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The Turbellaria Fauna of Egypt (New Macrostomida)

By

Samir Beltagi[1]

With 12 Figures

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Introduction

As only little scientific work had been done in the field of Fresh-Water-Turbellaria especially in the African Continent, I was really encouraged to examine some specimens living in the Egyptian stagnant water ponds near Cairo and it is considered to be the first scientific work in this field.

At first, I offer my greatest thank and respect to my Prof. Dr. Friedrich Schaller, Director of the I. Zoological Institute at Vienna University, as he had kindly granted me a research work place at his Institute for the Academic Year 1969/1970, and also for his valuable assistance in my recent research work. I thank Prof. Dr. Karling, Prof. Dr. Reisinger, Prof. Dr. F. Papi and Dr. Valeria Mac-Fira, for their kindness of sending to me their important scientific work in the field of Turbellaria, which have a great influence on my work.

This work has an important value, mainly from the systematic point of view, besides its importance from the zoogeographical and ecological aspects.

In this work, I had intended to draw detailed reconstructions of the new specimens from the Median-Sagittal position. The gathered specimens are preserved in Bouin solution. Squeezed preparations of the living specimens are examined mainly for drawing the male genital apparatus 'stylet'. Transverse and long and frontal sections are done for every type of the 4 different specimens. The thickness of sections are generally 7 μm. I had used in staining the serial sections of every specimen Mallory solution, which gave a satisfactory result.

Location (Fundort)

I had collected these 4 types of the family Macrostomidae from a pond of stagnant fresh water, 25 kilometres far from Cairo, near a small village called 'Shebin El Kanater', and that in July and August 1969. These Turbellarians are living in the aquatic vegetation such as Eichhornia crassipes, Elodea canadensis, Ceratophyllum. sp. — Potamogeton sp. — Cladophora — the salinity of the water is 0.39 gram per 100 cm^3. — *pH* value — 7.3.

Systematics

Phylum: Platyhelminthes, Gegenbaur, 1859.
Class: Turbellaria, Ehrenberg, 1831.
Order: Archoophora, Karling, 1940.
Sub-order: Macrostomidae, Karling, 1940 (Macrostomida, Meixner, 1942; Opisthandropora, Bresslau, 1928—1933), Macrostomidae (Van Beneden, 1870).

[1] Dr. Samir Beltagi, Assistant Prof. of Zoology, Ein Shams University, Cairo (A.R. Egypt).

Genus *Macrostomum* (Schmidt, 1848)

I. *Macrostomum niloticum* n. sp.

1. Habitus (external features) (Fig. 1): This animal has a length ranging between 1 and 2 mm. It has a blunt anterior end and a spatulate posterior end. At the beginning of the second half of the body, it reaches its largest width. It has a pale yellow coloration at the outer edge and pale brown intestine in the

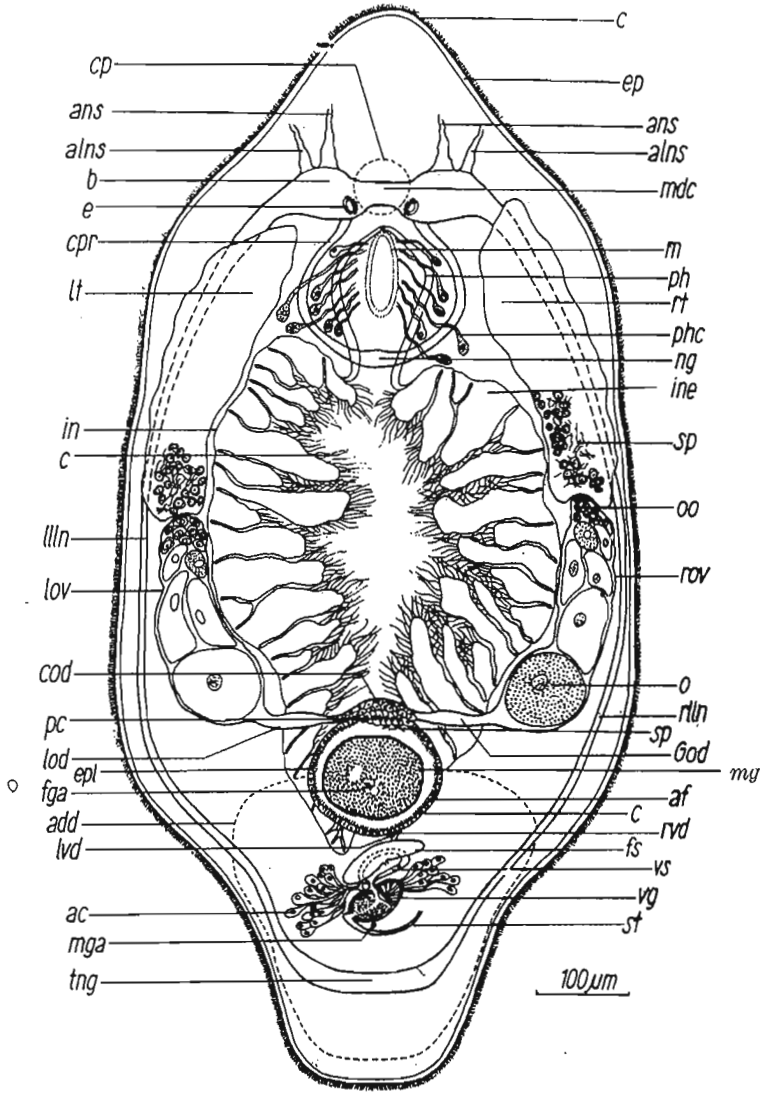

Fig. 1. *Macrostomum niloticum* n. sp. Diagrammatic dorsal view (Gross Anatomy)

middle of the body. The 2 simple eyes are kidney shaped, dark brown in colour and placed at the end of the first 1/6th part of the body. Adhesive papillae are distributed only at the ventral surface of the epithelium in the caudal region. Sausage-like Rhabdites are distributed in the epithelial layer in great or large numbers at the dorsal surface anterior and posterior end of the body.

2. Epithelium: The dorsal epithelial layer is about 6.6 μm in height,

while the ventral layer is about 8.2 μm. The epithelial cells are cylindrical with oval nuclei. Fluid filled spaces are more frequently scattered between the epithelial cells at the dorsal surface than the ventrale. The basal granules of the cilia, form together along the whole outer surface of the body a thick line like in *Macrostomum thermophilum* Riedl (*M. thermophilum* and mare boreale, Riedl 1932, p. 37, 38). Rhabdites are found in large number at the dorsal epithelial layer, while at the ventral side, they are very scarce (Fig. 2 — r). They are single, or grouped in packets varying from 2 to 6 in number. Each rhabdite is a slightly curved sausage-like rod, which reaches about 11 μm at its maximal length and 1.1 μm in width. Rhabdites are located in large number too at the posterior end of the body. The ventral epithelial layer at the region of the 'Haftscheibe' are free from nuclei, as the latter are sunk under the epithelial muscular layer and embedded in the parenchymous tissue (Fig. 3).

3. Musculature: a) The subepithelial muscle layers consists as normal of an outer circular muscle and an inner longitudinal muscle layer. Length of the muscle fibre is about 6.8 μm and diameter 0.7 μm (Fig. 3 — cm, Lm).

b) Body musculature is composed, with exception of the muscles of each internal organ, of dorso-ventral muscle fibres which are embedded mainly in the parenchymolous tissue. They are abundant especially at the anterior and posterior part of the body and extending from the dorsal subephitalial muscle layer to the ventral one. The maximal length of each muscle fibre reaches about 15.4 μm. Longitudinal muscle fibres are found in 2 layers beneath the ventral subepithelial muscle layer to strengthen the creeping ventral surface of the body. Diagonal muscle fibres are scatterred at the anterior 1st fourth and the posterior last part of the body. Strong thick and long muscle fibres extend dorso-ventrally from the dorsal subepithalial muscle layer of the first part of the second fourth of the body towards the anterior part of the body and covering the dorsal anterior part of the intestine and the proximal part of the pharyngeal tube and diverge into 2 branches. The first runs to the ventral subepithelial muscle layer and the second branch sends its own elements to surround the outer surface of the brain mass (Fig. 2 — dsm).

4. Parenchyma: The syncytial parenchyma is slightly vacuolarised and it surrounds the principal internal organs. 'Freie Stammzellen' are scattered in its plasmodial structure. The 'Stammzelle' is oval and has a length of about 6.6 μm and a rounded nucleus of about 2.2 μm in diameter. It is surrounded by a thick mass of the plasma. The nuclei of the syncytial parenchyma are found in large numbers and each is small and oval, its length measures about 4.4 μm.

5. Digestive System: The mouth aperture is located medio-ventrally at the end of the 1st fourth part of the body. It is oval and leads to a flask-shaped pharynx simplex. It connects dorso-posteriorly to the anterior part of

the intestine by an aperture which is surrounded by a strong set of circular muscle fibres acting as sphincter (Fig. 2 — Scm).

The epithelial layer of the pharyngeal tube (Fig. 2 — Ph) is an invagination of the ventral epithelium. The epithelial cells are cylindrical. — It possesses a strong and thick cilia which reaches 6.6 μm in height and their basal granules build a striking thick line. The cells of the epithelial layer are interrupted by the outlets of the pharyngeal glandular cells (Fig. 2 — Phc) (pyri-

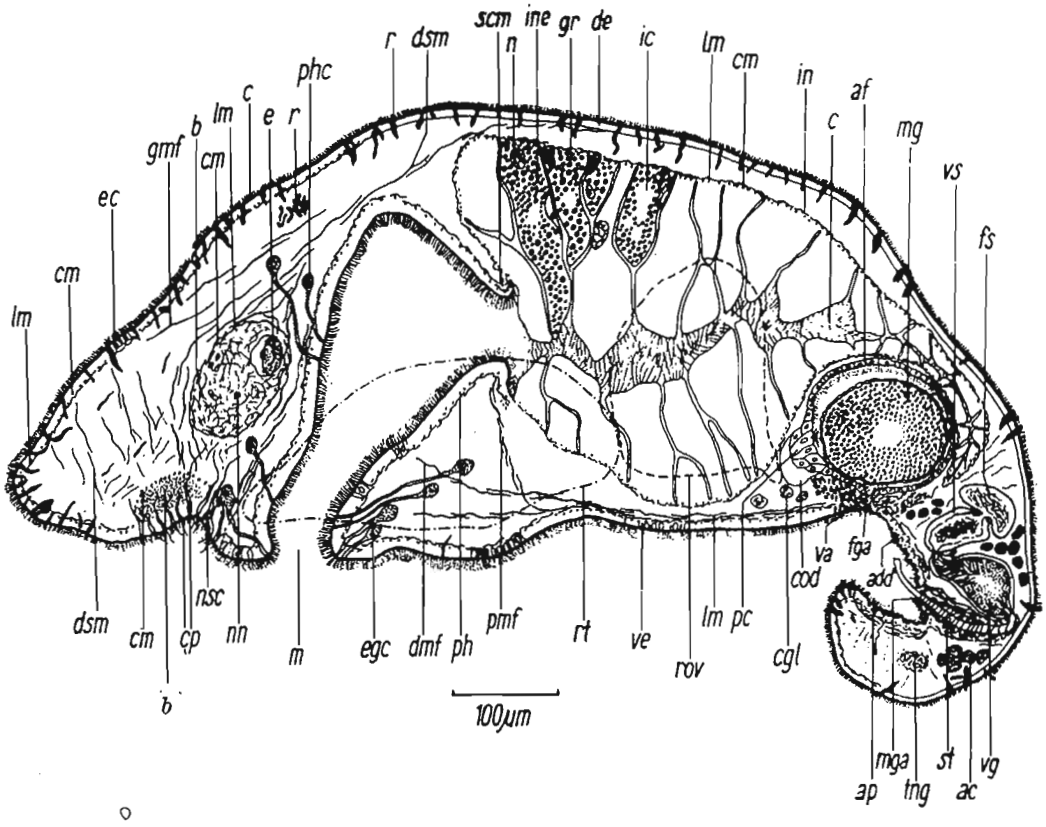

Fig. 2. *Macrostomum niloticum* n. sp. Lateral view based on sagittal sections

form) embedded at the surrounding parenchyma. They are of cyanophilous type. Eosinophilous Rhammitae gland cells (Fig. 2 — egc) are pouring their fine rounded granules at the mouth region. The diameter of the cyanophilous gland cell is about 11 μm and it is filled with fine coarse granules. Dilatator muscle fibres (Fig. 2 — dmf) are present, which extend from the distal part of the pharynx radially to the ventral subepithelial muscle layer. Protractor muscle fibres (Fig. 2 — Pmf) are attached to the proximal part of the pharynx. The intestine is sack-like and reaches its maximum width at the middle part of the body. It has a narrow tapering posterior end. The length of the intestine is about 560 μm. It has slightly outer wavy boarders. Its posterior fourth part is dorsally placed to the Antrum femininum. The intestinal epithelium consists of large cylindrical cells (Fig. 2 — in, ine, ic). The height of each cell reaches about 140 μm and the width 27 μm with long fine cilia (Fig. 3 — c) which have no basal granules. They are mostly filled with coarse granules (Fig. 2 — gr). It has an oval nucleus which reaches about 13.2 μm in length.

The diameter of the coarse granule is ranging between 1.1 to 2.2 μm. In between these ciliated cells, spindle-like cells are placed. It has a length of 22 μm and 4.4 μm in width and it possesses a rounded nucleus 3.9 μm in diameter.

The outer boarder of the intestinal sack is surrounded by an outer layer of fine longitudinal muscle fibres and an inner layer of thick circular muscle fibres (Fig. 2 — Lm, cm). They resemble in shape and size the subepithelial muscle fibres. The epithelial cells are not in close connection with each other, but they are separated by the radial branches of the central intestinal lumen. As food materials, „crustaceae" like copepods and *Cypris* are often found in the intestinal lumen. In some specimens of this species the ciliated intestinal cells possess small rounded fluid filled vacuoles surrounded by the coarse granules. Their diameter is about 11 μm.

6. Excretory System: Protonephridia were not to be observed neither in living material nor in prepared sections.

7. Nervous System (Fig. 1): The brain is composed of two ganglia joined by a medio-dorsal commissure (Fig. 1 — bcmdc). Each ganglion has a Maximaldiameter of 56 μm and consists of a thick fibrillar plasmatic mass in which are embedded oval nuclei. Each nucleus has a moderate length of 4.4 μm. A membrane surrounding the brain mass as mentioned by Braun (1885 p. 65), is not to be observed. The biganglionic brain is surrounded by muscular capsule of an outer longitudinal muscle fibre and few inner circular muscle fibres. The length of the longitudinal muscle fibre is about 15.4 μm and 0.8 μm width. Two pairs of nerve stems are extending anteriorly from the antero-mid part of the brain mass. The first pair are the anterior nerve stems situated just in the middle part of the body, while the second pair are the antero-lateral nerve stems. From both sides of the brain mass extend a pair of latero longitudinal nerves to the posterior part of the body, which unite to form the tail nerve ganglion as in *Macrostomum viride* Luther (1905 p. 25).

A circumpharyngeal ring (Fig. 1 — cpr) is extended from the postero-ventral part of the brain mass and forms just behind the pharynx and ventrally a thick nerve ganglion.

It had not been observed any traces of nerve commissures between the two longitudinal lateral nerves especially behind the circum-pharyngeal ring as mentioned by Luther (1905, p. 24) in *Macrostomum viride*.

Sensory Organs (Fig. 1): The eyes are paired, dark brown in colour, reniform and located dorso-posteriorly to the brain (Fig. 2, 3 — e). Each eye is composed of the eye cap which consists of numerous small rounded granules. The diameter of each granule is about 2 μm, the diameter of the cap reaches about 24.2 μm. The lens is half moon-like in shape and has a diameter of 19.8 μm. The eye-chambers are slightly oval and have a length of about of 30.8 μm. They are completely embedded in the brain (Kepner and Stiff 1932, p. 223) — and the species varies in this respect from *Macrostomum tennessensis* (Ferguson 1940, p. 124).

8. Reproductive System: Female genital organ (Fig. 1): The two ovaries

are partially lobed structures and located laterally. The two oviducts join nearly in the mid-line of the body and unite to form the common oviduct (Fig. 1 — Cod). The female genital atrium (af) is nearly rounded in shape and reaches in maximal diameter about 140 μm. Its epithelial layer is formed of a single layer of cubical to flattened especially when it is filled with the mature egg (Fig. 2 — mg) (Luther 1947, p. 15). Its thickness is about 4.4 μm and are ciliated. The height of the cilia is the same as that of the epithelial layer. The porus femininum (fga) is located nearly at the beginning of the last 6th part of the body. It reaches about 11 μm in diameter and leads to a short vagina.

It is considered to be an invagination of the ventral epithelium (Reisinger 1933, p. 247—250). At the medio-anterior wall of the antrum femininum, the epithelial cells are enlarged in a certain area (Luther 1947, p. 5) of pyramid-like cells to form the "Verschlußapparat" or the "passage cells" (Fig. 1 — pc). The height of each cell is about 11 μm and the width 6.6 μm. Each cell has an oval nucleus of 4.4 μm in length and possesses a fine granulated cytoplasm. The epithelial layer is surrounded by fine outer longitudinal muscle fibres and inner circular muscle fibres embedded in the surrounding parenchyma. A group of spermatozoa are seen attached to the inner surface of the passage cells which is attached anteriorly to the common oviduct. At the place of the connection of both (the common oviduct and the passage cells), exist a strong set of circular muscle fibres acting as sphincter which control the passage of the mature egg from the oviduct to the antrum femininum. The wall of the common oviduct is formed of polygonal cells. A mature egg is found inside the antrum femininum which has oval shape. Its length is about 126 μm and the width 98 μm. It has flattened yellow granules. The Yolk granules are coarse in shape and reach a moderate length of 4.4 μm. Two types of cement glandular cells are well observed. They are generally oval in shape, embedded in the parenchymatous tissue surrounding the ventral parts of the female genital atrium. The moderate of this glandular-cell, is about 11 μm long and has a width of about 6.6 μm. Its nucleus is nearly rounded and has a diameter of 2.2 μm. The first kind of this glandular cell has a cyanophilous secretion in the form of coarse elongated polygonal granules which measure in length about 4.4 μm. This kind of secretion opens at the ventral epithelial layer and is surrounding the porus femininus from all sides in radial form. The second type of secretion is of eosinophilous type (stained red with acidic fuchsin). Each granule is of narrow rod-shaped structure and has a length of about 6.6 μm and a width of 1.1 μm. The granules are grouped in a thick mass surrounding the first type of cyanophilous granular secretions — and open at the ventral epithelial layer. The thickness of this eosinophilous granular mass reaches about 22 μm. It had not been observed in these prepared stained sections any cement secretions in the female genital canal (Riedl 1932, p. 82).

b) The Male Genital Organ (Fig. 1, 3): It is formed of two testes which are situated at the first half of the body laterally placed to the intestine on

both sides and are slightly indented. The sperm cell is wavy spindle-shaped and has a length of 20 μm. The male genital aperture is located posteriorly to the female genital aperture, and the distance between them is about 112 μm. The vasa deferentia extends from the anterior part of the testis longitudinally to the posterior part of the body and in its route is situated ventrally to the ovary, then enters as they join into the false vesicula seminalis, which is pear-shaped, and has a length of about 56 μm and a moderate width of about 21 μm. Its cavity is filled with thick spermatic mass and is surrounded by a very thin muscular layer, mainly of outer longitudinal muscle fibres, each of which has a length of about 8.8 μm and few inner scattered circular muscle fibres. The false vesicula seminalis is situated nearer to the dorsal surface than the ventral one. It leads to an oval vesicula seminalis by a very short ductus seminalis. The vesicula seminalis has a length of about

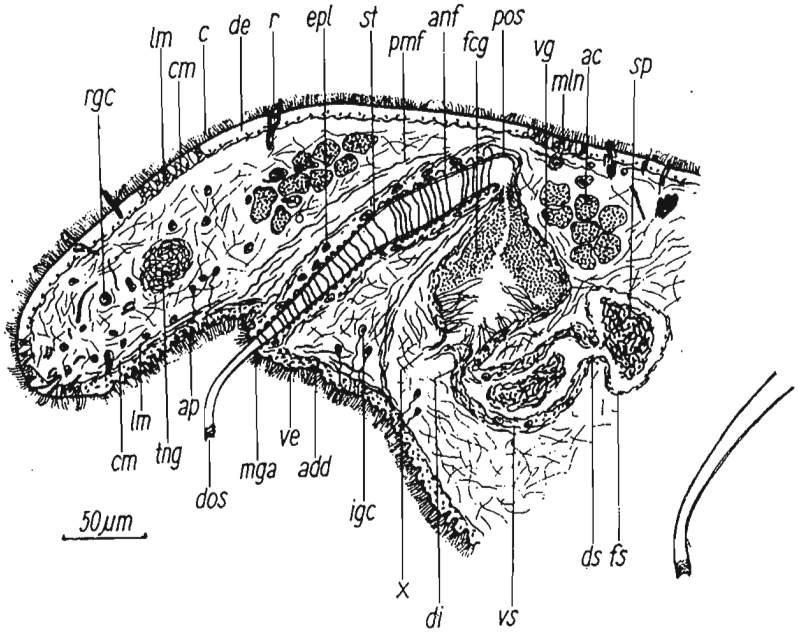

Fig. 3. *Macrostomum niloticum* n. sp. Detail of male genital apparatus

44 μm and a width of about 24.2 μm. It is situated ventrally to the false vesicula seminalis (sperma-ball). The epithelial layer of the vesicula seminalis is a syncytial structure and is formed of fine fibrillated plasma, in which are embedded oval nuclei which range about 4.4 μm in length each. The wall of the vesicula seminalis is formed by longitudinal, circular and diagonal muscle fibres. It is filled with a thick mass of sperms. The vesicula seminalis leads to a pear-shaped vesicula granulorum through a very short ductus intervesicularis, surrounded by a strong sphincter. It has a length of about 6.6 μm. Its wall is about 4.4 μm in thickness and it possesses a length of about 66 μm. The ventral half of the vesicula granulorum is provided with long cilia and the dorsal half is filled with fine coarse granules each of which has a diameter of about 0.7 μm. The epithelial wall is provided with long and circular muscle fibres. It has a syncytial plasmodial structure, whereon nuclei are

scattered. Each nucleus has a length of 4.4 μm. The distal end of the vesicula granulorum is attached to the proximal part of the chitinised stylet. The stylet is of tubular form. Its proximal part is curved and its diameter reaches about 9.9 μm. In this respect it differs from that of *Macrostomum tennessensis* (Ferguson 1940, part VII p. 125), as the latter has a widened crenate base. It has an average length of about 130 μm. It is not a straight but a curved tube and the distal part is sharply bent to the ventral surface of the body. The termination of the stylet has a great resemblance to that of *Macrostomum tennessensis* (Ferguson 1940, part 7, p. 125), as it is slightly expanded but the distal part is largely bent, as the oval aperture is directed anteriorly. The latter has 4.4 μm in diameter. The distal end is slightly thickened. The ventral part is more thickened than the dorsal part. The male genital canal has a syncytial epithelial layer with oval nuclei. Each nucleus measures about 4.4 μm in length. It is surrounded by an outer layer of longitudinal muscle fibres and an inner layer of circular muscle fibres and the strong annular muscle fibres are surrounding a large part of the stylet. Dorso-ventral muscle fibres which act as a protractor to the stylet are present.

The accessory granular gland cells are surrounding the vesicula granulorum especially from the dorsal part of the body and pour its their granular contents into the vesicula granulorum from its ciliated ventral part near the short ductus intervesicularis. This type of gland cells are flask-shaped and have a diameter of about 14 μm each. This glandular cell has a rounded nucleus of about 2.2 μm in diameter.

9. The Adhesive Disk (Fig. 2, 3 — add): It is located ventrally nearly at the last fourth part of the body. It is formed by a large number of cyanophilous adhesive gland cells scattered in the parenchymatous tissue. Each gland cell is pear-shaped and has a length of 6.6 μm and a rounded nucleus of about 2.2 μm in diameter. It has a long twisted canal of a moderate length about 26.4 μm. It opens ventrally into the papilla which is a protrusible part of the ventral epithelial layer (Luther 1905, p. 10). It was observed that the nuclei of the ventral epithelial layer are sunk and are provided with numerous thick muscular layers of outer circular and inner longitudinal muscle fibres, assisting in holding fast the disc to the substratum.

Discussion

It is important in defining this species, to compare it with the other known *Macrostomum*-species which possess a slightly thickened and enlarged terminal ends of their stylets, thus *Macrostomum tennessensis* (Ferguson 1940, part 7, p. 125), has a penis stylet which bears a similarity only in its thickened enlarged terminal end, while this animal, at this part, is thinner. Moreover, this animal possesses a stylet that at its proximal end is curved at its connection with the distal part of the vesicula granulorum, and thus it differs from *Macrostomum tennessensis,* as the latter possesses a straight funnel-shaped stylet, with crenate base. This newly described animal has a stylet of a very sharped curved tube which is directed nearly vertically to the

ventral body surface. — The two eyes are embedded completely in the brain mass. Besides, a short ductus intervesicularis is present. "Rhabditenstraßen" are absent here. A ventral posterior adhesive disc is existing, which is totally absent in *Macrostomum tennessensis.*

It is worth too, to compare this animal to *Macrostomum mediterraneum* (Ax 1956, p. 24), as it has an enlarged distal terminal part of the stylet which is highly thickened only from the dorsal part and the distal aperture is not directly terminal. Also *Macrostomum niloticum* differs in that respect from *Macrostomum tenuicauda* (Luther 1947, p. 23) and also from *Macrostomum ermini* (Ax 1959, p. 67).

Species Diagnosis

Macrostomum niloticum is a new species.

II. *Macrostomum aegyptium* n. sp.

1. External features (Fig. 4): This animal has a blunt anterior end and a narrow posterior part. The body reaches its maximum width at the second third region of the body. It has a pale white coloration. The length of the body varies between 1 and 2 mm. The 2 eyes are kidney-shaped and dark-brown in colour and are placed at the beginning of the 2nd fifth part of the body. "Rhabditenstraßen" (rs) are present which are formed of 2 streams of spindle-shaped rhammites starting in front of the lateral sides of the brain mass and unite at the anterior tip of the body. Adenal Rhabdites are scattered in large numbers especially at the anterior and dorsal and posterior epithelial layer of the body. Adhesive disc (Fig. 8 — add) is located at the ventral surface in the last fifth part of the body.

2. Epithelium: The dorsal epithelial layer is thinner than the ventral epithelial layer. The first one measures about 5.5 μm in height, while the latter measures about 6.6 μm. Both epithelial layers are covered with cilia, which have the same height of the adjacent layer. Oval nuclei are embedded in the epithelial layer. Each nucleus measures about 4.4 μm in length. Fluid-filled spaces are scattered between the epithelial cells which are more abundant at the ventral epithelial. These are considered to be the outlets of the adenal cyanophilous mucous glands embedded in the parenchyma. Sausage-like rhabdites are scattered also in great numbers at the dorsal epithelial layer and the anterior and posterior part of the body. Rhabdites are single or in bundles (Varying between 2—3—5 in number). Each rhabdite measures moderately 11 μm in length and about 1.5 μm in width. The basal granules of the cilia form a thick line surrounding the shold body.

3. Musculature: a) The subepithelial muscle layer consists as normal, of outer circular muscle fibres and inner longitudinal muscle fibres.

b) The mesenchymatous muscle fibres: Strong dorso-ventral muscle fibres are scattered in the mesenchymatous tissue, extending from the dorsal subepithelial muscle layer to the ventral one. They are numerous in this animal especially at the posterior part of the body. Many layers of longitudinal

muscle fibres are well observed underneath the ventral subepithelial muscle layer, especially thick in the region of the adhesive disc. Diagonal muscle fibres are distributed through the whole mesenchymatous tissue.

4. Mesenchyma: The main internal organs are embedded in this syncytial plasmodial structure of the parenchyma. Parenchymatous cells are scattered, without order, and are oval in shape. "Freie Stammzellen" are existing. Adenal rhabdoid gland cells are found in this tissue. They secrete rhabdites either two or three or five or eiht in each packet. These glandular cells (Eosinophilous gland cells) are more concentrated at the posterior part of the body.

5. Digestive system: The mouth aperture (Fig. 4 — m), is oval in shape and is located ventrally at the beginning of the 2nd sixth part of the body.

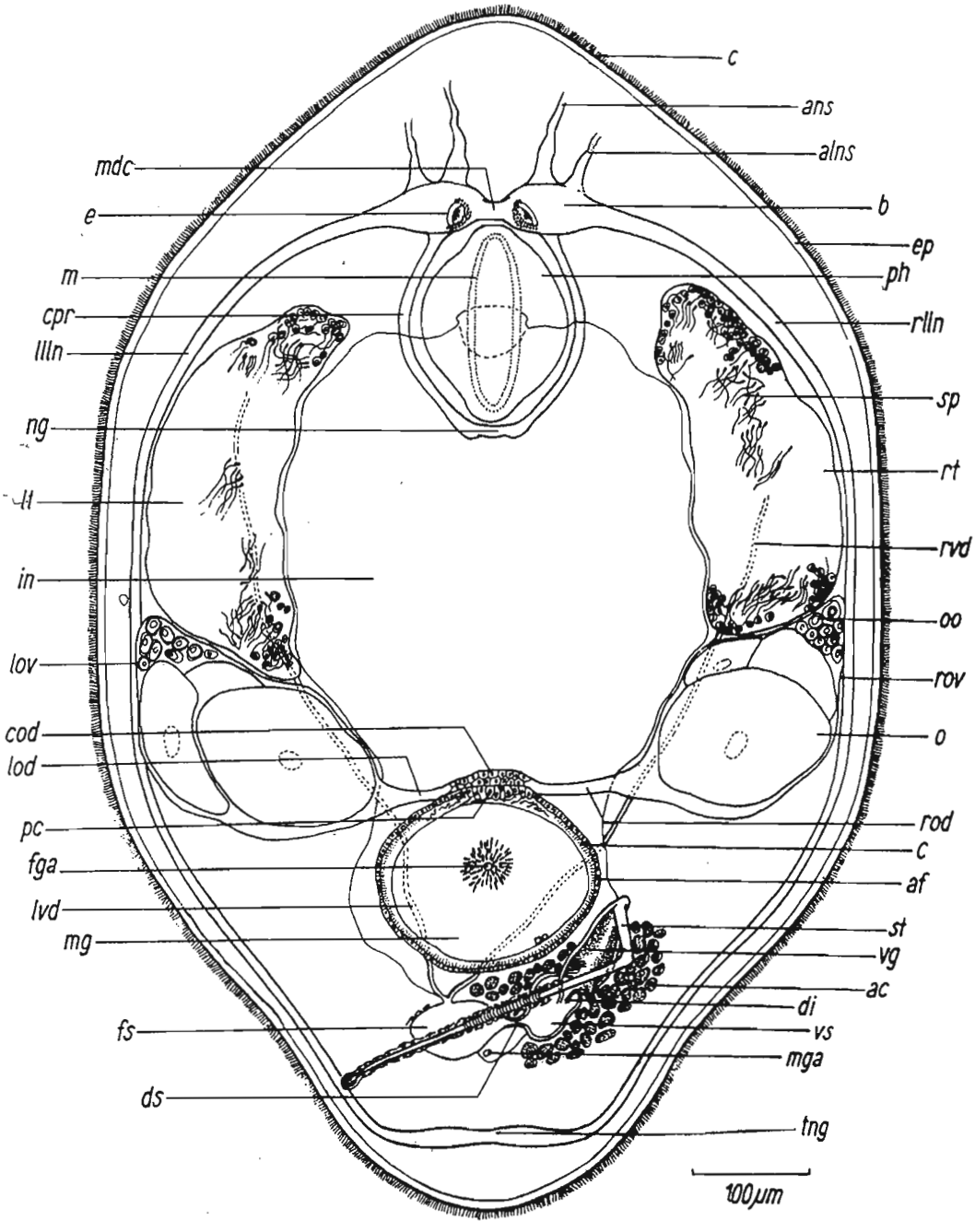

Fig. 4. *Macrostomum aegyptium* n. sp. Diagrammatic dorsal view (Gross Anatomy)

It leads to a flask-shaped pharynx (Fig. 4 — Ph) which is connected with a sack-like intestine (Fig. 4 — in). Its epithelial layer is formed of cylindrical cells which possess long cilia. The intestine is surrounded externally by an outer layer of longitudinal muscle fibres (Fig. 5 — Lm) and an inner layer of circular muscle fibres (Fig. 5 — Cm). Cyanophilous pharyngeal gland cells (Fig. 8 — Phc), are embedded in the parenchymatous tissue surrounding the pharynx. Eosinophilous gland cells, pour their fine contents at the mouth aperture and are located radially (Westblad 1923).

6. Excretory System: Protonephridia were not to be observed neither in living material nor in sections.

7. Nervous system (Fig. 4): The brain is composed of a biganglionic mass (Fig. 4 — b), which is connected together by a medio-dorsal commissure (Fig. 4 — mdc). Two pairs of nerve stems are extending from the brain mass towards the anterior part of the body. The first pair are the anterior nerve stems and the second pair are the antero-lateral nerve stems (Fig. 4 — ans, alns). Two latero-longitudinal nerves are extending posteriorly from both sides of the brain mass (Fig. 4 — rlln, llln). A circum-pharyngeal nerve ring (Fig. 4 — cpr), is extending from the posterior part of the brain. It is surrounding the pharynx and ends posteriorly with a thick nerve ganglion (Fig. 4 — ng).

Both right and left latero-longitudinal nerves unite nearly before the posterior end of the body, to form the tail nerve ganglion (Fig. 7 — tng).

8. Sensory organs: The eyes: A pair of eyes (Fig. 4 — e), which are embedded dorso-posteriorly in the brain mass. Each eye is composed of a pigment cup, eye-lens and eye chamber.

9. Reproductive System: a) Female genital apparatus: It is formed of a right and a left ovary which are slightly indented (Fig. 4 — rov, lov) and lead to the right and left oveduct (Fig. 4 — rod, lod). The two ovaries are situated nearly in the third fourth part of the body and laterally placed on both sides of the intestinal sack.

Both oviducts unite posteriorly nearly at the medio-ventral part of the body to form the common oviduct (Fig. 4 — cod). The common oviduct is connected posteriorly to the "passage cells" (Verschlußapparat) (Fig. 4 — Pc) which are a thickened part of the epithelial wall of the Antrum femininum (Fig. 4 — af). The antrum femininum (af) is an oblong sack which has a layer of nearly cubical cells. The female genital aperture (Fig. 4 — fga) is located ventrally at the beginning of the last fourth part of the body. It leads to the short vagina (Fig. 4 — va) which has a ciliated epithelial wall and opens into the Antrum femininum which contains a median mature egg.

b) The male genital apparatus (Figs. 5, 6): It is composed of 2 testes (right and left) (Fig. 4 — rt, lt). They are located on both lateral sides of the intestine nearly in the second fourth part of the body and they are slightly indented. From each testis extends a vas deferens (Fig. 4 — rvd, lvd) which begins from the medio-anterior part of the testis, towards the posterior part of the body and both vas deferens unite to open in the false vesicula seminalis (Fig. 4 — fs) which is oval in shape and is surrounded by a thin muscu-

lar layer of an outer longitudinal and an inner circular muscle fibre (Fig. 5 — lm, cm). The false vesicula seminalis opens into a pear-shaped vesicula seminalis (Fig. 5 — Vs) by a short ductus spermaticus (Fig. 5 — ds). The vesicula seminalis has a thick epitheliated syncytial layer which is surrounded by longitudinal, circular and diagonal muscle fibres (Fig. 5 — lm, cm, gmf). It leads posteriorly to an oval vesicula granulorum (Fig. 5 — vg), through the ductus intervesicularis (Fig. 5 — di) surrounded by a sphincter (Fig. 5 — scm).

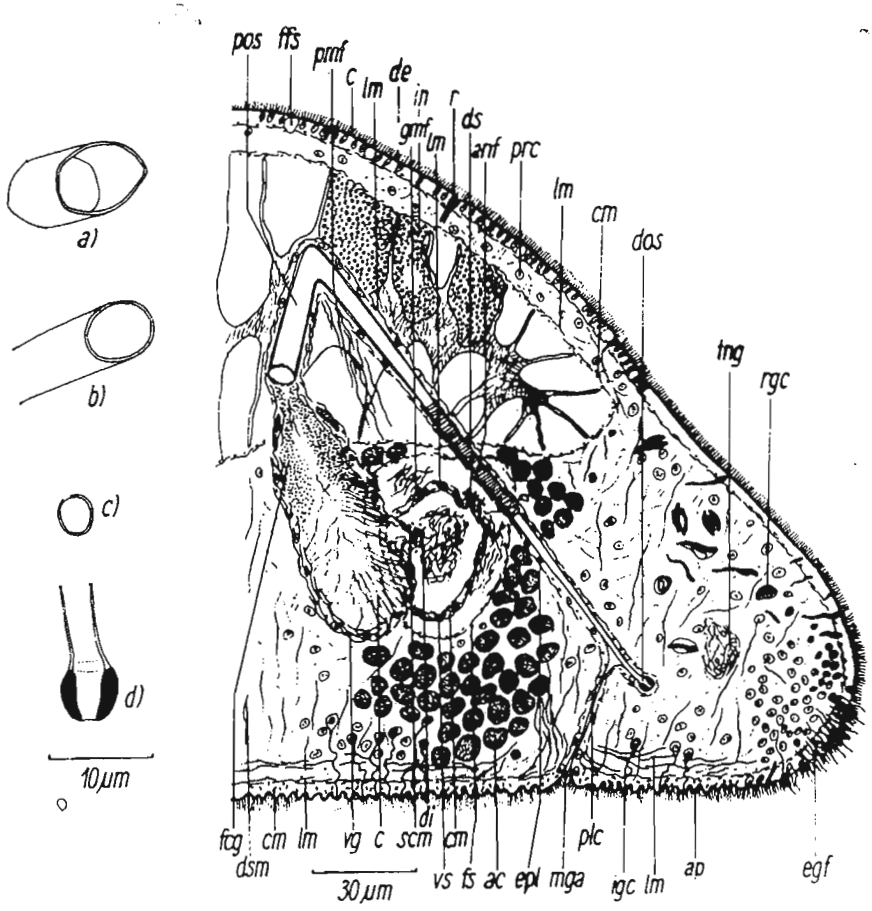

Fig. 6. Fig. 5.

Fig. 5. *Macrostomum aegyptium* n. sp. Detail of male genital apparatus
Fig. 6. *Macrostomum aegyptium* n. sp. A and B — Lateral parts of the proximal end of the stylet, C — T. S. in the stylet tube in the region before the distal end, D — the enlarged distal part of the stylet

The ventral half of the vesicula granulorum is internally ciliated (Fig. 5 — c), while the dorsal half is filled with fine coarse granules (Fig. 5 — fcg). A large number of accessory gland cells (Figs. 4, 5 — ac) are pouring their fine contents into the vesicula granulorum by a short canal placed ventrally. The dorsal part of the vesicula granulorum is connected with the proximal part of the penis stylet (Fig. 5 — Pos). The penis stylet (Fig. 5 — st) is a long tubular structure which reaches about 394 μm in length and is gradually reduced from its basal part to its bulbar termination. The bulbous end of the stylet has 2 latero-terminal thickened walls and the external opening is circular (Fig. 6 — c, d). The distal part of the stylet is slightly bent dorsally (Fig. 5 — dos). The male genital aperture (Fig. 5 — mga) is located medio-ventrally

nearly at the beginning of the last 8th part of the body. It leads to the penial canal (Fig. 5 — Plc), which has a syncytial epithelial layer (Fig. 5 — epl), surrounded by a layer of an outer longitudinal and an inner circular muscle fibre. Annular muscle fibres (Fig. 5 — anf), are surrounding nearly the third fourth part of the penis stylet. Protractor muscle fibres (Fig. 5 — Pmf), are attached to the penis stylet, especially at the proximal bent part.

Discussion

It is important in defining this species, to compare the structure of its penis stylet with those species relating to the *Macrostomum tuba* group.

This animal differs from *Macrostomum bulbostylum* (Ferguson 1939, p. 65), as the penis stylet in this animal is sharply bent at its proximal part (Fig. 5 — Pos) and also in this respect, it differs from *Macrostomum rhabdophorum* (Beklemischeff 1927, Plate I, Fig. 4).

This type of penis stylet differs also from that described in *Macrostomum pseudoobtusum* (Beklemischeff 1927) in the distal part of the penis stylet and also in the proximal part of it which is nearly tubular and has a sharp bent (nearly forming an angle of 90° with the main penis stylet axis) (Fig. 4 — st). This stylet of this animal differs greatly from that described in *Macrostomum tuba* (Graff 1882) and from *Macrostomum subterraneum* (Jens-Uwe Rixen 1961, p. 482), in connection with its proximal and distal end of the stylet.

Thus this animal is a new species — *Macrostomum aegyptium.*

III. *Macrostomum dorsiforum* n. sp.

1. External Features (Fig. 7): This animal has a narrow anterior end and a broad posterior part. The body reaches its maximal width nearly at the second third region of it. "Rhabditenstraßen" are existing (Fig. 7 — rs). The length of the body varies between 1 and 3 mm. The body has a pale grey coloration in the center (intestine) and is transparent at the outer edge. The eyes are dark brown in colour. Adhesive disc is well developped and is located ventrally at the last third part of the body. Adenal rhabdites (Fig. 7 — rh) are in large numbers especially at the anterior end, dorsal and lateral surface of the body. They are single or in bundles (two or three in every bundle).

2. Epithelium: The dorsal epithelial layer is thinner than the ventral epithelial layer (Fig. 8 — de and ve). The whole body is surrounded externally by cilia (Figs. 7, 8 — c). These cilia are longer at the ventral surface than the dorsal one. The basal granules of the cilia form a thick line through the outer part of the epithelial layer. Fluid filled spaces are scattered between the epithelial cells and are abundant at the ventral epithelial layer which are the outlets of the adenal cyanophilous gland cells embedded in the parenchymatous tissue. Spindle-shaped rhabdites (Fig. 8 — r) are to be found in large numbers at the dorsal, anterior and posterior epithelial layer. The nuclei of

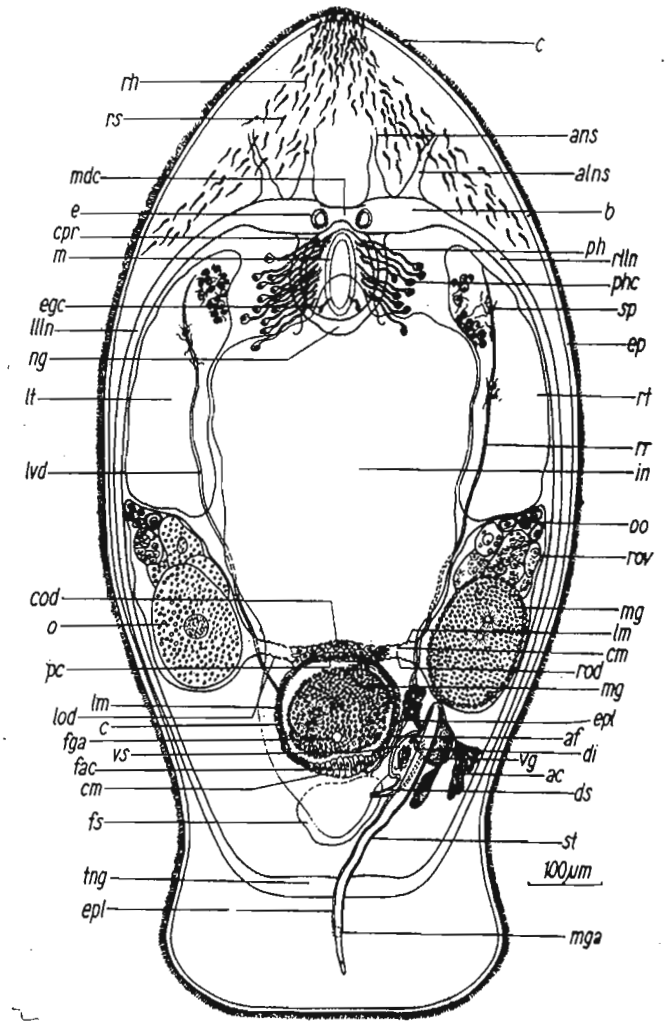

Fig. 7. *Macrostomum dorsiforum* n. sp. Diagrammatic dorsal view (Gross Anatomy)

the epithelial layer are oval in shape. In the region of the adhesive disc, the epithelial nuclei are sunk under the muscle layer.

3. Musculature: a) The subepithelial muscle layer consists as usual, of outer circular and inner longitudinal muscle fibres. In the region of the adhesive disc, the circular muscle fibres are embedded in large numbers and surrounded internally by several layers of strong longitudinal muscle fibres.

b) The mesenchymatous muscle fibres: This animal shows a striking feature of strong and developped muscular formation. Dorso-ventral muscle fibres are scattered in the parenchymatous tissue, especially at the anterior and posterior part of the body. Diagonal muscle fibres are extending through the whole parenchymatous tissue.

4. Parenchyma: It has a syncytial plasmodial structure, surrounding the main internal organs. Parenchymatous cells are scattered through the whole mesenchyma. Oval adhesive gland cells are found embedded in the parenchymatous tissue, nearly at the ventral part of the body, just underneath the adhesive disc. Adenal rhabdite gland cells are found in this tissue, and in large numbers especially at the anterior and posterior part of the body.

5. Digestive System: The mouth aperture (Figs. 7, 8 — m) is located

near the end of the first fourth part of the body. It is oval in shape and is surrounded by a large number of eosinophilous gland cells which pour their fine coarse granules into it. The mouth leads vertically to a flask-shaped pharynx (Fig. 8 — ph) which is thickly ciliated. Cyanophilous pharyngeal gland cells (Fig. 8 — phc) are surrounding the pharynx in radial streams. The pharynx leads to a sack-shaped intestine (Fig. 8 — in), which is surrounded by a strong muscular layer of an outer longitudinal and an inner circular muscle fibre (Fig. 8 — lm, cm). The intestinal epithelial layer is formed of large cylindrical intestinal cells (Fig. 8 — ic), which are filled with large coarse granules (Fig. 8 — gr). Few fusiform intestinal cells (Fig. 8 — ic) are found between the cylindrical intestinal cells. These intestinal cells possess long wavy cilia (Fig. 8 — c), which cross each other in the intestinal lumen.

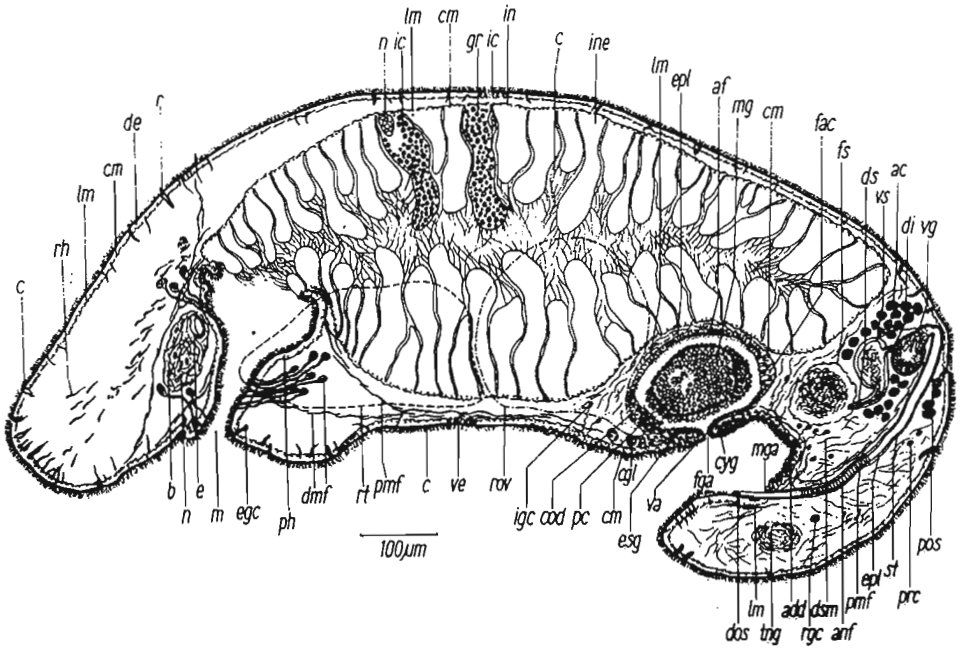

Fig. 8. *Macrostomum dorsiforum* n. sp. Lateral view based on sagittal sections

6. Excretory System: Protonephridia were not to be observed neither in living material nor in sections.

7. Nervous System (Fig. 7): The morphological structure of this system, is similar to that described in the latter 2 species.

8. Reproductive System: a) Female genital apparatus: It is formed of right and left ovaries (Fig. 7 — rov, lov) which are lobed and situated in the third fourth region of the body. In the right ovary (Fig. 7 — rov), oogonia, ovocytes and mature eggs are well observed (Fig. 7 — oo, o, mg). Each ovary leads to a transverse oviduct (Fig. 7 — rod, lod), each of which has a thin wall of polygonal cells surrounded by a layer of an outer longitudinal and an inner circular muscle fibre (Fig. 7 — lm, cm). Both right and left oviducts, unite at the medio-ventral parts of the body to form a short common oviduct (Fig. 7 — cod). The latter leads to the passage cells (Fig. 7 — pc) which are cylindrical and non-ciliated. Large numbers of foreign sperms are attached to the

passage cells which are a thickened anterior part of the antrum femininum (Fig. 7 — af). Its epithelial layer is formed of cubical ciliated cells (Figs. 7, 8 — epl, c). The newest important characteristic feature in this animal, is that the epithelial layer of the antrum femininum is largely thickened at its posterior part which is formed of a group of large non-ciliated cylindrical cells which may have a secondary sexual glandular function. This group of cells (Figs. 7, 8 — fac) have been given the name of "Female accessory gland cells". It may be considered as a transitional stage which leads to the formation of the ductus genito-intestinalis in a few other genera of the family Macrostomidae. The antrum femininum contains a median mature egg (Fig. 7, 8 — mg). The latter leads to a short ciliated vagina (Fig. 8 — va), which opens medioventrally into the female genital aperture (Figs. 7, 8 — fga) and is located at the first beginning of the last fourth part of the body. At the ventral part of the antrum femininum and surrounding the vagina, are the two types of cement granular secretions (Fig. 8 — B, cgl, cyg, esg).

b) The Male genital apparatus (Figs. 7, 8, 9): It is formed of a right and left testis (Fig. 7 — rt, lt). They are slightly indented and located laterally to the intestine and occupy nearly the 2nd fourth region of the body. From each testis extends centrally a vas deferens nearly from its anterior part (Fig. 7 — rrt, lvd). Both vas deferens unite at the medio-ventral part of the body, posteriorly and then open into a pear-shaped false vesicula seminalis (Figs. 7, 9 — fs) which is filled by sperms. It is surrounded by a thin muscular layer of an outer longitudinal and an inner circular muscle fibre (Fig. 9 — lm, cm).

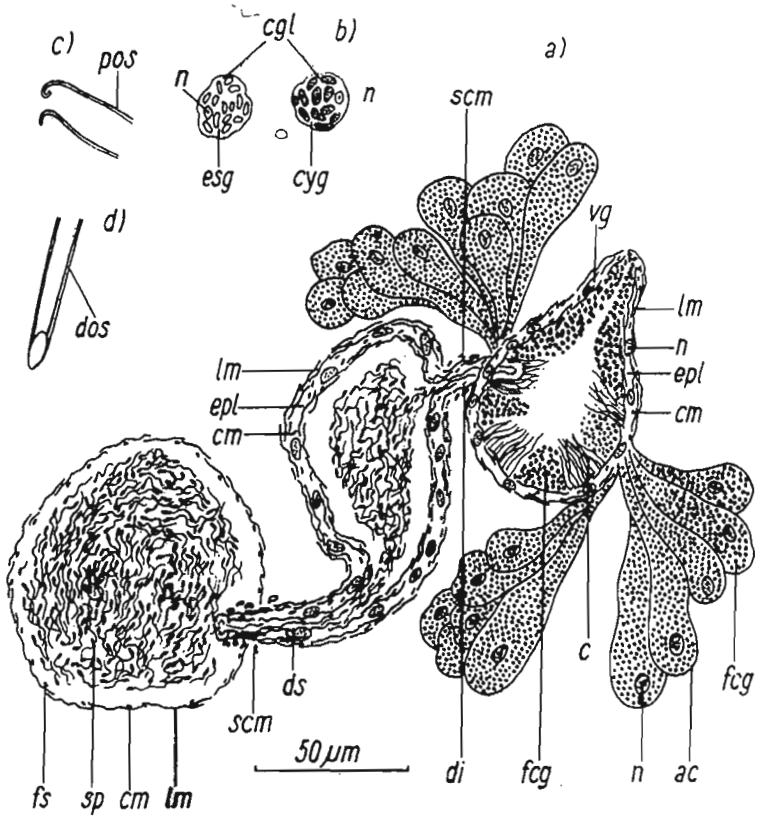

Fig. 9. *Macrostomum dorsiforum* n. sp. a — Detail of male genital apparatus, b — the 2 types of cement gland cell, c — proximal part of stylet, d — distal part of stylet

The false vesicula seminalis is connected to a thickened wall vesicula seminalis (Fig. 9 — Vs), through a slightly curved ductus spermaticus (Fig. 9 — ds) surrounded by a sphincter of strong circular muscle fibres (Fig. 9 — Scm). The vesicula seminalis is oval in shape. Its epithelial layer is surrounded by longitudinal and circular muscle fibres (Fig. 9 — lm, cm). — It leads to the vesicula granulorum (Fig. 9 — vg) through a short ductus intervesicularis (Fig. 9 — a, di), which is surrounded by a strong sphincter of circular muscle fibres (Fig. 9 — a, scm). The vesicula granulorum is pear-shaped and its ventral half part is ciliated, which is characterised by the presence of 3 separate groups of fine coarse granules (Fig. 9 — a, fcg). The upper dorsal part of the vesicula granulorum is filled with the fine coarse granules. Its dorsal distal end is connected with the proximal curved part of the penis stylet (Fig. 9 — c). Accessory granular gland cells (Fig. 9 — a, ac) are flask-shaped and pour their fine contents into the vesicula granulorum at its dorsal and ventral parts. The penis stylet (Figs. 7, 8 — st), is a long wavy cuticularised tube and has a length of about 378 μm. Its proximal part (Fig. 9 — c, pos), is nearly a straight tube and then in the middle part of the stylet, shows several twisting wavy routes (Fig. 8 — st). The distal end of the stylet (Fig. 9 — d, dos) is slightly curved and it has an oval terminal aperture.

The distal termination of the stylet is somewhat stumped as described in *Macrostomum orthostylum* (Braun 1885). The male genital aperture (Fig. 8 — mga), is located medio-ventrally at the beginning of the 1st 10th part of the body. It leads directly to the penial epithelial layer (Figs. 7, 8 — epl), which is surrounded by a muscular layer of an outer longitudinal and an inner circular muscle fibre. Protractor muscle fibre of the penis stylet is well developed (Fig. 8 — pmf).

Discussion

This animal shows a new characteristic feature of the female accessory gland cells (Figs. 7, 8 — fac) in the antrum femininum, which is not, till now, known in the other species especially relating to the genus *Macrostomum*. In principal, it is important to compare the structure of the penis stylet of this animal with that belonging to the other species of the genus Macrostomum.

Thus this animal differs in this respect, from *Macrostomum orthostylum* (Braun 1885, Plate II, Fig. 1), as the latter is a straight funnel tube.

This animal also differs in the structure of the penis stylet from that of *Macrostomum pithecusae* (Papi 1959, p. 8), as the latter has a curved stylet and distally spiral, and pointed and its length reaches 41.5 μm.

The stylet of this animal differs from that described in *Macrostomum karlingi* (Papi 1953, p. 14, 15).

It differs likewise from that described in *Macrostomum obtusum* (Vejdovsky 1895) sensu (Papi 1951).

Thus this animal is a new species of the genus *Macrostomum:*
Macrostomum dorsiforum n. sp.

IV. *Macrostomum cairoense* n. sp.

1. External features (Fig. 10): This animal has a blunt anterior end and a somewhat narrower posterior part. It is nearly oval in shape and has a pale brown coloration in the middle part (intestine). Its outer boarder is transparent. It has a length between 1 and 3 mm and the body reaches its maximal width at the last region of the first fourth part of it. "Rhabditenstraßen" are existing (Fig. 15 — rs) and it is formed of 2 lateral streams of spindle-shaped rhammiten (Fig. 10 — rh). The 2 eyes are kidney-shaped and are embedded in the brain mass dorso-posteriorly (Fig. 10 — e, eb, pu, el).

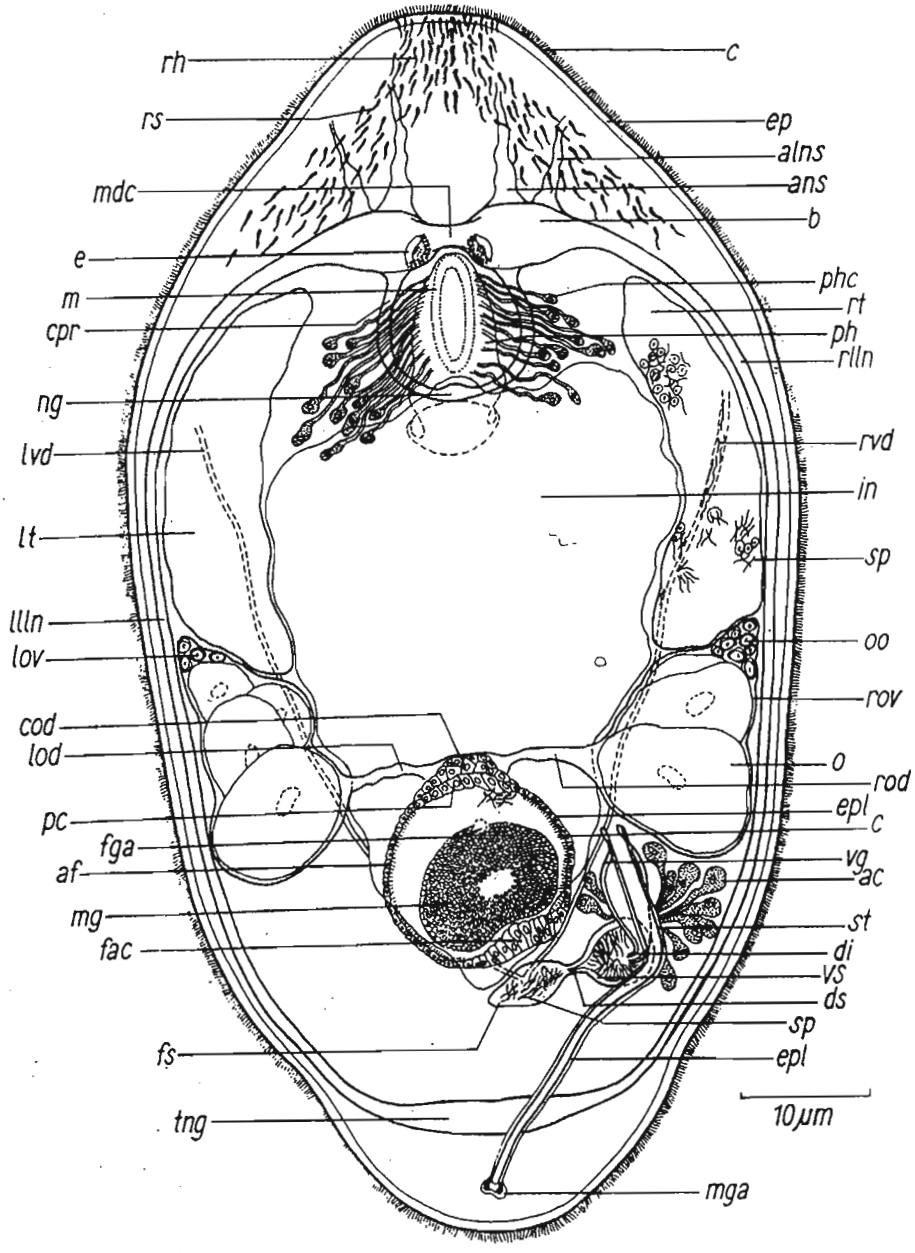

Fig. 10. *Macrostomum cairoense* n. sp. Diagrammatic dorsal view (Gross Anatomy)

2. Epithelium (Fig. 11): As normal, the dorsal epithelial layer (de) is thinner than the ventral one (ve). The cilia (c), have the same height as com-

pared to the adjacent epithelial layer. The epithelial cells have oval nuclei (n). They are cylindrical in shape and are interrupted by fluid-filled spaces (ffs) which are more abundant at the ventral epithelial layer that at the dorsal one. Adenal rhabdites (r) are single or in bundles (of 2 to 3 in number each). They are spindle-shaped and are in large numbers especially at the dorsal, anterior and posterior epithelial layer. At the region of the adhesive disc (Fig. 11 — add), the epithelial nuclei are sunk underneath the ventral subepithelial muscle layer.

3. Musculature (Fig. 11): a) The subepithelial muscle layer: As normal, it is formed of an outer circular and an inner longitudinal muscle fibre (Fig. 11 — cm, lm).

b) The mesenchymatous muscle fibres: Long and thick dorso-ventral muscle fibres (Fig. 11 — dsm), are well-developped at the anterior and posterior part of the body. Longitudinal and diagonal muscle fibres are scattered through the whole mesenchymatous tissue (Fig. 11).

4. Parenchyma (Fig. 11): It has, as described in the latter 3 new species of *Macrostomum,* a plasmodial syncytial structure in which are embedded small oval parenchymatous nuclei. At the region of the ventral adhesive disc (Fig. 11 — add), are found the adhesive gland cells (Fig. 11 — igc, ap) which are oval in shape and have a twisting canal ending ventrally to open at the tip of the adhesive papilla. The adhesive disc (Fig. 11 — add) is located ventrally nearly at the region of the last third part of the body and is supplied with strong several layers of outer circular and inner longitudinal muscle fibres

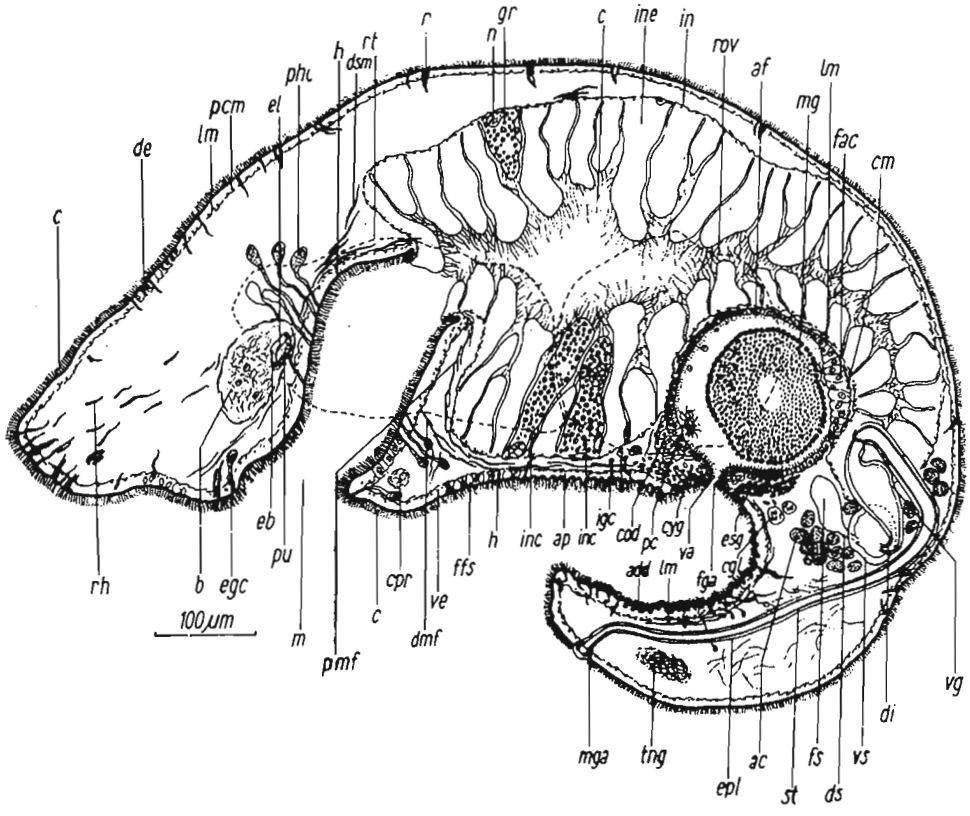

Fig. 11. *Macrostomum cairoense* n. sp. Lateral view based on sagittal sections

(Fig. 11 — cm, lm). Rhabdite gland cells are also embedded in the mesenchymatous tissue which contain rhabdites (1 or 2 or 3 or 4 in number each).

5. Digestive system (Fig. 11): The mouth aperture (Fig. 11 — m), is oval in shape and is surrounded radially by eosinophilous gland cells (Fig. 11 — egc). It leads dorsally to a flask-shaped pharynx (Fig. 11 — ph), which possesses protractor muscle fibres and dilatator muscle fibres. The pharynx is connected dorso-posteriorly to a centrally placed large sack-shaped intestine (Fig. 11 — in) which reaches its maximal width nearly at the middle part of the body. It is surrounded by a muscle layer of outer longitudinal and inner circular muscle fibres. The intestinal epithelium (Fig. 11 — ine) is formed as in the latter described 3 species, of large ciliated cylindrical cells (Fig. 11 — inc) and other spindle-shaped intestinal cells (Fig. 11 — inc).

6. Nervous system (Fig. 10): It has the same structure as described in the 2nd and 3rd new species.

7. Excretory system: Protonephridia were not to be observed neither in living material nor in sections.

8. Reproductive system: a) Female genital apparatus (Figs. 10, 11): It is formed of a right and left ovary (Fig. 10 — rov, lov) which are lobed. They are located laterally in the third fourth part of the body. Each ovary consists of oogonia, ovocyte (Fig. 10 — oo, o). From each ovary extends a transverse oviduct (Fig. 10 — rod, lod), which unite with the other one, medio-ventrally to form the common oviduct (Fig. 10 — cod), which leads to the passage cells (Fig. 10 — pc) and are located at the anterior part of the antrum femininum.

The antrum femininum (Fig. 10 — af), is nearly spherical in shape and its epithelial wall is formed of ciliated cubical cells (Fig. 11 — epl). The epithelial wall shows an enlargement at its dorso-posterior part. The latter is formed, as described in the third new species, of large non-ciliated cylindrical epithelial cells (Fig. 10 — fac), which are named as female accessory gland cells. There is a median mature egg, which is located inside the antrum femininum (Fig. 11 — mg). The antrum femininum is surrounded by a muscular layer of outer longitudinal and inner circular muscle fibres and it leads ventrally to a short vagina (Fig. 11 — va), which is surrounded radially by outer eosinophilous rod-shaped granules and inner cyanophilous polygonal granules (Fig. 11 — esg, cyg). They are the two types of cement gland cells. The vagina leads medio-ventrally to the female genital aperture (Fig. 11 — fga) which is located at the beginning of the last fourth part of the body.

b) Male genital apparatus (Figs. 11, 12): It is formed of a right and a left testis (Fig. 11 — rt, lt), which are located laterally, on both sides of the intestine and occupy the second fourth region of the body. They are slightly indented. Long vas deferens is extending from the anterior part of each testis, towards the posterior part of the body and then both vas deferens unite to open at the ventral part of the false vesicula seminalis (Fig. 11 — rvd, lvd, fs). The false vesicula seminalis is small and oval in shape, surrounded externally by a thin muscular layer of outer longitudinal and inner circular muscle fibres (Fig. 12 — lm, cm), and is filled with fusiform shaped sperms (Fig. 12 — sp).

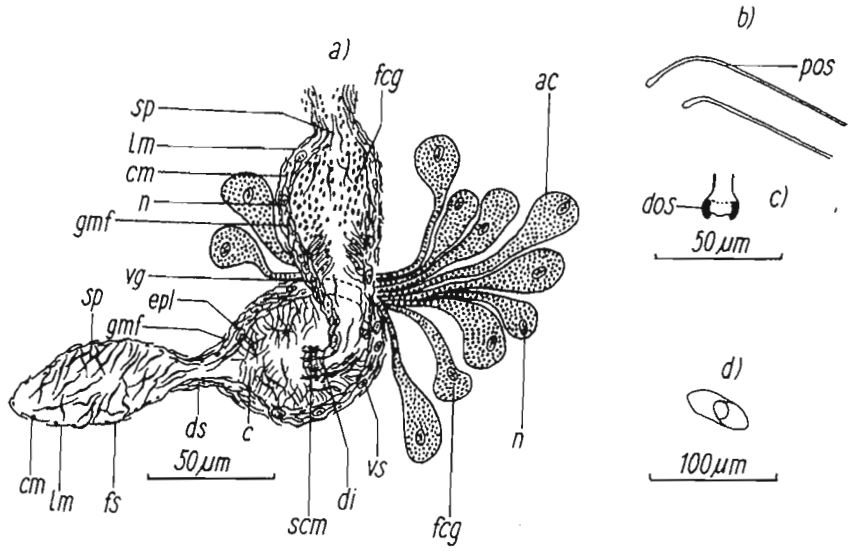

Fig. 12. *Macrostomum cairoense* n. sp. a — Detail of male genital apparatus, b — lateral view of proximal part of stylet, c — L. S. in the distal part of stylet, d — lateral view of the 1st curved part of stylet

The false vesicula seminalis leads to a nearly spherical vesicula seminalis through a ductus spermaticus (Fig. 12 — vg, ds). It has a syncytial epithelial layer (Fig. 12 — epl), and is surrounded by longitudinal, circular and diagonal muscle fibres (Fig. 12 — vs, lm, cm, gmf). The vesicula seminalis is ciliated and leads to a pear-shaped vesicula granulorum through a curved ductus intervesicularis (Fig. 12 — vg, di), which is surrounded by a strong sphincter of circular muscle fibres (Fig. 12 — scm). Its proximal part is ciliated, while the distal part is filled with coarse oval granules (Fig. 12 — fcg). Accessory granular gland cells (Fig. 12 — ac), open at the ventral part of the vesicula granulorum. The proximal part of the penis stylet is attached to the distal part of the vesicula granulorum (Fig. 11 — st). The penis stylet is a long curved, wavy cuticularised tube and has a length of about 490 μm. Its proximal part is sharply curved around the dorso-posterior part of the vesicula granulorum (Figs. 11, 12 — b, pos), and then extends posteriorly in a wavy form and endly curves sharply to open at the dorsal surface, a little distance before the posterior end and that with its bulbous distal end (Figs. 11, 12 c, dos). The wall of the terminal distal end of the penis stylet is theckened at both lateral sides (Fig. 12 — c, dos).

The stylet of this animal is surrounded by the syncytial epithelial layer (Fig. 11 — epl).

Discussion

This animal shows also an important and new female secondary sexual morphological structure inside the epithelial layer of its antrum femininum, which is named the female accessory gland cells (Fig. 11 — fac), exactly the same as that described in the third new species of the genus *Macrostomum*. This characteristic feature, is absolutely not to be found in any other known species of the genus *Macrostomum*.

It has a peculiar form of penis stylet, which opens distally in the male

genital aperture located dorsally a little distance before the posterior end of the body. In this respect, it differs mainly from any known species of the genus *Macrostomum.* It is important too in defining this animal, to compare the structure of its penis stylet with that of the other species of the genus *Macrostomum* which possess a bulbous thickened wall termination of their stylets:

Thus this animal differs greatly from that of *Macrostomum tuba* (Graff) *var. gigas* Okugawa (Okugawa, 1930, p. 75—88, 2t), especially from the distal part of the stylet, as this animal has 2 symmetrical lateral thicknessess of the wall of stylet.

It differs also from *Macrostomum curvituba* (Luther 1947, p. 25—27) as the stylet tube is sharply curved proximally and wavy at its middle part and has 2 symmetrical lateral thicknessess in the wall of its distal circular termination. It differs also, for the latter reason, from *Macrostomum subterraneum* (Rixen 1961, p. 482).

In addition to that, it differs from that described in *Macrostomum lewisi* (Ferguson 1939, part 5, p. 275).

Zusammenfassung

Vier neue *Macrostomum*-Arten aus einem Süßwasserteich in der weiteren Umgebung von Kairo werden in anatomischer, histologischer und taxonomischer Hinsicht charakterisiert. Damit wird ein erster Beitrag zur Kenntnis der Kleinturbellarienfauna Ägyptens geliefert. Die neuen Arten gehören auf Grund des Baues des Penisstiletts zur Gruppe des *Macrostomum tuba* Graff sens. lat. Zwei der neuen Arten, *M. dorsiforum* und *M. cairoense,* sind durch den Besitz eines accessorischen Drüsenorgans unbekannter Funktion im Antrum femininum ausgezeichnet.

List of Abbreviations

ans = anterior nerve stem. — alns = antero-lateral nerve stem. — add = adhesive disc. — ac = accessory granular gland cell. — af = antrum femininum. — ap = adhesive papilla. — anf = annular muscle fibre. — b = brain. — c = cilia. — cp = ciliated pit. — cpr = circum-pharyneal nerve ring. — cod = common oviduct. — cm = circular muscle fibre. — cgl = cement gland cell. — cyg = cyanophilous polygonal granule. — de = dorsal epithelial layer. — dos = distal end of the stylet. — di = ductus inter vesicularis. — dmf = dilatator muscle fibre. — ds = ductus spermaticus. — dsm = dorso-ventral muscle fibre. — ep = epithelium. — e = eye. — epl = epithelial layer. — ec = epithelial cell. — egc = eosinophilous gland cell. — esg = eosinophilous rod-shaped granule. — el = eye-lens. — egf = eosinophilous granules of rhabdite-gland cell. — eb = eye-chamber. — ffs = fluid-filled space. — fcg = fine coarse granule. — fac = female accessory gland cells. — fga = female genital aperture. — fs = false vesicula seminalis. — gr = granule. — gmf = diagonal muscle fibre. — in = intestine. ine = intestinal epithelium. — ic = intestinal cell. — igc = adhesive gland cell. — llln = left latero-longitudinal nerve. — lov = left ovary. — lod = left oviduct. — lvd = left vas deferens. — lt = left testis. — lm = longitudinal muscle fibre. — lbg = layer of basal granules. — m = mouth. — mga = male genital aperture. — mdc = medio-dorsal commissure. — mg = mature egg. — ng = nerve ganglion. — nn = nerve nuleus. — n = nucleus. — nsc = neuro-sensory cell. — o = ovocyte. — oo = oogonium. — og = yolk granule. — ph = pharynx. — pc = passage cells (Verschlußappa-

rat). — phc = pharyngeal gland cell. — pmf = protractor muscle fibre. — prc = parenchymatous cell. — pos = proximal end of the stylet. — pu = pigment cup. — plc = penial canal. — rlln = right latero-longitudinal nerve. — rov = right ovary. — rod = right oviduct. — rvd = right vas deferens. — rgc = rhabdite gland cell. — rs = Rhabditenstraßen. — rh = rhammiten. — rt = right testis. — r = rhabdites. — scm = sphincter of circular muscle fibre. — st = stylet. — sp = sperm. — tng = tail nerve ganglion. — vs = vesicula seminalis. — vg = vesicula granulorum. — ve = ventral epithelial layer. — va = vaginal. — yg = yellow granule

References

Ax, P.: Les turbellaries des étangs cotiers du littoral méditerranéen de la France méridionale. Vie et Milieu (Paris), Suppl. No. 5 (**1956**) 1—215.

— Zur Systematik, Ökologie und Tiergeographie der Turbellarienfauna in den ponto-kaspischen Brackwassermeeren. Zool. Jahrb. Abt. Syst. **87** (1959) 43, 184.

Beklemischev, W.: Über die Turbellarienfauna des Aralsees. Zool. Jahrb. Abt. Syst. **54** (1927) 87—138 (russ.).

Braun, M.: Die rhabdocoeliden Turbellarien Livlands. Arch. Naturkde. Liv-, Est- und Kurlands. Ser. II, **X** (1885) 1—125.

Bresslau, E.: Turbellaria. In: Handbuch der Zoologie (Kükenthal und Krumbach), Vol. 2 (1933).

Ehrenberg, C. G.: In: Hemprich et Ehrenberg, Symbolae physicae. Animalia evertebrata exclusis insectis recensuit Dr. C. G. Ehrenberg. Series prima cum tabularum decade prima. Berolini. fol. Phytozoa Turbellaria africana et asiatica in phytozoorum tabula IV et V delineata. Folia a—d (1831).

Ferguson, F. F.: A monograph of the genus *Macrostomum* O. Schmidt 1848. 8 parts. Zool. Anz., **126** (1939/1940) 7—120; **127**: 131—144; **128**: 49—68; 188—205, 247—291; **129**: 21—48, 120—164, 244—266.

Graff, L. von: Monographie der Turbellarien, I. Rhabdocoelida. Text und Atlasband, 442 S. Leipzig (1882).

Karling, Tor G.: Zur Morphologie und Systematik der Alloeocoela cumulata und Rhabdocoela lecithophora (Turbellaria). Acta Zool. Fenn. **26** (1940) 269 p., 17 t.

Kepner, W. A., and W. N. Stiff: Observations upon the American representative of *Macrostomum tuba*. J. Morph. **54** I (1932) 221—231.

Luther, A.: Zur Kenntnis der Gattung *Macrostoma*. Festschr. F. Palmen. Helsingfors 5 (1905) 61 pages.

— Untersuchungen an Rhabdocoelen Turbellarien. VI. Macrostomiden aus Finnland. Acta Zool. Fennica **49** (1947) 3—40.

Okugawa, K.: A list of the fresh-water Rhabdocoelida found in Middle-Japan, with preliminary descriptions of new species. Mem. Cool. Sc. Kyoto Imp. Univ. Ser. B, **5** (1930) 75—88, t. 3—4.

Papi, F.: Ricerche sui Turbellari Macrostomidae. Arch. Zool. Ital. **36** (1951) 289—340.

— Beiträge zur Kenntnis der Macrostomiden. Acta Zool. Fenn. **78** (1953) 1, 32.

— Specie nuove o poco note del gen. Macrostomum (Turbellaria macrostomida) rivenute in Italia. Monitore Zool. Ital. **66** (1959) Sep., 19 p.

Reisinger, E.: Turbellarien der Deutschen Limnologischen Sunda-Expedition. Arch. Hydrobiol. Suppl. 12, Trop. Binnengewässer **4** (1933) 239—262.

Riedel, G.: Ergebnisse einer von E. Reisinger und O. Steinböck mit Hilfe des Rask-Örsted-Fonds durchgeführten Reise in Grönland 1926. 3 Macrostomida. 4 Dalyelliidae. Vidensk Medd. Dansk naturh. Foren. **94** (1932) 34—107, 4 t.

Rixen, J.-U.: Kleinturbellarien aus dem Litoral der Binnengewässer Schleswig-Holsteins. Arch. Hydrobiol. **57** (1961) 464—539.

Schmidt, E. O.: Die rhabdocoelen Strudelwürmer (Turbellaria rhabdocoela) des süßen Wassers. Jena 1848, 67 p., 6 t.

Vejdovsky, F.: Zur vergleichenden Anatomie der Turbellarien. Z. wiss. Zool. **60** (1895) 90—214.