Hitherto, only two freshwater species of the genus *Macrostomum* have been recorded from East and Central Africa. Beauchamp (1935) described *Macrostomum viride* E. Beneden, 1870 var. *elgonense* from Mt. Elgon, which lies partly in Uganda and partly in Kenya; collection dates and localities are given in his paper. Ferguson (1939*a*, p. 18; 1939*b*, p. 55) believes that the animal should have been ranked a new species and accordingly re-names it *M. beauchampi.* Marcus (1955) is of the opinion that Ferguson (1939*a*; 1939*b*) should have used the existing name and that the animal should have been called *M. elgonense.*

The second record is of *Macrostomum tuba* (Graff, 1882) var. *verbekei* collected from Lake Kivu at Goma in Zaire and described by Marcus & du Bois-Reymond Marcus (1957). It is very doubtful if this animal is in fact *M. tuba.*

Beadle (1932–34*a*) lists *Microstomum* from the east shore, opposite Crescent Island, of Lake Naivasha, Kenya. It is possible that the genus *Macrostomum* was intended. There are no records of the genus *Macrostomum* from South or West Africa. Recently, Beltagi (1972) reported four new species, viz. *M. niloticum, M. aegyptium, M. dorsiforum* and *M. cairoense* from vegetation in a pond in Egypt.

This paper reports the species of *Macrostomum* found during a survey of the freshwater microturbellarians in E. Africa, mainly Kenya but also a few localities in Tanzania and Uganda, over the period October 1971 to September 1972.

2. Methods

Microturbellarians were collected by means of a standard F.B.A. zooplankton net of 60 meshes/in. (23.6 meshes/cm) which was used to scoop up substratum and sweep through vegetation. Samples were placed in water in 3-litre glass vessels and left to stagnate; turbellarians were removed from the jars at intervals. Anatomical features were studied in both living and preserved animals. Animals were killed in Steinmann's fluid, fixed in Bouin, 70% alcohol or 10% neutral buffered formalin, and blocked in paraffin wax. Sections (6–8 μm) were stained by Ehrlich's haematoxylin and eosin or the Mallory trichrome method.

3. New species of *Macrostomum*

Descriptions of the new species are based mostly on living animals. Sectioned, stained material of each of the species has been deposited as type material in the British Museum (Nat. Hist.), London. At the beginning of the description for each species, the type locality and Registration Number(s) of the type material housed in the B.M. are given. Except for the paratypes listed below there are paratypic specimens in the author's private collection. Information is obtainable from the author on habitats, including details of water chemistry, and number and size of specimens obtained at each site.

Macrostomum coxi sp.n.

The specific name is a tribute to Noel Cox, St. Mary's School, Nairobi, for his assistance in the collection of turbellarian material from E. Africa, and for his research work on the invertebrate fauna of Lake Naivasha.

Locations and material. Four localities in Kenya. (1) Lake Naivasha; a full description is given in Jenkin (1932; 1936), Beadle (1932–34*b*), and Talling & Talling (1965). 17.12.71, 20.1.72, 30.3.72, 30.4.72, 24.6.72, 31.7.71—361 specimens: from mid-December to the end of July, a range of body lengths (0.5–2.4 mm) was present; it seems likely that recruitment takes place throughout this period. Animals of 1.0 mm and less in body length are usually immature, i.e. without a penis stylet. Many specimens had oligochaete setae in their gut. (2) Wellcome Dam at Kabete, Nairobi: details of this habitat are given in Young & Gibson (in press). 24.3.72—1 specimen. (3) Pond about 88 km from Nakuru, on Nakuru to Eldoret road. 22.4.72—2 specimens. (4) Dam at Limuru, north-west of Nairobi. 14.5.72—1 specimen.

Type locality. Lake Naivasha, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.9. (Paratype—Reg. No. 1975.7.31.10.)

Description. Length of body up to 2.4 mm; anterior and posterior ends rounded. Body almost parallel-sided, though with a distinct waist in region of vesicula granulorum and vesicula seminalis and tapering towards extremities; body width 1/5th to 1/6th body length (Fig. 1*A*). Body fairly transparent in transmitted light and whitish in reflected light.

In specimens of 2.2 mm in length, the epidermis varies in height from 9 to 12 μm but usually 10 μm; a basal membrane

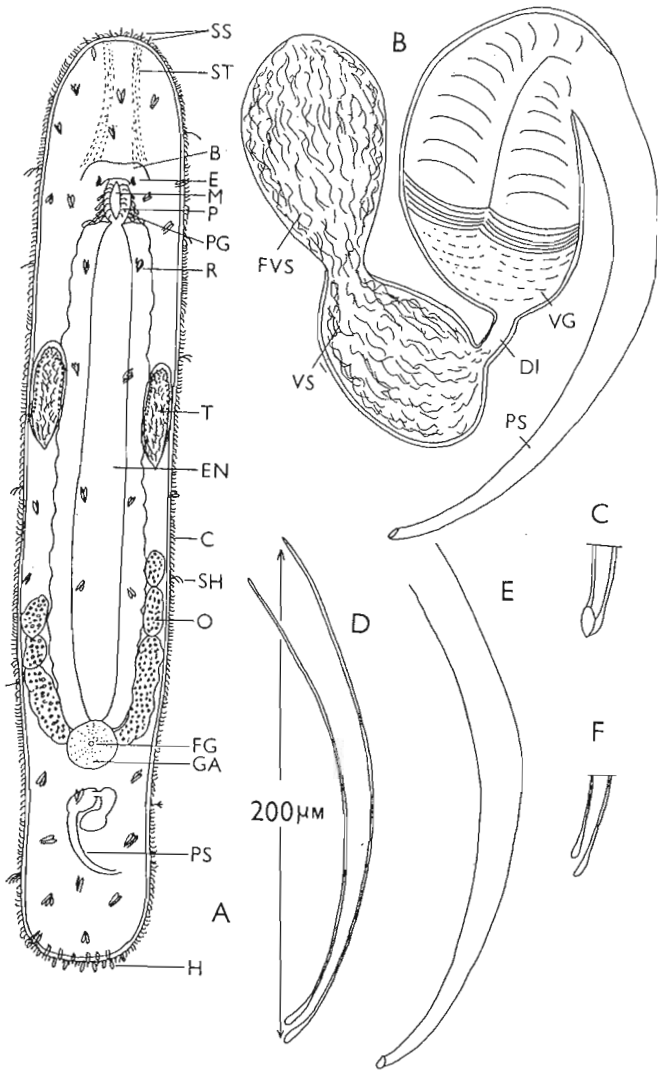

Fig. 1. Macrostomum coxi sp.n. *A*, general view of structure of body (ventral aspect). — *B*, diagram of part of the male reproductive system from a squash preparation of a specimen 2.2 mm in length. — *C*, distal tip of penis stylet shown in (B). — *D*, *E*, camera lucida drawings of stylet in two other squash preparations of specimens 2.2 mm in length. — *F*, distal end of stylet shown in (E). (B), (D), and (E) drawn in same scale.

was not observed (see Bedini & Papi, 1974). Cilia, about 6 to 8 μm in length, cover body. Sensory hairs, 16 to 20 μm in length, occur singly or in groups of up to 4 hairs; they are sparsely distributed. A very few semi-rigid hairs occur on the anterior body margin; their length ranges from 8 to 13 μm. Rhabdites, 13 to 19 μm in length, are scattered in groups of up to 8, though mostly 2 to 6, over the entire body surface; they are least numerous in the middle regions. "Stäbchenstrassen" are present but not strongly developed. "Haftpapillen" occur up to a length of 10 μm.

Sub-epithelial outer circular and inner longitudinal muscle fibres are evident. Scattered in the parenchymatous tissue are dorso-ventral muscle fibres extending from the dorsal to the ventral sub-epithelial muscle layers. The parenchyma is vacuolarised and embedded between the parenchymatous cells are mucous, rhabdite and adhesive (tail region) gland cells.

Gland cells are present in the region of the simple pharynx. The sac-shaped gut has undulant borders, and its posterior end is usually placed dorsal to the female genital atrium. The epithelial layer of the enteron consists of large ciliated cylindrical cells plus a few spindle-shaped cells; outer longitudinal and inner circular fibres are present.

The brain appears to be typical for the genus. The eyes are embedded in the cerebral ganglia in a dorso-posterior position. They are slightly curved and vary in size; in 20 specimens of length 2.1 to 2.2 mm length ranged from 16 to 22 μm and breadth from 10 to 17 μm. The distance between the eyes is less than between each eye and its nearest body margin.

In living animals the lateral excretory system comprised two main coiled stems with branching ducts. Cross stems and external openings were not located.

The component parts of the female and male reproductive systems are typical of the genus. The size of the distinctly indented ovaries, which lie in a latero-dorsal position, varies according to the animal's state of maturity, as does the size of the genital atrium (Fig. 1 *A*). The lining epithelium of the genital atrium comprises cells up to 10 μm in height, with cilia of about 8 μm in length. In the medio-anterior wall of the atrium is situated a "Verschlussapparat"; sometimes sperm were observed attached to this. A short, ciliated vagina, which is surrounded by glandular cells, extends ventrally to the gonopore.

The testes, which seemingly have a smooth surface, are situated antero-latero-ventrally. They are positioned just anterior to the midway point along the length of the enteron. A vas deferens extends from each testes tail-wards and joins its counterpart in the mid-line of the body in the region of the posterior end of the enteron. A false vesicula seminalis is present; it is usually oval-shaped though this varies according to state of sexual maturity (Fig. 1 *B*). The oval-shaped vesicular seminalis is separated from the false vesicula seminalis by a slight, though distinct, constriction. An elongated ductus intervesicularis, surrounded by muscle fibres, connects the vesicular seminalis with an oval vesicula granulorum which is usually the longest of the three vesicles and has walls with characteristic musculature. Spiral muscles sheath the vesicula seminalis and the vesicula granulorum. Accessory gland cells, which are present around the vesicula granulorum, enter this vesicle in the vicinity of the ductus intervesicularis. The penis stylet is elongated and curved (bow-shaped) in one plane (Figs. 1 *B* to *F*). It decreases in diameter towards the distal tip. In 50 specimens of 2.0 mm and over the stylet length ranged from 134 μm to 220 μm with an average-size of 200 μm. The diameter of the proximal and distal openings averaged, in three slightly squashed preparations, 17 μm and 4 μm respectively. The distal opening is terminal and oblique, facing the concave side of the bow. The walls surrounding the distal opening appear to be very slightly thickened (Fig. 1 *F*).

Discussion. The stylet of *Macrostomum coxi* sp.n. is similar to that of *M. curvituba* Luther, 1947 (see, for example, Luther, 1947, Figs. 39 and 40, p. 26, and Luther, 1960, Fig. 19 C, p. 80), which is a typical brackish water species found in the Baltic Sea and the North Sea (see Luther, 1947, 1960; Ax, 1951, 1954, 1956, 1957; and Westblad, 1953). The body and the penis stylet of the new species are much larger.

Macrostomum baringoense sp.n.

The specific name reflects the type locality.

Location and material. Lake Baringo, Kenya; the lake is fully described in Jenkin (1932, 1936), Beadle (1932–34*b*), and Talling & Talling (1965). Sampling site in littoral on west side of lake near Kampi ya Samaki which is on Marigat to Loruk road. 16.12.71—10 specimens.

Type locality. Lake Baringo, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.11.

Description. Length of body up to 1.1 mm. Body tapering very gradually towards posterior end which is distinctly spatulate (Fig. 2*A*). Front end slightly more rounded than posterior extremity. Body is without colouration though enteron appears very pale yellow.

The epithelial layer varies from 4 to 6 μm in height; cilia cover the body surface and are 4 to 5 μm in length. Very few sensory hairs are seen; they occur singly or in pairs up to a length of 20 μm. Anterior semi-rigid hairs or spines occur up to a length of 9 μm. Sausage-shaped rhabdites, reaching a length of 11 μm, occur singly or in groups up to 14 but most commonly 4 to 8; they are sparsely distributed more so at the sides and tail region than in other parts. Distinct "Stäbchenstrassen" present. "Haftpapillen" occur up to a length of 8 μm.

Outer circular and inner longitudinal muscle fibres are present in the body wall; also, a few dorso-ventral muscle fibres were seen, particularly in the posterior end of the body. Between enteron and body-wall parenchymatous cells and vacuolated spaces are seen. Rhabdite and mucous gland cells are embedded in the parenchyma, and in the ventral side of the posterior body extremity adhesive gland cells. The pharynx, a thin-walled tube with ciliated epithelium, has surrounding gland cells, particularly where it enters the sac-shaped intestine which has an undulating outline, a high ciliated epithelium and is surrounded by outer longitudinal and inner circular fibres; a very few fibres are seen to span the space between the walls of the enteron and the sub-epithelial layers of the body-wall. The posterior end of the enteron and the genital atrium overlap slightly.

The brain is typical of the genus and the eyes are small with an irregular shape with dimensions of 8 to 12 μm in the largest specimens. The eyes are closer together than each is to its nearest body margin. The excretory system consists of two main coiled stems with branching ducts; the external openings and cross stems were not observed.

The reproductive systems are as usual for the genus. The ovaries, which have a granular appearance extend half-way along the enteron; they are only slightly lobulate (Fig. 2*A*). The oviducts join each other in the region of the genital atrium; the atrium is lined with ciliated, cubical cells about 5 μm in height (Fig. 2*F*). Where the common oviduct enters the atrium is found a well-developed "Verschlussapparat"; in two species spermatozoa were observed attached to these so-called "passage cells". A short, ciliated vagina extends ventrally from the atrium and is surrounded apparently by two types of glandular cells.

The testes are fairly elongated (maximum length of about 200 μm recorded in living specimens) and are located at the front end of the enteron just behind its front margin; they have a smooth outline (Fig. 2*A*). The vasa deferentia unite behind the posterior end of the enteron. A false vesicula seminalis was not observed. The vesicula seminalis and vesicula granulorum are small and spherical, and are connected by a short distinct ductus intervesicularis (Fig. 2*E*). In one living specimen of length 1.0 mm the vesicula granulorum had a diameter of 60 μm and the vesicula seminalis 40 μm. Accessory gland cells occur round the vesicula granulorum but are not too distinct; they appear to enter close to the ductus intervesicularis. The penis stylet (Figs. 2*B–D*) has its distal end bent at more-or-less a right angle to the main tube. This tip constitutes the thickened wall of the tube. The distal opening is situated at the heel of the stylet. The largest stylet measured 85 μm in length in a large specimen but all the others (9 stylets) were within the limits 73 to 78 μm. The proximal opening varied from 11 μm in unsquashed specimens to 17 μm in heavily squashed specimens. The distal opening varied from 5 to 9 μm. The bent distal tip measured 7 to 10 μm.

Discussion. The stylet of *Macrostomum baringoense* sp.n. resembles that of *M. balticum* Luther, 1947 (see Luther, 1947, Figs. 14, 15, 16, p. 14, and Luther, 1960, Figs. 19 M, N, O, p. 80) which has been found in Finland in the Baltic Sea and the North Sea (see Luther, 1947, 1960; Ax, 1951). In Italy a subspecies *meridionalis* was described by Papi (1953). In the

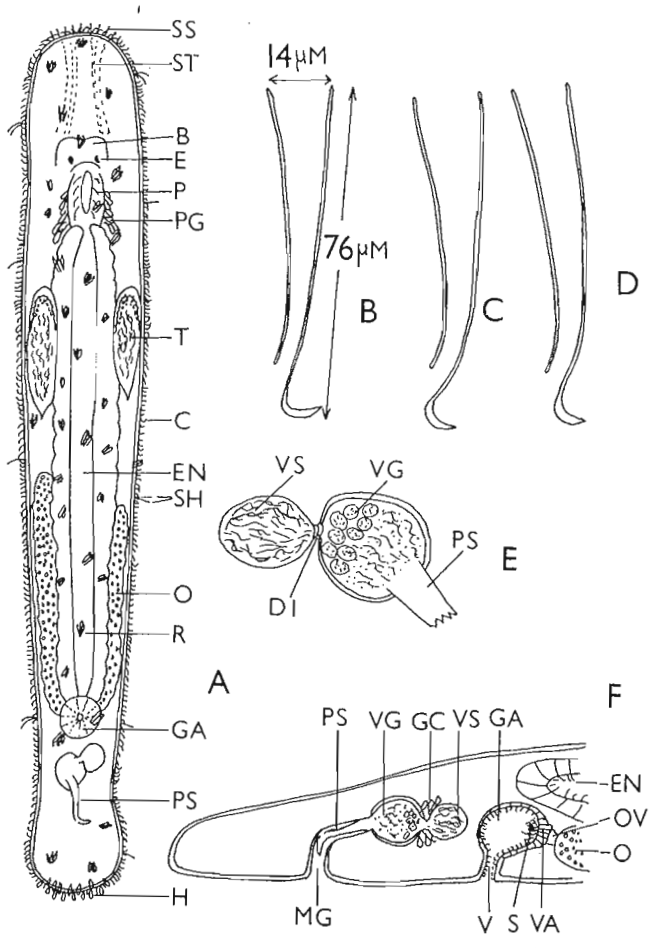

Fig. 2. Macrostomum baringoense sp.n. *A*, general body structure (ventral view). — *B*, *C*, *D*, penis stylets from three different, slightly-squashed specimens. —*E*, proximal end of stylet illustrated in (D). — *F*, male and female reproductive organs reconstructed from saggittal sections.

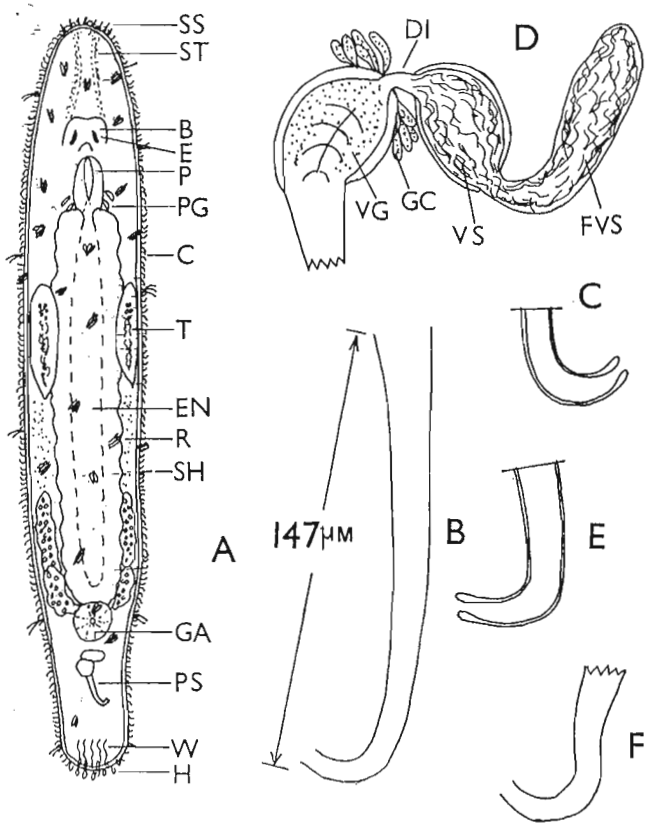

Fig. 3. Macrostomum reynoldsoni sp.n. *A*, ventral view of anatomical features. — *B*, drawing of typical penis stylet (camera lucida). — *C*, tip of same showing very slightly thickened walls round distal opening. — *D*, part of male reproductive system, including base of stylet. — *E*, *F*, the distal part of two slightly aberrant stylets.

penis stylet of *M. balticum* the distal opening is more terminal and not on the heel of the stylet as in the new species.

Perhaps also near this species is *Macrostomum sensitivum* (Silliman, 1884) recorded from N. America, Italy, Roumania and Poland (see Silliman, 1884; Papi, 1951, 1967; Mack-Fira, 1968; Kolasa, 1973). Adequate illustrations of the penis stylet of this species are given, for example, in Papi (1951, Figs. 40–42) and Kolasa (1973, Figs. 7 C, E and F).

Macrostomum reynoldsoni sp.n.

The specific name is a gesture to Prof. T. B. Reynoldson, U.C.N.W., Bangor for his scholarly work on the ecology of freshwater Turbellaria, and for introducing the author to the group.

Locations and material. Two sites in Kenya. (1) River Mwena, south of Mombasa on Lungalunga Road. 17.2.72—5 specimens. (2) Canal, south of Mombasa at the side of Lungalunga Road. A few kilometres nearer to Mombasa than River Mwena. 17.2.72—4 specimens.

Type locality. River Mwena, south of Mombasa, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.12. (Paratype—Reg. No. 1975.7.31.13.)

Description. Length of body up to 1.5 mm. Sides of body almost parallel and tapering towards extremities; distinct narrowing of body at level of genital atrium. Tail end of body with seemingly characteristic faint longitudinal folds or creases (see Fig. 3 *A*). Body is almost colourless but is whitish in reflected light. Maximum epidermal height 10 μm, with cilia up to 9 μm occurring over the body-surface. Semi-rigid hairs or spines at front end of body up to 11 μm. Sensory hairs attain a length of up to 18 μm, and are scattered over the surface; at any one location, from 1 to 4 hairs occur with 2 being the most frequently observed number. Rhabdites, up to 16 μm in length and in pockets of 1 to 12 though most commonly 4 to 7, are less abundant in the tail region of the animal. "Stäbchenstrassen" are present. "Haftpapillen" are present; up to a length of 14 μm.

The eyes are very close together measuring 21 × 10 μm. The lateral borders of the enteron are distinctly undulated. The posterior end of the enteron and the genital atrium do not overlap.

The female and male reproductive systems are typical of the genus. The ovaries are short and indented, extending anteriorly about a quarter of the way along the length of the enteron from its posterior end (Fig. 3 *A*). A distinct "Verschluss-apparat" is present in the genital atrium. The vagina is of medium length and is surrounded by glandular cells.

The elongated testes appear to have a smooth surface, and are situated just in front of the mid-way mark along the length of the enteron (Fig. 3 *A*). Between the elongated false vesicula seminalis and oval vesicula seminalis (Fig. 3 *D*) there is a constriction, and between the latter and the oval vesicula granulorum there is a distinct ductus intervesicularis. The penis stylet is typically in the form of a blunt hook (Figs. 3 *B*, *C*, *E* and *F*). The walls of the tube around the distal terminal opening are very slightly thicker than the walls in the remaining part of the stylet. The length of the stylet from the proximal opening to the base or lowest margin of the hook varied from 142 to 150 μm; the proximal opening is approximately 19 μm and the distal opening 5.5 μm. In one specimen the distal tip was not so hooked as in the typical form (Fig. 3 *E*), and in another specimen the part of the tube immediately before the hooked more distal part, was slightly curved in a direction opposite to that of the hook (Fig. 3 *F*).

Discussion. Superficially, the penis stylet of the new species resembles that found in *Macrostomum mystrophorum* Meixner, 1926 (see Meixner, 1926, Fig. 7, p. 602, and Papi, 1953, Figs. 14–17, p. 11), which has been recorded from the Alps (freshwater) and Italy (brackish-water) (Meixner, loc. cit. and Papi, loc. cit.), and *M. japonicum* Okugawa, 1930 (see Okugawa, 1930, Figs. 10–13, p. 79), which has been described from Japan. However, in both species, the curve of the distal end of the stylet is rounder and greater.

Macrostomum nairobiense sp.n.

The species is named after the city which harbours the type locality.

Location and material. Wellcome Dam, Nairobi. 24.3.72—3 specimens.

Type locality. Wellcome Dam, Nairobi, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.14.

Description. The description of this new species is rather meagre since so few specimens were collected; however, the distinctive shape of the stylet warrants the erection of a new species.

Length of body up to 1.0 mm, with both extremities rounded. Sides of body somewhat parallel though there is a distinct waist in the region of the genital atrium (Fig. 4 *A*). The body is without colouration but in reflected light appears whitish.

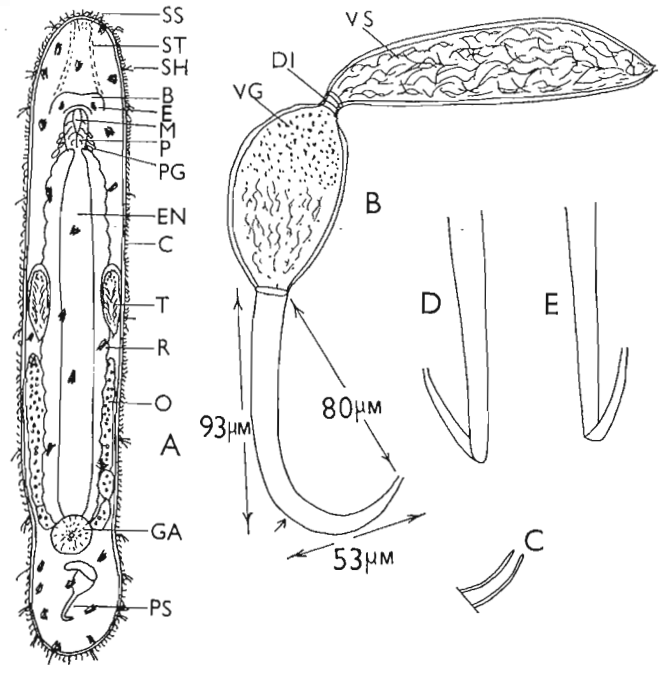

Fig. 4. Macrostomum nairobiense sp.n. *A*, ventral aspect of general body structure. — *B*, diagram of male reproductives. — *C*, distal tip of stylet shown in (B). — *D*, *E*, dorsal and ventral views of penis stylet shown in (B) (free-hand).

The epidermal height varied up to 9 μm with cilia up to 8 μm. Semi-stiff sensory spines or hairs occur at the anterior end of the body, and reach a length of up to 10 μm. Sensory hairs, up to 19 μm in length, are scattered over the body surface but are particularly numerous at the front and hind end of the body; they occur singly or in tufts of up to 5 hairs, 2 to 3 hairs being the usual complement. Rhabdites are scattered over the body-surface but are particularly plentiful in the tail region; they often attain a length of 16 μm and occur singly or in groups of 2 to 12, but most commonly 5 to 8. "Stäbchenstrassen" are present but weakly developed. "Haftpapillen" were not seen. The eyes are as distant from each other as each is from its nearest body margin. The outer margin of the enteron is slightly wavy in appearance. The genital atrium and the posterior end of the enteron overlap slightly.

The male and female component parts of the reproductive system are typical of the genus. The ovaries were slightly indented and extended almost half-way along the length of the enteron (Fig. 4*A*). In the genital atrium a "Verschlussapparat" was observed but did not appear to be well developed. Cement glands appear around the female gonopore. The vagina is short.

The posterior end of the testes are placed about mid-way along the length of the enteron; they are oval-shaped, and, apparently, have a smooth outline. An elongated vesicula seminalis leads, via a very short ductus intervesicularis, into an oval vesicula granulorum (Fig. 4*B*). A false vesicula seminalis was not apparent. The penis stylet is hook-shaped (Figs. 4*B–E*); it is slightly bent in another plane at a point indicated by the arrow in Fig. 4*B*. Its walls are not thickened at any particular point. Its distal opening is terminal. The length of the largest stylet, from the proximal opening to the base of the hook or curve was 93 μm; other dimensions are shown in Fig. 4*B*.

Discussion. Though the hook-shaped penial stylet of the new species does not resemble closely the stylet of any established species of *Macrostomum*, it is closest to that of *M. purpureum* described from the headwaters of Eptá Pighés, the Island of Rhodes by Reisinger & Kelbetz (1964, Fig. 2, p. 478).

Macrostomum christinae sp.n.

The specific name is an expression of gratitude to the author's mother, who, together with his late father, first stimulated his interest in natural history.

Locations and material. (1) Kitenkela/Athi River, where Nairobi–Hunters Lodge Road crosses river (Kenya); pool approximately 55 m wide, very deep, muddy bottom, and with much vegetation including *Typha*, *Polygonum* and water-lilies. 30.3.72—4 specimens: body lengths of 0.7, 0.8, 0.8 and 0.9 mm; all with penis stylet. (2) Lake Amani, at Amani in Usumbara Mts. in Tanzania; this is a large pond, choked with vegetation. 19.3.72—2 specimens: 0.8 mm; both with stylet.

Type locality. Kitenkela/Athi River, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.15.

Description. The description is rather limited because so few animals were obtained. Body-length up to 0.9 mm with rounded anterior and posterior ends. Body widest mid-way along length of animal; constriction towards posterior extremity (Fig. 5*A*). Body colourless though whitish in reflected light.

Epithelial cells up to 9 μm in height. Cilia, up to 7μm in length, cover body surface. Front margin of body with semi-stiff hairs or spines up to 11 μm. Sensory hairs occur sparsely over the body surface, singly or in groups of up to 6 hairs;

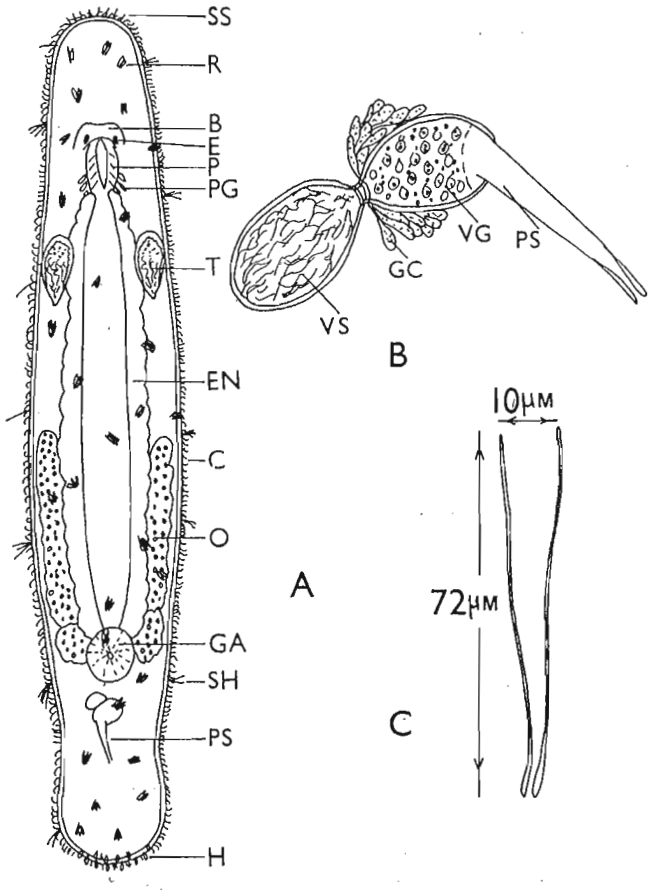

Fig. 5. Macrostomum christinae sp.n. *A*, details of anatomical features. — *B*, male reproductives (diagrammatic). — *C*, camera lucida drawing of slightly squashed specimen.

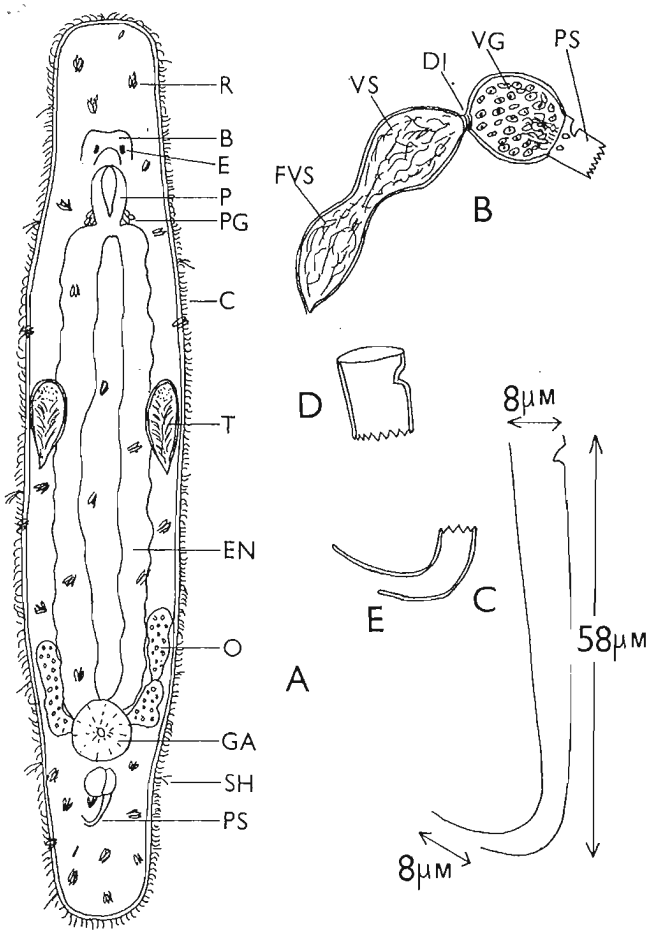

Fig. 6. Macrostomum thingithuense sp.n. *A*, diagram of ventral aspect of body to show anatomical features. — *B*, part of male reproductive system. — *C*, camera lucida drawing of penis stylet of slightly squashed specimen. — *D*, *E*, proximal and distal parts of same stylet.

they vary in length up to a maximum of 18 µm. Rhabdites, most frequently in pockets of 2 to 5 though range of 1 to 8 rhabdites were observed, are scattered sparingly over the body surface with no apparent concentration in any area; lengths of up to 13 µm were recorded. "Haftpapillen" were present reaching a length of up to 7 µm. "Stäbchenstrassen" were not observed. Eye dimensions averaged 8 µm × 11 µm; they are situated nearer to each other than each is to its nearest body margin. The posterior end of the enteron, which had a slightly wavy outline, overlapped the genital atrium.

The reproductive organs are as usual for the genus. The slightly indented ovaries almost reach mid-way along the enteron (Fig. 5*A*). A "Verschlussapparat" is present in the genital atrium but is not very conspicuous. The vagina is short. The oval-shaped, small, inconspicuous testes are placed near the front end of the enteron. A false vesicula seminalis was not seen. An oval-shaped vesicula seminalis leads into an oval-shaped vesicula granulorum, via a very short ductus intervesicularis (Fig. 5*B*). Accessory gland cells appear to surround the vesicula granulorum near the ductus intervesicularis; the vesicula granulorum contained granular secretions. The penis stylet is a more-or-less straight tube which diminishes in diameter towards its distal tip; in fact the latter is slightly bent as shown in Figs. 5*B* and *C*. The walls of the tube around the distal terminal opening are slightly thickened. The stylet attained a length of 78 µm in one specimen but averaged 72 µm. The proximal opening averaged 10 µm in diameter and the distal opening 3 µm in very slightly squashed specimens.

Discussion. The penis stylet of the new species is very similar to that of *M. poznaniense* Kolasa, 1973 (see Figs. 1B–D, p. 182) from Poland; however, the stylet in the latter species is small and slightly spiralled. The stylet of *M. christinae* sp.n. has similarities to the stylet of *M. quiritium* Beklemischev, 1951 (see Fig. 43, p. 36) recorded in freshwater from Italy (Papi, 1967), and in Poznan Palm House, Poland (Kolasa, 1973). However, in *M. quiritium* the wall of the tube is not thickened all the way around the terminal opening. Lastly, the stylet of the new species resembles that of *M. tenuicauda* Luther, 1947 (see Figs. 33–36, p. 23) (also see Luther, 1960, Figs. 19 D, E and L, p. 80), which has been recorded from Finland in the Gulf of Finland. In the new species, however, the distal opening of the stylet is not oblique as in *M. tenuicauda*; also, in the present new species all of the surrounding wall of the distal opening is slightly thickened.

Macrostomum thingithuense sp.n.

The specific name is derived from the type locality.

Location and material. River Thingithu, 3 miles north of Nkuba, at an altitude of approximately 1 640 m on Mt. Kenya. 27.1.72—4 specimens.

Type locality. River Thingithu, near Nkuba, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.16.

Description. The description is rather terse because of the limited material. Body more-or-less parallel-sided and tapering to rounded posterior end and more flattened anterior extremity; distinct body constriction posterior to genital atrium (Fig. 6*A*). Body without colour though whitish in reflected light. Epithelial height varies from 7 to 10 µm; cilia range from 6 to 8 µm in length. Sensory hairs, occurring singly or in groups of 2 to 4, distributed sparsely and attaining a length of 16 µm. Rhabdites in pockets of up to 8 and reaching a length of 13 µm scattered sparingly over body surface, with a greater concentration in the tail region. "Haftpapillen" and "Stäbchenstrassen" were not observed. Eyes nearer to each other than to sides of body; almost round in appearance with average measurements of 8 × 9 µm. Margins of enteron weakly undulating. Posterior end of enteron slightly overlaps with the genital atrium.

Female and male reproductives are typical for the genus. Ovaries short and deeply indented (Fig. 6*A*). Genital atrium with "Verschlussapparat". Vagina short. Testes were observed in one specimen only; they were small and transparent being inserted about mid-way along the length of the enteron but more in the anterior than the posterior half. A very slight constriction would appear to separate off a false seminal vesicle from the oval vesicula seminalis per se (Fig. 6*B*). A distinct ductus intervesicularis separates the latter from the rounded vesicula granulorum. The distal end of the penis stylet is bent so that the angle between this and the main axis is slightly less than a right-angle (Fig. 6*C*). The distal opening is oblique (Figs. 6*C* and *E*). The walls of the tube are of even thickness. A distinctive notch is present in one of the walls near the proximal opening (see Fig. 6*D*). The stylet measure-

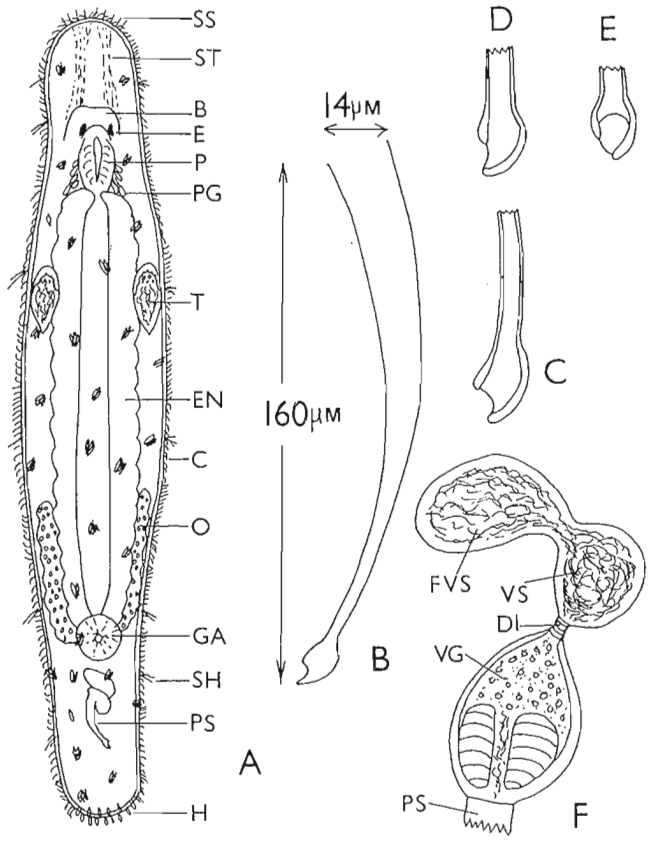

Fig. 7. Macrostomum amaniense sp.n. *A*, diagram of ventral view of body. — *B*, camera lucida drawing of penis stylet of slightly squashed specimen. — *C*, *D*, *E*, distal tip of stylets from three different specimens. — *F*, drawing of part of male reproductive system, including proximal end of stylet.

ments are as follows: average length 58 μm, with extremes of 55 to 59 μm observed; proximal and distal openings both 8 μm (Fig. 6*C*).

Discussion. The penial tube of the new species resembles that of *M. hamatum* Luther, 1947 (see Figs. 19 and 20, p. 17) (also, see Luther, 1960, Figs. 19 F, H, I and K, p. 80), which is a brackish water species recorded from Finland, Sweden and Poland (Luther, loc. cit.; Ax, 1951, 1954, 1956). However, in *M. hamatum* the stylet is much longer and the angle between the distal tip of the stylet and the main axis is more acute.

Macrostomum amaniense sp.n.

The specific name reflects the type locality.

Location and material. Lake Amani, at Amani in the Usumbara Mts. in Tanzania; this is a large pond choked with vegetation. 19.3.72—4 specimens: body lengths of 0.9, 1.2, 1.2 and 1.3 mm; the 3 longest specimens had a penis stylet.

Type locality. Lake Amani, Amani, Tanzania.

Type material. Holotype—Reg. No. 1975.7.31.17.

Description. Due to the limited material, the description of the new species is meagre. Length of body up to 1.3 mm. Body bulges slightly at the sides (Fig. 7*A*); extremities rounded. Without much body colouration though whitish/pale yellowish in reflected light. Epidermal cells have a maximum height of 10 μm; cilia up to 10 μm cover the body surface. Semi-rigid hairs or spines on the anterior body margin reach a maximum size of 13 μm. Sensory hairs, single or in groups of up to 4, reach a maximum length of 20 μm; they are distributed sparsely over the body surface. Rhabdites are plentiful with no particular concentration; they occur singly or in groups of up to 9 but most commonly 3 to 5; they reach a maximum length of 16 μm. "Stäbchenstrassen" are present. "Haftpapillen" occur, and reach a size of 14 μm. The eyes are closer together than each is to its nearest body margin; average measurements of 13 × 25 μm were recorded. The enteron margin is distinctly indented. The posterior end of the gut and the genital atrium overlap to some extent.

The female and male reproductives are as usual for the genus. The ovaries are slightly indented and short (Fig. 7*A*). A "Verschlussapparat" is present in the genital atrium. The vagina is medium-sized. Cement glands round the vagina were noted. The testes are small with a smooth outline, and situated near the front end of the enteron (Fig. 7*A*). A false vesicula seminalis is separated by a slight constriction from the round vesicula seminalis (Fig. 7*F*). The latter leads, through a distinct ductus intervesicularis, into the oval, distinctive vesicula granulorum. The penis stylet is bow-shaped, gradually tapering in diameter towards the swollen distal end (Fig. 7*B*). The walls of the distal end are slightly thickened (Figs. 7*C–E*); the distal opening is displaced slightly to one side of the swollen end and is not exactly terminal. The stylet length, from proximal to distal tip (see Fig. 7*B*) measured approximately 160 μm in all specimens; the proximal and distal openings measured 14 and 5 μm respectively.

Discussion. Quite close to the new species lies *Macrostomum lutheri* Beklemischev, 1927 which has been recorded in Finland (Tundra and Taiga regions of Papi, 1967) (see Beklemischev, 1927, 1951 (*M. lacustre*?); Papi, 1951, 1967; and Luther, 1960). Diagrams of the penis stylet of *M. lutheri* are presented, for example, in Papi (1951, Figs. 5 to 8, p. 293); the stylet of the new species differs in its smaller length and in that its distal tip has more of a hood-shape, that is, the walls bulge outwards.

Macrostomum georgeense sp.n.

The specific name is derived from the type locality.

Location and material. Lake George, Uganda; a full description is given in Beadle (1932–34*b*), Talling & Talling (1965) and Viner (1969). Lagoon where River Nsonge enters lake. 16.4.72—3 specimens.

Type locality. Lake George, Uganda.

Type material. Holotype—Reg. No. 1975.7.31.18.

Description. The description of the new species is not full due to the paucity of specimens; never-the-less, the characteristic shape of the penis stylet justifies the erection of a new species.

Length of body 1.0 mm. Body widest in middle region; anterior and posterior ends somewhat truncated; body narrows towards hind end of gut; tail spatulate (Fig. 8*A*). Epidermal height up to 9 μm with cilia up to same length. Sensory hairs, up to 20 μm in length, scattered sparsely over body and occurring singly or in groups of up to 4 hairs. Rhabdites, up to 17 μm in length, occur singly or in groups of up to 8, most commonly 2 to 4; sparse with no particular concentra-

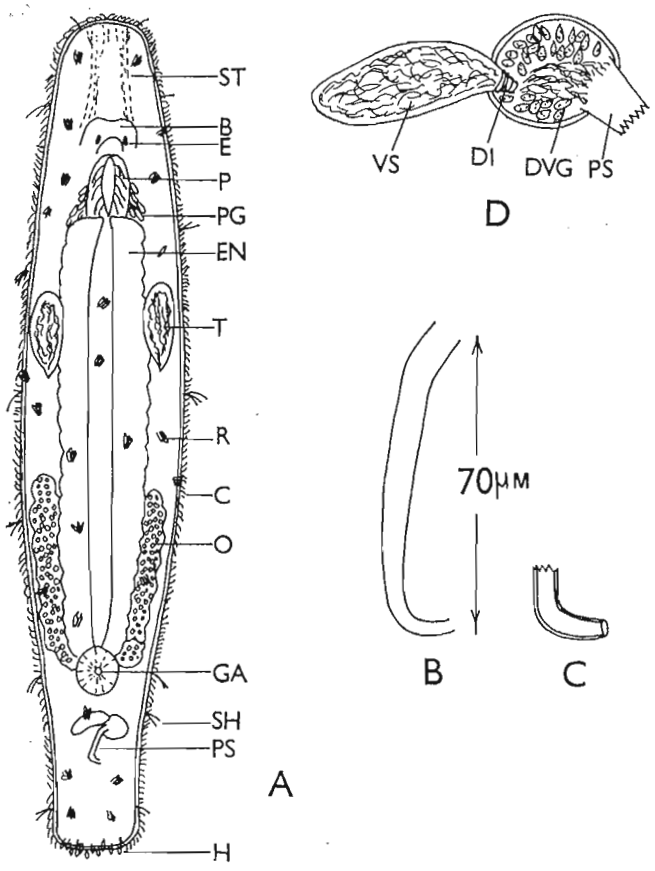

Fig. 8. Macrostomum georgeense sp.n. *A*, general structure of body (diagrammatic ventral view). — *B*, camera lucida drawing of penis stylet of slightly squashed specimen. — *C*, tip of same. — *D*, part of male reproductive system, including proximal end of penis stylet.

tion on the body-surface. "Stäbchenstrassen" present but inconspicuous. "Haftpapillen" present, and up to 14 μm in length. Eyes closer together than each is the nearest body margin; average dimensions were 8 × 11 μm. Outer margin of enteron undulating. Posterior end of enteron overlaps with genital atrium.

Female and male reproductive systems typical of the genus. Ovaries fairly compact without distinct indentations, do not quite reach mid-way along length of enteron (Fig. 8*A*). A "Verschlussapparat" appears to be present in the genital atrium but is poorly developed. A short ciliated vagina surrounded with gland cells is present. The oval-shaped testes are located mid-way along the anterior half of the enteron; they have a relatively smooth surface (Fig. 8*A*). A false vesicula seminalis was not seen. The elongated vesicula seminalis is connected by a short but distinct ductus intervesicularis to the vesicula granulorum (Fig. 8*D*). The penial tube has a slight bend at its proximal end, and a distinct and sharp bend at its distal end (Fig. 8*B*). The distal tip of the stylet is blunt with a terminal opening (Fig. 8*C*). The walls appeared of uniform thickness along the length of the tube. The tube length, from proximal opening to base or lower margin of distal arc (see Fig. 8*B*), is approximately 70 μm; the diameter of the proximal and distal openings are 9 μm and 3.5 μm respectively.

Discussion. The penis stylet of *Macrostomum georgeense* sp.n. bears a superficial resemblance to *M. reynoldsoni* sp.n. Reference should be made to "Discussion" under *M. reynoldsoni*.

Macrostomum sinyaense sp.n.

The specific name reflects the type locality.

Locations and material. All sites located in Kenya. (1) Sinya River, where Nairobi–Hunters Lodge road crosses river. 30.3.72—2 specimens. (2) Small pond near Karen, half way between Ngong Road and Nairobi National Park link road. 3.11.71, 1.3.72, 1.8.72—14 specimens. (3) Dam at Kiserian Village on Magadi Road. 3.12.71—2 specimens. (4) Large pond at outskirts of Thika on Thika–Nairobi Road. 23.3.72—1 specimen. (5) Small pond near Belle-Vue drive-in cinema, Nairobi; details are given in Young & Kolasa (1974). 24.7.72—6 specimens. (6) Three sites on Machakos Farm, Machakos, near Nairobi. 19.6.72—pool in stream with no flow; 12 specimens. Stream with slow flow and vegetation on muddy bottom; 17 specimens. Small pool choked with vegetation; 2 specimens. (7) Un-named stream in Spring Valley, Nairobi. 17.1.72—3 specimens. (8) Kirichwa Kubwa River at side of Argwings Kodhek Road, Nairobi. 29.11.71—4 specimens. (9) Mathare River where Limura Road crosses stream in Nairobi. 15.11.72—2 specimens. (10) Masonga Wai River, where stream flows past the Department of Zoology, University of Nairobi; a description of this site is given in Young & Young (1975). 8.11.71, 8.12.71, 23.12.71, 6.1.72, 7.2.72, 9.3.72, 2.4.72, 2.5.72, 4.7.72, 11.8.72, 2.9.72, 3.10.72—66 specimens. (11) Wellcome Dam at Kabete, Nairobi. 26.10.71, 23.11.71, 27.12.71, 31.1.72, 29.2.72, 24.3.72, 24.4.72, 11.6.72, 1.9.72—69 specimens. In the last two habitats immature and mature animals were recorded in many of the monthly samples, which perhaps suggests continued recruitment of young throughout the year. Animals mature at a length of 0.7 to 0.8 mm. Many specimens had their gut packed with rotifers.

Type locality. Sinya River, Kenya.

Type material. Holotype—Reg. No. 1975.7.31.19. (Paratype—Reg. No. 1975.7.31.20.)

Description. Body length up to 1.1 mm; most common length for sexually mature animals is 0.8 mm. Anterior and posterior ends rounded, though latter somewhat spatulate (Fig. 9*A*). Body is more-or-less parallel-sided but is slightly wider in the middle region, where it is about 1/5th to 1/6th body length, and tapers slightly towards the extremities. In transmitted light the body is transparent and in reflected light is whitish; the enteron varies in colour according to its contents.

The epithelial layer varies from 4 to 8 μm in height and is tallest on the ventral surface; a basal membrane was not observed; mucous glands, embedded in the parenchyma and more abundant on the ventral side open out on its surface; the cells are cuboidal to cylindrical with an oval nucleus. Cilia, about 4 to 7 μm, cover the body surface. Sensory hairs, single or in pairs and up to 20 μm in length are sparsely scattered over the body. Semi-rigid spines or hairs are present at the front end of the body; their length varies from 8 to 14 μm. Sausage-shaped rhabdites, up to 16 μm in length, are scattered all over the body though they are very sparse on the ventral surface; they are most abundant on the mid-dorsal side; they occur singly or grouped in pockets varying from 2 to 10 in number but most commonly 3 to 6. "Stäbchenstrassen" are present but weakly developed. "Haftpapillen" are evident and average 7 μm.

The sub-epithelial muscle layers comprise outer circular and inner longitudinal muscle fibres; sparse diagonal fibres also occur. Dorso-ventral muscle fibres are scattered in the parenchyma tissue, extending from the dorsal sub-epithelial muscle layer to the ventral one. The parenchyma is vacuolarised; parenchymatous cells and "freie Stammzellen" are found. Mucous and rhabdite gland cells are embedded in the parenchyma; adhesive gland cells occur in the region of the postero-ventral adhesive disc area.

The oval mouth leads to a pharynx simplex which opens

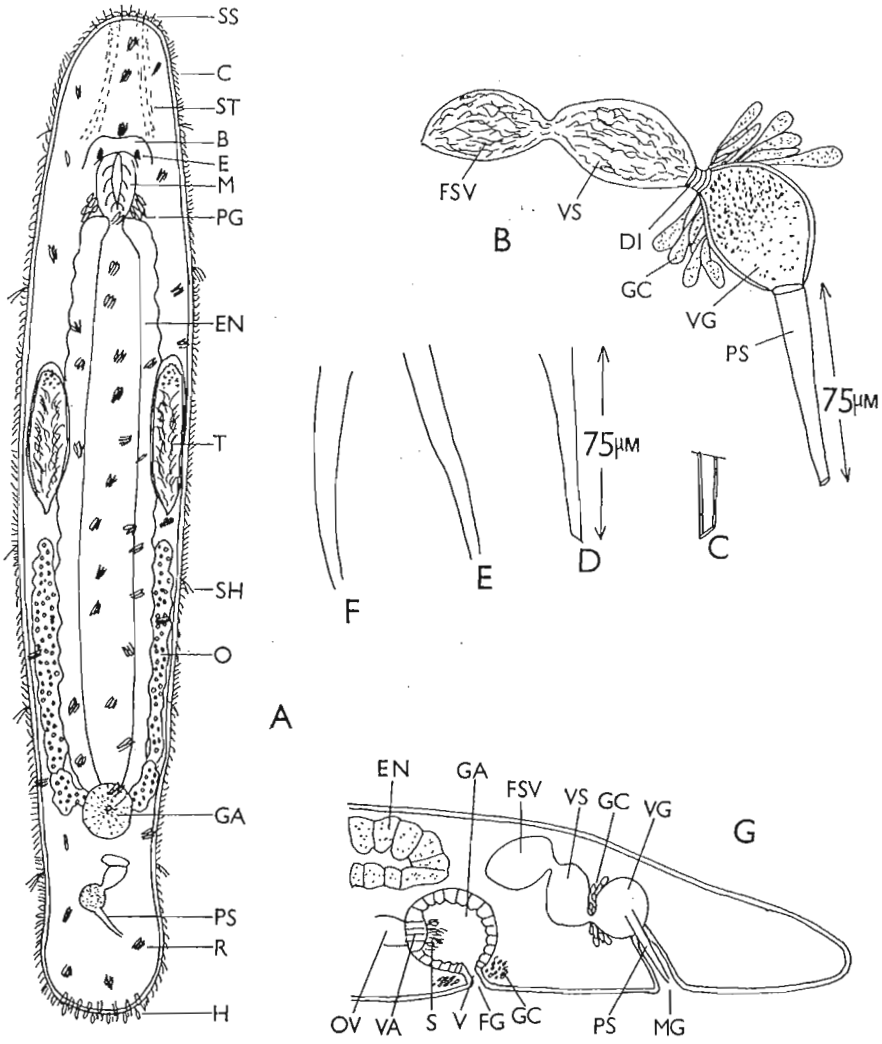

Fig. 9. Macrostomum sinyaense sp.n. *A*, diagram of body to show anatomical features (ventral view). — *B*, drawing of part of male reproductive system. — *C*, distal tip of stylet illustrated in (B). — *D*, *E*, *F*, camera lucida drawings of range of penis stylets observed in a single population (slightly squashed preparations; same size-scale for all). — *G*, lateral view of posterior end of animal.

dorso-posteriorly into the enteron. The epithelial layer of the pharyngeal tube is an invagination of the ciliated ventral epithelium. The pharynx possesses protractor and dilatator muscle fibres. The mouth and pharynx are surrounded radially by two types of gland cells. The sac-shaped enteron, which has undulant borders, is surrounded by outer longitudinal and inner circular fibres; sparse radiating fibres extend from the walls of the enteron to the sub-epithelial layer of the body-wall. The intestinal epithelial layer comprises large ciliated cylindrical cells and a few spindle-shaped or fusiform cells. Granules are often seen in the large cells. The posterior tip of the enteron is placed dorsally to the female genital atrium.

The brain, situated equidistant from the dorsal and ventral sides of the body, is crescent-shaped and consists of two ganglia connected by a short commisure. The eyes appear to be embedded in the tissue of the ganglia of the brain in a dorso-posterior position. In living specimens of 0.8 mm in length, the dimensions of the eyes varied but averaged 9 μm in breadth and 17 μm in length; maximum dimensions observed were 12 μm in width and 22 μm in length. Granules varied in size up to a maximum of 2.4 μm. The distance between the eyes is less than between each eye and its nearest body margin. The lateral excretory system, as seen in living animals, consists of two main coiled stems with branching excretory ducts which terminate in flame cells. Cross stems between the lateral tubes and external openings were not located.

The female and male reproductives are typical for the genus. The slightly lobulate ovaries lie in a latero-dorsal position (Fig. 9*A*); their size varies according to state of sexual maturity but they are longer than the testes. The oviducts extend latero-caudally from each ovary and caudally, in the region of the genital atrium, bend to join the mid-line at the posterior margin of the atrium to form the common oviduct. The genital atrium varies in size according to state of sexual maturity; its lining epithelium is formed of cubical cells about 4 to 6 μm in height with cilia about the same length (Fig. 9*G*). A "Verschlussapparat" is present in the medio-anterior wall of the female atrium where the common oviduct enters; its cells are about 10 μm in height and sometimes spermatozoa were observed attached to them. From the female atrium a short, ciliated vagina extends obliquely ventro-caudally to the gonopore. Surrounding the vagina radially are two types of glandular cells apparently (Fig. 9*G*).

The testes, situated antero-latero-ventrally, are slightly elongated with an apparently smooth surface (Fig. 9*A*). They lie adjacent to the anterior half of the enteron, stretching caudally to approximately half way along the gut. A false vesicula seminalis, harbouring sperm, is present; again its size and shape varies according to state of sexual maturity (Figs. 9*B* and *G*). A very slight constriction separates the false

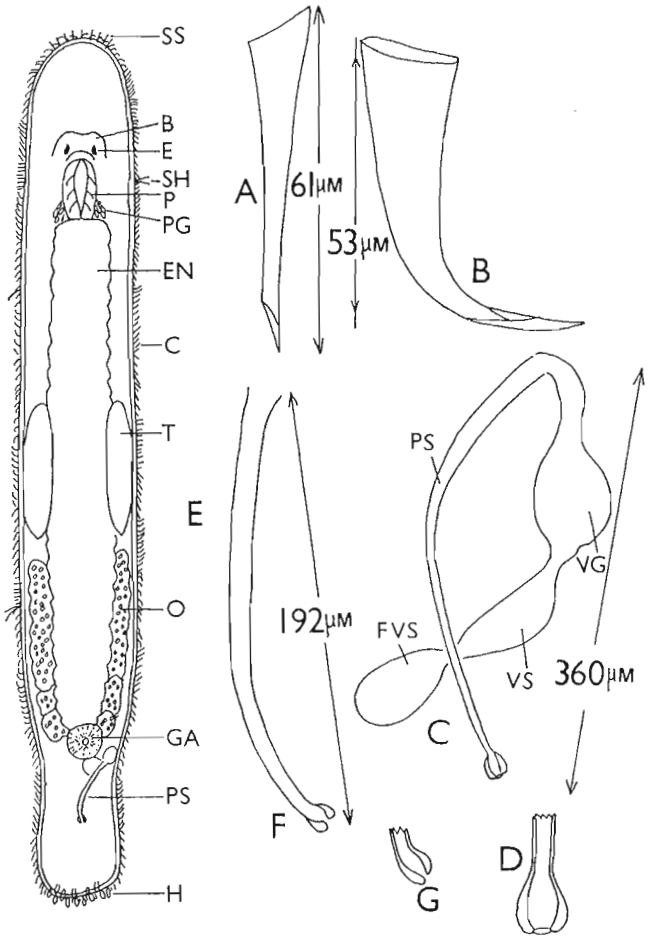

Fig. 10. A, penis stylet of *Macrostomum orthostylum*. — *B*, stylet of *M. rostratum*. — *C*, part of male reproductive system of *M. tuba*. — *D*, distal tip of same. — *E*, ventral view from life of specimen from Lake Edward, tentatively identified as *M. tuba*. — *F*, free-hand drawing of penis stylet of same. — *G*, distal tip of same.

vesicle from the vesicula seminalis which is oval-shaped, longer than and situated ventro-caudally to the false vesicula. A very short ductus intervesicularis, which is surrounded by a sphincter of muscle fibres, connects the vesicula seminalis with an oval vesicula granulorum; this is often the largest of the three vesicles. As for the vesicula seminalis, the walls of the vesicula granulorum are provided with apparent spiral muscle fibres. Accessory gland cells surround the vesicula granulorum and appear to enter this near the ductus intervesicularis. The proximal part of the chitinised penis stylet is attached to the distal end of the vesicula granulorum. The stylet is a short straight tube the diameter of which decreases distally (Figs. 9*B–F*). Exceptionally the tube appeared very slightly curved in a few specimens. In squash preparations of mature specimens of body length 0.8 mm the length of the stylet varied from 65 to 85 μm with the diameter of the proximal and distal openings approximately 10 and 3.4 μm respectively. The distal, terminal opening is slightly oblique. The walls of the tube are of a uniform thickness.

Discussion. The species resembles closely *Macrostomum orthostylum* (M. Braun, 1885) which has been recorded from several localities in Europe, including Finland, Russia, Poland and Italy (see, for example, Braun, loc. cit.; Luther, 1905, 1960; Hofsten, 1911; Meixner, 1915; Papi, 1951, 1967; and Beklemischev, 1951) and in N. America (see Ferguson & Jones, 1940). However, the distal end of the penis stylet in the new species is not so sharp as that of *M. orthostylum*. Perhaps the tip of the stylet of the new species resembles that of a form of *M. orthostylum* featured in Fig. 38, p. 36 in Beklemischev (1951). Certain other structural features in the new species are at variance with descriptions of *M. orthostylum*. Differences from *M. orthostylum* include the occurrence of anterior semi-rigid hairs or spines, the possession of larger testes, and absence of deep indentations in the ovaries (cf. for example, Meixner, 1915).

4. First records in East Africa of established species of *Macrostomum*

Specimens of the following species are stored in the author's private collection.

Macrostomum orthostylum (M. Braun, 1885)

Locations and material. Two sites near Mombasa, Kenya. (1) River Mwena, south of Mombasa on Lungalunga road. 17.2.72—1 specimen. (2) River Maji Ya Chumvi in Mariakani/Kmango road. 23.2.72—2 specimens: 0.7 and 0.8 mm in body length.

Description. The structure of the animals agrees with the description of the species given in Meixner (1915), Ferguson (1939*c*), which was based on the former mainly, and Luther (1960). Thus, the testes were small and the ovaries distinctly indented. The penis stylet (see Fig. 10*A*) was almost identical to that illustrated in Papi (1951, Fig. 28, p. 309) and Luther (1960, Fig. 18 D, p. 76). The penis stylet length varied from 57 to 63 μm in the 3 specimens obtained.

Discussion. The known distributional range of *M. orthostylum* has been outlined in the "Discussion" under *M. sinyaense* sp. n.

Macrostomum rostratum (Papi, 1951)

Location and material. Dam at Kiserian Village on Nairobi to Magadi road. 17.1.72—1 specimen: body length of 1.2 mm.

Description. All features agree with earlier descriptions of the species (see, for example, Papi, 1951; 1952; and Luther, 1960). The shape of the penis stylet (see Fig. 10 B) is almost identical to the stylet shown in Luther (1960, 17 C, p. 68). Its height was 53 μm.

Discussion. Previously, the species was recorded in Finland, Italy, Poland and Russia (see Papi, 1951, 1952, 1959, 1967; Beklemischev, 1951; and Chodorowski, 1959–? *M. phytophilum*?).

Macrostomum tuba (Graff, 1882)

Locations and material. (1) River Sirimon, 5 miles south-east of Timau, at an altitude of 2 330 m on Mt. Kenya. 26.1.72—2 specimens. (2) Small pond near Belle-Vue drive-in cinema, Nairobi. 6.4.72—15 specimens. (3) River Chania at Nyeri, at altitude of 1 700 m on Aberdare Mts. 28.3.72—2 specimens. (4) Masonga Wai River, Nairobi. 8.11.71, 8.12.71, 23.12.71, 7.2.72, 9.3.72, 2.4.72, 2.5.72, 11.8.72, 2.9.72, 3.10.72—76 specimens. (5) Wellcome Dam, Nairobi. 26.10.71, 23.11.71, 27.12.71,

31.1.72, 29.2.72, 24.3.72, 24.4.72—24 specimens. (6) Small pond just outside Ngong Village on right hand side of Ngong to Nairobi main road. 3.11.71—7 specimens. (7) Un-named large dam on Lower Kabete Road in Nairobi. 10.11.71—6 specimens. (8) Nairobi Dam on Aerodrome Road, Nairobi. 10.11.71—2 specimens. (9) Dam in rice fields at Kandongu in the Sagana area. 6.12.71—1 specimen. (10) Kirichwa Kuba River, Nairobi, by Kenton Drive at bridge. 29.11.71—2 specimens. (11) Tentatively assigned to this species is a single specimen taken from the north-eastern littoral of Lake Edward, near Katwe, Uganda on 18.4.72. Physico-chemical information on Lake Edward appears in Beadle (1932–34*b*) and Talling & Talling (1965).

Description. The historical controversy about *Macrostomum tuba* is discussed thoroughly in Hyman (1955) and Marcus & du Bois-Reymond Marcus (1957). From the various descriptive reports it would seem that the species must be rather variable (see, for example, Hyman, 1936; Weise, 1942; Papi, 1951; Luther, 1960; and Mack-Fira, 1968). The specimens recorded from E. Africa are not at variance with these published descriptions. The penis stylet varied considerably in size according to the size of the specimen. Small stylets in small specimens were usually straight and not curved like those found in larger specimens (see Figs. 10*C* and *D*); thus, small specimens (1.5 to 1.6 mm) in the Belle-Vue pond, River Chania, Masonga Wai River and Wellcome Dam had short straight stylets averaging 115 μm, 115 μm, 117 μm and 120 μm respectively. In the Belle-Vue pond and Masonga-Wai river in specimens 2.3 and 2.5 mm in length respectively, stylet lengths of up to 360 μm were recorded; in the Wellcome Dam the largest specimen obtained contained a stylet of length 440 μm. The index, stylet length to proximal diameter of stylet (see Marcus & du Bois-Reymond Marcus, 1957), varies according to the state of development. In a specimen of 2.5 mm in length with a penis stylet length of 360 μm from the Masonga Wai River, the ratio was 1 : 20.

Unfortunately, the single specimen from Lake Edward (see above), which has been placed tentatively in *M. tuba*, did not fix well after being squashed between a slide and coverslip during preliminary observations on the anatomy of the living animal, and subsequent histological sections were useless. Thus, the following observations are based on a cursory examination of a single, living specimen. Length 0.7 mm; rounded at anterior end but more blunt at the posterior end; lateral margins almost parallel but tapering towards the extremities (Fig. 10*E*). Epidermis, cilia and anterior spines all 8 μm in height or length. Sensory hairs sparse, indeed 2 pairs and a single hair observed; 17 μm in length. Rhabdites, single or in groups of 2 to 14, most commonly 3 to 7, scattered over body surface; up to 21 μm in length. Eyes nearer to each other than each is to its nearest lateral body margin. "Stäbchenstrassen" not seen. "Haftpapillen" present. Gut with undulating margins. Ovaries lobulate. Testes elongated and situated fairly far back from the anterior end of the enteron; in fact only anterior tip of testes extends into the front half of the enteron length (Fig. 10*E*). False vesicula seminalis not seen. Distinct ductus intervesicularis between vesicula seminalis and vesicula granulorum. Penis stylet like that usually illustrated for *M. tuba*; tapering, slightly curved and with thickened walls round the distal terminal opening (Fig. 10*F* and *G*). Length of penis stylet 192 μm; proximal opening 16 μm and distal opening 4 μm in diameter.

The position of the testes in the specimen is atypical for *M. tuba* (including specimens obtained from habitats in present study) in which they are situated in a more anterior position, their anterior end reaching almost to the front end of the enteron. However, position of testes may be variable. In the Masonga Wai and Wellcome populations of *M. tuba*, animals of 0.7 mm in length would certainly be immature; however, the specimen from Lake Edward was fully mature at this size. In the specimen, the index, penis stylet length to diameter of proximal end of tube, was 1 : 12, but it is not certain that this stylet was fully developed.

Discussion. M. tuba has been recorded widely in Europa (see Luther, 1960 and Papi, 1967), including warmed aquaria (see, for example, Young & Young, 1967), Japan (Okugawa, 1930), United States of America (Kepner & Stiff, 1932; Hyman, 1936, 1943; Ferguson, 1939*b*, and S. America (Marcus, 1946; Hyman, 1955). The record of *M. tuba* var. *verbekei* from Lake Kivu in Africa by Marcus & du Bois-Reymond Marcus (1957) has been commented on in the introduction to the present paper.

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Abbreviations in the figures

B	brain
C	cilia
DI	ductus intervesicularis
E	eyes
En	enteron
FG	female gonopore
FVS	false vesicula seminalis
GA	genital atrium
GC	gland cells
H	"Haftpapillen"
M	mouth
MG	male gonopore
O	ovary
OV	oviduct
P	pharynx
PS	penis stylet
PG	pharyngeal gland-cells
R	rhabdites
S	spermatozoa
SH	sensory hairs
SS	semi-stiff hairs
ST	"Stäbchenstrassen"
T	testes
V	vagina
VA	"Verschlussapparat"
VG	vesicula granulorum
VS	vesicula seminalis
W	wrinkles

References

Ax, P. 1951. Die Turbellarien des Eulitorals der Kieler Bucht. — Zool. Jb. Syst. *80:* 277–378.

— 1954. Die Turbellarienfauna des Küstengrundwassers am Finnischen Meerbusen. — Acta zool. fenn. *81:* 1–54.

— 1956. Das oekologische Verhalten der Turbellarien in Brackwassergebieten. — Proc. XIV Int. Congr. Zool.: 462–464.

— 1957. Die Einwanderung mariner Elemente der Mikrofauna in das limnische Mesopsammal der Elbe. — Verh. dt. zool. Ges. *1956:* 428–435.

Beadle, L. C. 1932–34*a*. Scientific Results of the Cambridge Expedition to the East African Lakes 1930–1. 3. Observations on the bionomics of some East African swamps. — J. Linn. Soc. Lond. *38:* 135–155.

— 1932–34*b*. Scientific results of the Cambridge Expedition to the East African Lakes, 1930–1. 4. The waters of some East African lakes in relation to their fauna and flora. — J. Linn. Soc. Lond. *38:* 157–211.

Beauchamp, P. de 1935. Turbellaries et Bryozoaires. — Mission scient. Omo *3* (23): 141–153.

Bedini, C. & Papi, F. 1974. Fine structure of the turbellarian epidermis. *In* Biology of the Turbellaria (eds. N. W. Riser & M. P. Morse). Libbie H. Hyman Memorial Volume: 108–147. — McGraw-Hill, New York.

Beklemischev, W. N. 1927. [Über die Turbellarienfauna der Bucht von Odessa und der in dieselbe mündenden Quellen.] — Izv. biol. nauchno-issled. Inst. biol. Sta. perm. gosud. Univ. *5:* 177–207. (In Russian, with German summ.)

— 1951. О видах рода *Macrostomun* (Turbellaria, Rhabdocoela) СССР. — Byull .mosk. Obshch. Ispyt. Prir. Biol. *56* (4): 31–40.

Beltagi, S. 1972. The Turbellaria fauna of Egypt (New Macrostomida). — Zool. Anz. *188:* 343–365.

Beneden, E. van 1870. Étude zoologique et anatomique du genre Macrostomum et description de deux espèces nouvelles. — Bull. Acad. r. Sci., Lett. et Beaux arts de Belg. (2) *30:* 116–133.

Braun, M. 1885. Die rhabdocöliden Turbellarien Livlands. — Arch. Naturk. Liv-, Est- u. Kurlands *10:* 131–251.

Chodorowski, A. 1959. Ecological differentiation of Turbellarians in Harz-Lake. — Polsk. Arch. Hydrob. *6:* 31–73.

Ferguson, F. F. 1939*a*. A monograph of the genus Macrostomum O. Schmidt 1848. Part I. — Zool. Anz. *126:* 7–20.

— 1939*b*. A monograph of the genus Macrostomum O. Schmidt 1848. Part III. — Zool. Anz. *128:* 49–68.

— 1939*c*. A monograph of the genus Macrostomum O. Schmidt 1848. Part V. — Zool. Anz. *128:* 274–291.

Ferguson, F. F. & Jones, E. R. Jr 1940. Studies on the turbellarian fauna of the Norfolk area. V. Anatomical notes on the American representative of Macrostomum orthostylum Braun 1885. — Virg. J. Sci. *1:* 281–284.

Graff, L. von 1882. Monographie der Turbellarien. I. Rhabdocoelida. — Wilhelm Engelmann, Leipzig.

Hofsten, N. von 1911. Neue Beobachtungen über die Rhabdocölen und Allöocölen der Schweiz. — Zool. Bidr. Upps. *1:* 1–84.

Hyman, L. H. 1936. Studies on the Rhabdocoela of North America. 1. On Macrostomum tubum (von Graff) 1882. — Trans. Am. microsc. Soc. *55:* 14–20.

— 1943. On a species of Macrostomum (Turbellaria: Rhabdocoela) found in tanks of exotic fishes. — Am. Midl. Nat. *30:* 322–335.

— 1955. Miscellaneous marine and terrestrial flatworms from South America. — Am. Mus. Novit. *1742:* 1–33.

Jenkin, P. M. 1932. Reports on the Percy Sladen Expedition to some Rift Valley Lakes in Kenya in 1929. I. Introductory account of the biological survey of five freshwater and alkaline lakes. — Ann. Mag. nat. Hist. (10) *9:* 533–552.

— 1936. Reports on the Percy Sladen Expedition to some Rift Valley Lakes in Kenya in 1929. VII. Summary of the ecological results, with special reference to the alkaline lakes. — Ann. Mag. nat. Hist. (10) *18:* 133–160; 161–181.

Kepner, W. & Stiff, W. 1932. Observations on the American representative of Macrostomum tuba. — J. Morph. *54:* 221–231.

Kolasa, J. 1973. Two new species of Macrostomum (Turbellaria), a redescription of an established species and new records from Poland. — Boll. Zool. *40:* 181–200.

Luther, A. 1905. Zur Kenntnis der Gattung Macrostoma. — Festschr. f. Palmén, Helsingfors *5:* 1–61.

— 1947. Untersuchungen an Rhabdocoelen Turbellarien. VI. Macrostomiden aus Finnland. — Acta zool. fenn. *49:* 1–40.

— 1960. Die Turbellarien Ostfennoskandiens. I. Acoela, Catenulida, Macrostomida, Lecithoepitheliata, Prolecithophora, und Proseriata. — Fauna fenn. *7:* 1–155.

Mack-Fira, V. 1968. Macrostomide (Turbellaria Macrostomida) din apele interioare ale României. — Studii Cerc. Biol. *20:* 131–136.

Marcus, E. 1946. Sobre Turbellaria Brasileiros. — Bolm Fac. Filos. Ciênc. Univ. S. Paulo, Zool. *11:* 5–253.

— 1955. Turbellaria. — S. Afr. anim. Life *1:* 101–151.

Marcus, E. & du Bois-Reymond Marcus, E. 1957. Turbellaria. — Inst. Royal Sci. Nat. Belg., Explor. Hydrobiol. Lacs Kivu, Édouard et Albert 1952–1954. Rés. Sci. *3:* 25–51. — Bruxelles.

Meixner, J. 1915. Zur Turbellarienfauna der Ost-Alpen, insonderheit des Lunger Seengebietes. — Zool. Jb. Syst. *38:* 459–588.

— 1926. Beitrag zur Morphologie und zum System der Turbellaria-Rhabdocoela. II. Über Typhlorhynchus nanus Laidlaw und die parasitischen Rhabdocoelen, nebst Nachträgen zu den Calyptorhynchia. — Z. Morph. Ökol. Tiere *5:* 577–624.

Okugawa, K. 1930. A list of the freshwater rhabdocoelids found in Middle Japan, with preliminary descriptions of new species. — Mem. Coll. Sci. Kyoto Univ. Ser. B *5:* 75–88.

Papi, F. 1951. Ricerche sui Turbellari Macrostomidae. — Archo zool. ital. *36:* 289–340.

— 1952. Note faunistische sui Turbellari dell'Italia centrale. — Monitore zool. ital. *60:* 1–13.

— 1953. Beiträge zur Kenntnis der Macrostomiden (Turbellarien). — Acta zool. fenn. *78:* 1–32.

— 1959. Specie nuove o poco note del gen. Macrostomum (Turbellaria macrostomida) rivenute in Italia. — Monitore zool. ital. *66:* 1–19.

— 1967. Turbellaria (excl. Tricladida). *In* Limnofauna Europaea (ed. J. Illies). — Gustav Fischer, Stuttgart.

Reisinger, E. & Kelbetz, S. 1964. Feinbau und Entladungsmechanismus der Rhabditen. — Z. wiss. Mikrosk. *65:* 472–507.

Silliman, W. A. 1884–85. Beobachtungen über die Süsswasserturbellarien Nordamerikas. — Z. wiss. Zool. *41:* 48–76.

Talling, J. F. & Talling, I. B. 1965. The chemical composition of African lake waters. — Int. Revue ges. Hydrobiol. Hydrogr. *50:* 421–463.

Viner, A. B. 1969. The chemistry of the water of Lake George, Uganda. — Verh. int. Verein theor. angew. Limnol. *17:* 289–296.

Weise, M. 1942. Die Rhabdocoela und Alloeocoela der Kurmark mit besonderer Berücksichtigung des Gebietes von Gross-Berlin. — Sber. Ges. naturf. Freunde, Berl. *1941:* 141–204.

Westblad, E. 1953. Marine Macrostomida (Turbellaria) from Scandinavia and England. — Ark. Zool. (2) *2:* 391–408.

Young, J. O. & Gibson, R. Some ecological studies on two populations of the freshwater hoplonemertean Prostoma eilhardi (Montgomery, 1894) from Kenya. — Verh. int. Verein. theor. angew. Limnol. (In press.)

Young, J. O. & Kolasa, J. 1974. Studies on the genus Stenostomum O. Schmidt (Turbellaria; Catenulida). III. A new species from Kenya, East Africa. — Freshwat. Biol. *4:* 163–166.

Young, J. O. & Young, B. M. 1967. Macrostomum tuba (Graff) 1882 (Turbellaria, Rhabdocoela), recorded in British freshwater aquaria. — Nature, Lond. *213:* 1149–1150.

Young, J. O. & Young, B. M. 1975. The distribution of freshwater triclads (Platyhelminthes; Turbellaria) in Kenya and Tanzania, with ecological observations on a stream-dwelling population. — Zool. Anz. *193:* 350–361.

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