

Redescription of *Macrogyrodactylus clarii* Gussev 1961, A Monogenean Gill Parasite of *Clarias lazera* in Egypt

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ABSTRACT. A redescription is given of *Macrogyrodactylus clarii* Gussev 1961, a monogenean from the gills of *Clarias lazera* inhabiting Nile Delta waters in Egypt. This is the first record of a monogenean of the genus *Macrogyrodactylus* in Egypt. The gills of *C. lazera* represents a new microhabitat for *M. clarii*. Particular attention has been paid to the anatomy of the anterior adhesive apparatus, digestive system, reproductive system and haptor sclerites. A vagina was found to be absent. The possible functions of some internal organs are discussed.

During the course of studying the monogenean fauna of Egyptian freshwater fishes, *Macrogyrodactylus clarii* Gussev 1961, was encountered on the gills of the Karmout *Clarias lazera* inhabiting Nile Delta waters. Later, it became clear that this is the first record of the genus *Macrogyrodactylus* Malmberg 1957, in Egypt. Previous descriptions of *M. clarii* were incomplete since they have been limited to the shapes and sizes of the copulatory organ and haptor sclerites (Gussev 1961, and Paperna 1979). Thus, it was decided to extend our study to include detailed observations on the internal anatomy of the present parasite particularly the anterior adhesive apparatus, digestive system, reproductive system and haptor sclerites.

Material and Methods

Specimens of *C. lazera*, used in this study, were obtained from Manzala Lake and from the Demietta Branch of the River Nile near Mansoura, Dakahlia

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Governorate, Egypt. Fishes were kept alive until required in tanks containing circulating river water. Methods of collecting the parasites and studying their morphology and internal anatomy were as described by El-Naggar and Khidr (1985).

Results

The following account is based on the study of about 10 living specimens of *M. clarii* collected from the gills of *C. lazera*. The average dimensions of 10 well-flattened preserved adult specimens were as follows: length 2.330 (2.000-2.580) mm and breadth 0.400 (0.360-0.440) mm. In all other measurements of the soft parts and hard sclerites of the parasite, each average is based on measurements of 10 specimens.

Anterior Adhesive Apparatus

The head region of *M. clarii* is notched anteriorly to form two lobes. Each lobe bears a single adhesive area, located anteroventally near its distal extremity and terminates in a single spike-like process measuring 35 (33-37) μm in length (Fig. 1). Using the light microscope, the spike has been seen to protrude anteriorly through a circular aperture located dorsally at the distal extremity of the head lobe. The spike consists of at least 8 parallel fibres which appear to come into close contact with each other as they leave the circular aperture. In some living specimens, the spike was seen to retract into the main body of the lobe. Further ultra-structural investigations of these spikes are in progress, and these will permit a comparison to be made with those of *e.g. Gyrodactylus sp.* described by Lyons (1969).

Most of the lateral regions of the head, anterior and posterior to the pharynx, are occupied with unicellular glands with ducts converging on and opening on to two adhesive areas situated anteroventrally on the distal extremities of the head lobes (Fig. 1). Two kinds of gland cell could be recognized at the level of the light microscope, one producing two types of secretions, the rod-shaped bodies (S1) and ovoid to spherical secretory bodies (S2), the other producing irregularly-shaped secretory bodies filled with fibrous material (S3). The gland cells (G1) producing S1 and S2 bodies are dorsally located, numbering sixteen on each side (eleven anterior and lateral to the pharynx and five lateral to the oesophagus). The gland cells (GII) producing S3 bodies are ventrally located, numbering at least seven on each side of the oesophagus. The important feature which distinguishes between GI and GII cells is that S1 and S2 bodies are densely stained with eosin (acidophilic) while S3 bodies are densely stained with haematoxylin (basophilic).

As shown in Fig. 1, the gland ducts which extend anteriorly as cytoplasmic processes from both types of cells pass towards the distal extremity of the head

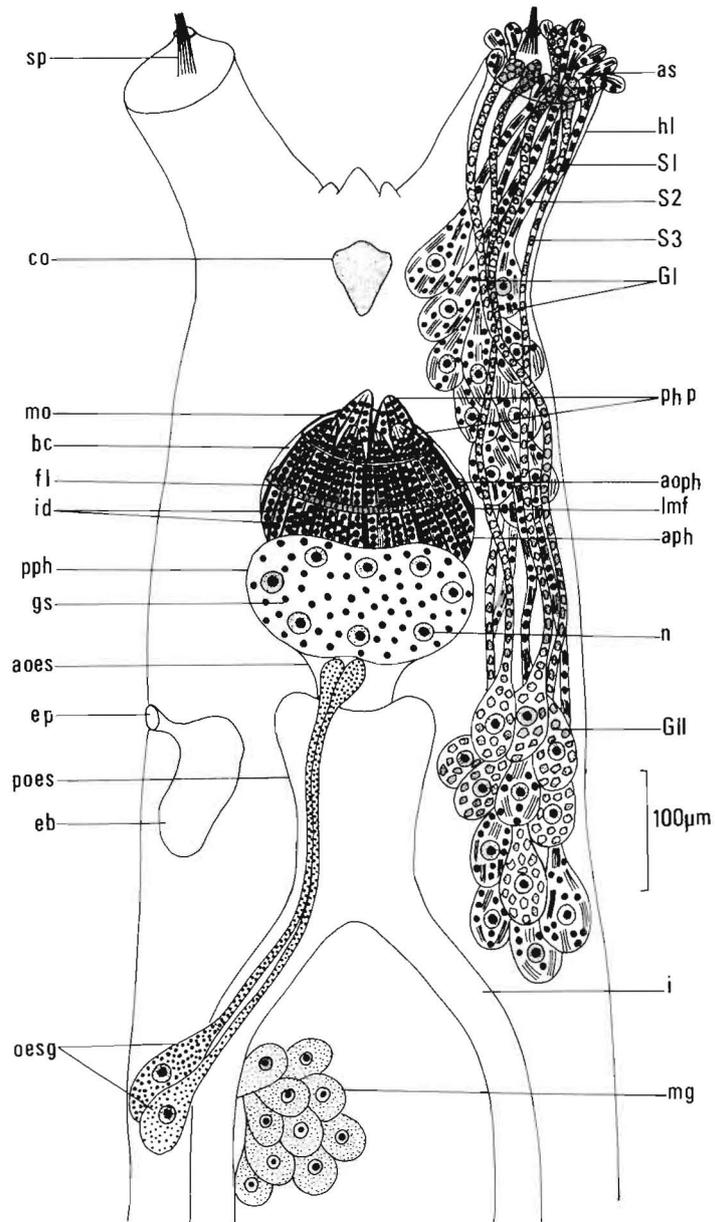


Fig. 1. Ventral view of the anterior portion of *M. clarii* showing detailed structures of the anterior adhesive apparatus, pharynx and excretory bladders. The anterior adhesive apparatus of only one side of the animal is included.

lobes where they open on to the anterior adhesive areas. The precise number of each category of these ducts was difficult to determine. However, in most specimens examined, at least five ducts containing S3 granules and 10 ducts carrying S1 and S2 bodies were observed opening on to each adhesive area.

Digestive System

The mouth opens ventrally in the anterior body region and communicates with the pharyngeal lumen through a spacious buccal cavity (Fig. 1). The pharynx is well developed and its length ranges from 130-170 μm (average 150 μm). It is divided in to an anterior protrusible section and a posterior glandular section demarcated from each other by a superficial constriction. The posterior section of the pharynx is a relatively large globular body and has a less developed musculature. This section appears to form a glandular syncytium since no evidence was found of cell boundaries between the nuclei. In most specimens examined, eight relatively large nuclei were seen dispersed in the syncytium. Each nucleus possesses a central nucleolus and two or three chromatin patches. The glandular syncytium produces oval to spherical secretory bodies which are lightly stained with eosin. The anterior section of the pharynx is protrusible and provided with six conical papillae which appear to extend anteriorly as cytoplasmic processes from the glandular syncytium. The distal ends of these papillae project into the mouth opening through the buccal cavity. Each papilla is ensheathed by longitudinal muscle fibres and is provided with 5-7 narrow gland ducts carrying spherical secretory bodies. The ducts are separated from each other by longitudinal muscle fibres and their openings are found on the distal extremity of each papilla. The anterior opening of the pharynx is surrounded by a zigzag-like fibrous lip (Fig. 1). The pharyngeal lumen leads posteriorly to the oesophagus which consists of two regions: an anterior narrower region and a posterior relatively longer and wider tube demarcated from the anterior region by a conspicuous constriction. There are two pairs of oesophageal gland cells producing relatively small spherical secretory bodies and lying, one pair on each lateral region of the head, at the level of the anterior region of the uterus. Gland ducts, arising as cytoplasmic extensions from these gland cell bodies, pass anteriorly where they dilate to form four reservoirs before opening into the anterior region of the oesophagus. The oesophagus gives rise to two intestinal limbs, one running on each side of the body and extending posteriorly as far as a short distance from the anterior edge of the haptor. The two limbs do not join each other at their posterior ends. In many adult specimens examined, two masses of gland cells were observed lying, one on each side of the body, in close contact with the anterior region of each intestinal limb (Fig. 1). The cytoplasm of these gland cells is filled with secretory bodies composed of fibrous-like material. It is not precisely known whether or not these unidentified glands open into the intestinal limbs. The answer of this question should await the results of current ultrastructural investigations.

Reproductive System

There is a single testis lying between the two intestinal limbs in the posterior region of the body proper. The single vas deferens takes an anterior course along the right side of the body. At the level of the intestinal bifurcation, the vas deferens dilates to form a vesicula seminalis which opens into the base of the cirrus by means of a relatively short narrow duct (Fig. 2). The cirrus lies ventrally, in the midline of the body, immediately behind the pharynx and its wall is entirely muscular forming what appears to be a muscular bulb. Around its aperture is a crown of twelve small, delicate spines measuring 10-15 μm (average 13 μm) in length and a single larger spine measuring 21-24 μm (average 23 μm) in length (Figs. 2 and 4). The latter large spine appears to originate from the inner wall of the posterior region of the cirrus bulb. The cirrus receives two ducts from male accessory reservoirs which lie, one on either side of the vesicula seminalis. The reservoirs are filled with fine granular secretory bodies (Fig. 2).

The two ovaries lie in the mid-line of the body just posterior to the testis (Fig. 2). A number of large cells, presumably oocytes, are situated ventrally in the median body region between both ovaries and rather behind them. They are arranged in two lateral rows and embedded in the parenchyma without a definite sheath. A large oocyte may be present in the ootype which lies to the left of the median line of the body between the testis and uterus. The receptaculum seminis lies on the right side of the ootype and appears to open into it by means of a short narrow duct. In spite of intensive search, no vaginal tube or vaginal opening was detected. Follicles of unidentified cells are found on both sides of the intestinal limbs, extending from the level of the posterior third of the body to the level of the posterior ends of the intestinal limbs. The large ovoid uterus occupies the space of the body between the two intestinal limbs and extends posteriorly to the level of the ootype. The uterus contains several embryos, contained within each other, in various stages of development (Fig. 2). In living specimens, the fully developed embryo (E1) was seen occasionally turning around in the uterus. This embryo bears a second embryo (E2) in its uterus and a third embryo (E3) was seen inside the second. The development of these embryos is still under investigation.

The Haptor

The haptor is delimited from the body proper by a constriction and is equipped with a variety of sclerites which include one pair of hamuli, eight pairs of marginal hooklets, two different connecting bars and a pair of accessory sclerites (Figs. 3 and 5). The haptor measures 400-500 μm (average 460 μm) in length and 400-480 μm (average 440 μm) in maximum width. There are two rows of tegumental papillae located ventrally, one on each side of the haptor (Fig. 3). The number of papillae varies between 32 and 36 in each row. The hamuli are large and lie in the central region of the haptor. Each hamulus possesses a single root measuring 176-184 μm (average 178 μm) long (hamuli are measured according to the method proposed by

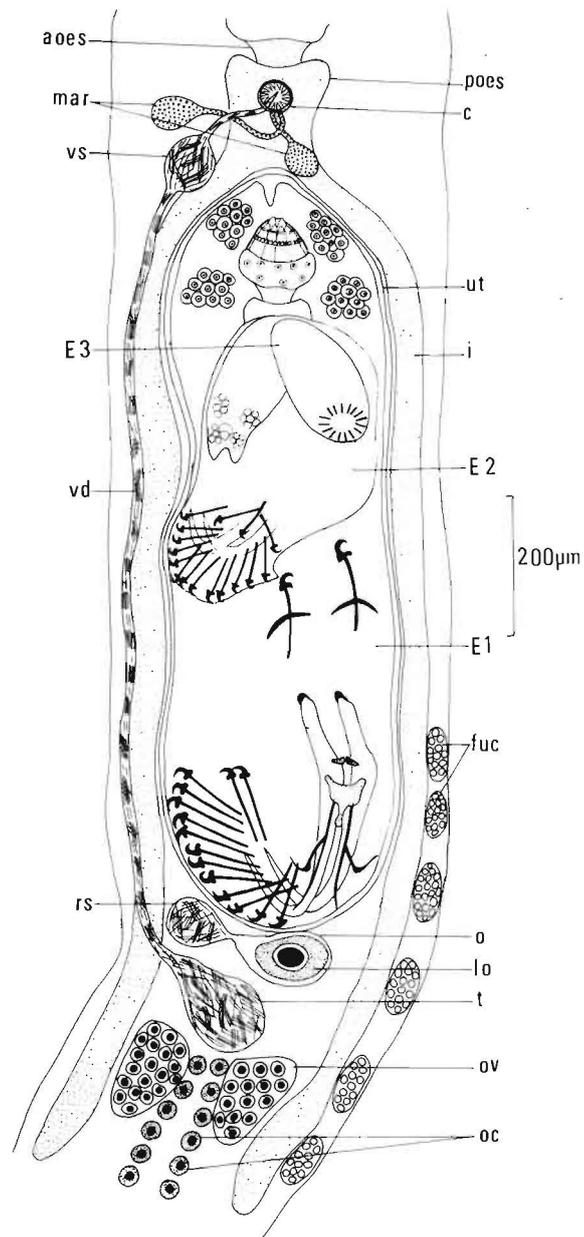


Fig. 2. Ventral view of the middle part of *M. clarii* showing details of the reproductive system

Gussev in Bykhovskaya-Pavlovskaya *et al.* (1962). The total length of the hamulus ranges from 376 to 392 μm (average 385 μm) while that of the hamulus point ranges from 112 to 128 μm (average 120 μm). There is a transverse muscle band inter-connecting the proximal ends of the roots of the hamuli (Fig. 3).

The ventral bar has a complex structure. It consists of a Y-shaped sclerite and two pairs of relatively long, posteriorly directed, rod-like sclerites. The dimensions of the Y-shaped sclerite are 110(104-116) μm in length and 106(96-112) μm in maximum breadth. Each pair of rod-like sclerites consists of two relatively long, narrow r_1 and r_2 sclerites. The r_1 sclerite appears to articulate with the posterior margin of the Y-shaped sclerite while the r_2 sclerite originates from the anterior part of the r_1 sclerite (Figs. 3 and 4). Both r_1 and r_2 sclerites extend in a posterior direction as far as the level of the posterior marginal hooklets.

The dorsal bar is comparatively small, consisting of two sclerites which appear to articulate with each other at their inner borders since in some specimens, they are arranged in a straight line while in others they follow a V-shaped arrangement. The two sclerites have never been seen completely separated from each other. The total length of each sclerite piece ranges from 32-36 μm (average 34 μm).

In addition to the dorsal and ventral bars, there are two accessory sclerites lying, one in each anterolateral region of the haptor, in close proximity with the anterolateral marginal hooklet. The accessory sclerite is a slightly curved plate measuring 76-82 μm (average 79 μm) in length.

The haptor is provided with 16 marginal hooklets, two of which occur on the anterolateral lobes while the others are found on the posterior edge of a separate fan-shaped tegumental flap projecting from the dorsal aspect of the haptor. The tegumental flap extends posteriorly where it forms fourteen finger-like processes through which the marginal hooklets protrude into the ventral surface of the haptor (Fig. 3). Each marginal hooklet consists of a rod-like handle and a sickle. There is a domus-like structure originating from near the tip of the blade of the sickle and extending proximally as far as the middle region of the handle. The proximal end of the domus is connected with the basal part of the handle by means of muscle fibres. The total length of the marginal hooklet ranges from 91 to 101 μm (average 96 μm ; handle 82 μm and sickle 14 μm).

An interesting feature of the haptor is that in those specimens stained with eosin, the dorsal bar, the ventral bar, the accessory sclerites and terminal portions of the roots of the hamuli are more deeply stained (Fig. 5).

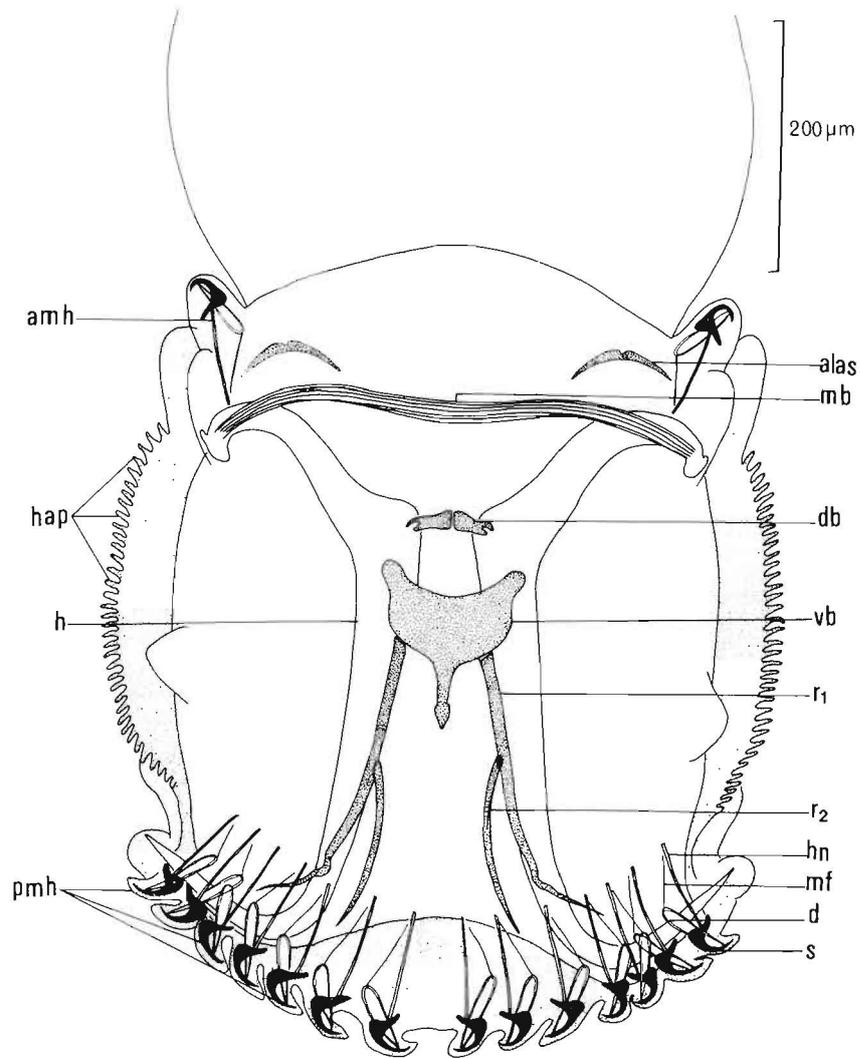


Fig. 3. The haptor of *M. clarii* showing details of the haptoral sclerites and haptoral papillae

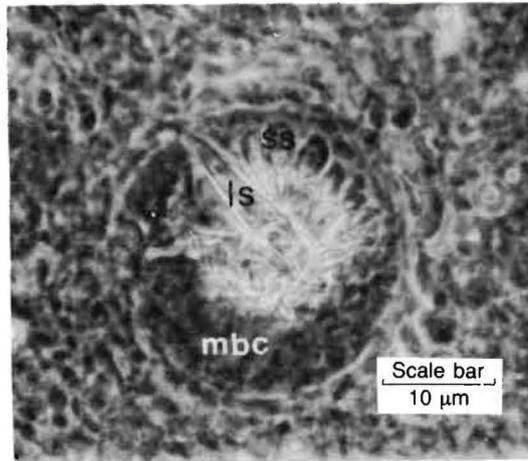


Fig. 4. Phase-contrast photomicrograph showing the detailed structure of the cirrus of *M. clarii*

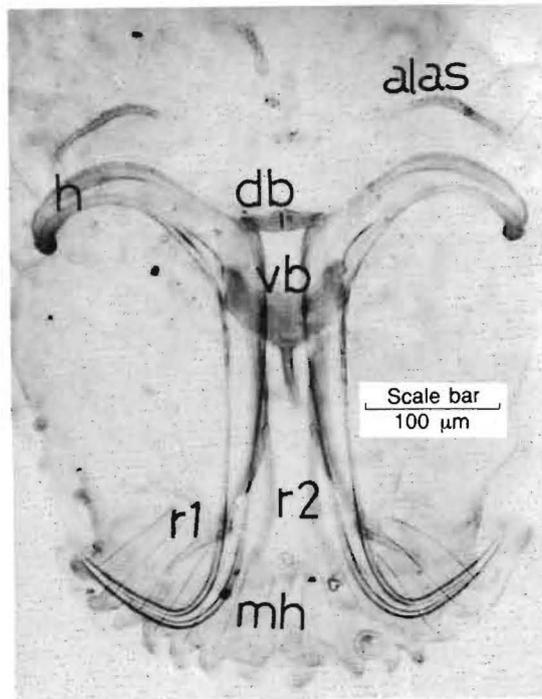


Fig. 5. Light microscope photograph of the haptor of *M. clarii* stained with eosin. Note that the dorsal bar, ventral bar, accessory sclerites and proximal portions of the roots of the hamuli are densely stained with eosin

Discussion

Only five species of the genus *Macrogyrodactylus* (other than *M. clarii*) have so far been described from the gills, fins and skin of African freshwater fishes. These five species are: *M. polypteri* Malmberg 1957, *M. congolensis* Prudhoe 1957, *M. latesi* Paperna 1969, *M. ctenopomii* Paperna 1973 and *M. anabantii* Paperna 1973. Only two of the above mentioned parasites were reported to be found on the skin of *C. lazera*; these are *M. clarii* recorded by Gussev (1961) and *M. congolensis* by Prudhoe (1957). Consequently, the gills of *C. lazera* represents a new microhabitat for *M. clarii* since no evidence was found of the parasite in scrapings of the skin and fins of the host. In the original description of *M. clarii*, Gussev (1961) has illustrated a V-shaped sclerite connecting between the roots of the hamuli. Such a sclerite was not seen in the haptor of *M. clarii* described in the present study. Gussev also described and illustrated 40-45 haptoral papillae projecting along each lateral margin of the haptor while in the present study only 32-36 haptoral papillae were detected. Furthermore, Gussev has illustrated the cirrus of *M. clarii* as being composed of 16 small spines and a single larger spine while in the present study, the cirrus was found always to consist of 12 small spines and a single larger spine. It should be emphasized that the above mentioned differences are considered to be intraspecific variations.

An interesting feature of *M. clarii* is the absence of a vagina. A vagina has been reported in most monogeneans, e.g. *Dactylogyus vastator* (Kollmann 1970) and *D. extensus* (Gerasev 1975), although no vagina has been reported in some other monogeneans, e.g. *Diclidophora merlangi* (Macdonald and Caley 1975), *Dactylogyus amphibothrium* and *D. hemiamphibothrium* El-Naggar 1980). Macdonald and Caley (1975) have shown that the sperms in *Diclidophora merlangi* gain entry *via* the tegument; the sperms themselves either penetrate the tegument or enter through a breach made by secretions from the penis or by the penis hooks. El-Naggar (1980) has pointed out that the sharply pointed nature of the copulatory tube of *Dactylogyus amphibothrium* indicates that hypodermic impregnation may occur. For those monogeneans which lack a vagina, Bychowsky (1957) has suggested that insemination may occur *via* the common genital opening and female tract. It seems likely that anchorage of the cirrus of *M. clarii* is achieved by small spines guarding the opening of the cirrus, while the larger spine serves to make a breach in the tegument of the co-copulant. Consequently, the sperms are pumped by the muscular bulb of the cirrus into the breach. A similar muscular bulb was described by El-Naggar and Serag (1986) in *Quadriacanthus aegypticus*, and it was suggested that the bulb serves for pumping the seminal fluid *via* the copulatory tube into the vagina of the co-copulant.

At the level of the light microscope, the anterior adhesive apparatus of *M. clarii* is composed of two kinds of gland cell, one of them producing two

morphologically different bodies (S1 and S2), while the other produces irregularly-shaped bodies enclosing fibrous material (S3). Gland ducts converge on and open into two cup-like sacs situated anteroventrally on the head lobes. In this respect, the anterior adhesive apparatus of *M. clarii* resembles that of *Gyrodactylus eucalia* reported by Kritsky (1978). However, the unique feature of *M. clarii* is that S1 and S2 bodies are produced in the same gland cell while in *G. eucalia* S1, S2 and S3 bodies are built up in separate gland cells. A similar pattern has been observed in *D. hemiamphibothrium* and *D. amphibothrium* (El-Naggar and Kearn 1980) while in *Entobdella soleae*, the skin parasite of *Solea solea*, only two kinds of gland cell were observed, one producing rod-shaped bodies (S1), and the other producing roughly spherical secretory bodies (S2) (El-Naggar and Kearn 1983). The S1 and S2 bodies of GI cells in *M. clarii* were found to be acidophilic while S3 bodies are basophilic. This observation confirms an earlier report by Kritsky (1978) who found that in *G. eucalia* S1 are strongly acidophilic, S2 are fairly acidophilic while S3 bodies are strongly basophilic.

Possible roles of S1, S2 and S3 secretory bodies in temporary attachment and detachment of the body during movements have been experimentally studied for *D. amphibothrium* and *D. hemiamphibothrium* (see El-Naggar and Kearn 1980) and in *Entobdella soleae* (see El-Naggar and Kearn 1983), where evidence was given to suggest that the rod-shaped bodies (S1) serve in attachment of the head region while the other secretions are used in detachment. Whether the same mechanism is present in *M. clarii* is not yet known, but ultrastructural and experimental work is now going on in order to understand this particular arrangement in which two kinds of secretory bodies are produced in the same gland cell. Whether the S1 and S2 bodies produced in the same cell are chemically different from each other is not yet known and histochemical investigations are needed to demonstrate their chemical nature.

The anterior section of the pharynx of *M. clarii* is provided with 6 papillae. In living specimens, these papillae have been seen to protrude through the mouth opening. Protrusion of the pharynx has been reported in many monogeneans such as *M. polypteri* (Khalil 1970), *E. soleae* and *Acanthocotyle* sp. (Kearn 1963). *Quadriacanthus aegypticus* (see El-Naggar and Serag 1986) and *D. hemiamphibothrium* and *D. amphibothrium* (see El-Naggar 1980).

It is noteworthy that in a brief description of *M. polypteri*, Khalil (1964) has reported the presence of six separate gland cells in the posterior region of the pharynx, while in *M. clarii* presented in this study, eight relatively large nuclei were observed without cell boundaries indicating that the posterior region of the pharynx is a glandular syncytium. The feeding mechanism and possible functions of the pharyngeal and oesophageal glands in *M. clarii* are not known. However, Khalil (1970) was able to observe the feeding mechanism in a closely related

species *M. polypteri*. He reported that the newly-born worm attaches itself to the host's skin, then the intestinal caeca become gradually filled with a bright red fluid, but the red colour soon disappears. Later, the oesophagus and the anterior part of the intestinal caeca become dark or brown in colour. In the present study, no evidence has been found of red fluid or dark colour in the intestinal caeca of *M. clarii*. This observation supports the suggestion that *M. clarii* feeds in the same way as the majority of monopisthocotylean monogeneans, *i.e.* a tissue feeder and not a blood feeder.

The pharyngeal papillae of *M. clarii* are provided with gland ducts containing spherical secretory bodies built up in the glandular syncytium. The possible functions of the pharyngeal papillae are not known. However, the presence of muscle fibres around each individual duct suggests that the contraction of these fibres may facilitate the passage of the secretory material as soon as the papillae come into close contact with the host's tissues during feeding.

An interesting feature of the digestive system of *M. clarii* is the presence of two pairs of oesophageal gland cells with their ducts converging on and opening into the anterior part of the oesophagus. The function of the secretory material produced in these glands is not known. However, they may play a role in digestion of the partially digested gill tissues after they pass into the oesophagus.

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Abbreviations for the Figs.

<i>alas</i>	Antero-lateral accessory sclerite
<i>amh</i>	Anterior marginal hooklet
<i>aoes</i>	Anterior part of the oesophagus
<i>aph</i>	Anterior section of the pharynx
<i>aoph</i>	Anterior opening of the pharynx
<i>as</i>	Adhesive sac
<i>bc</i>	Buccal cavity
<i>c</i>	Cirrus
<i>co</i>	Cerebral organ
<i>db</i>	Dorsal bar
<i>do</i>	Domus
<i>E1</i>	Fully developed embryo
<i>E2</i>	Second embryo
<i>E3</i>	Third embryo
<i>eb</i>	Excretory bladder
<i>ep</i>	Excretory pore

<i>fl</i>	Fibrous lip
<i>fuc</i>	Follicles of unidentified cells
<i>GI</i>	Gland cell producing rod-shaped bodies (S1) and ovoid to spherical secretory bodies (S2)
<i>GII</i>	Gland cell producing irregularly-shaped bodies filled with fibrous-like material (S3)
<i>gs</i>	Glandular syncytium
<i>h</i>	Hamulus
<i>hl</i>	Head lobe
<i>hn</i>	Handle
<i>hap</i>	Haptoral papillae
<i>i</i>	Intestinal limb
<i>id</i>	Individual ducts
<i>lmf</i>	Longitudinal muscle fibres
<i>lo</i>	Large oocyte
<i>lsp</i>	Large spine
<i>mb</i>	Transverse muscle band
<i>mar</i>	Male accessory reservoir
<i>mbc</i>	Muscular bulb of the cirrus
<i>mf</i>	Muscle fibre
<i>mg</i>	Masses of unidentified gland cell
<i>mh</i>	Marginal hooklets
<i>mo</i>	Mouth opening
<i>n</i>	Nucleus
<i>oc</i>	Oocyte
<i>o</i>	Ootype
<i>oesg</i>	Oesophageal glands
<i>ov</i>	Ovary
<i>ph</i>	Pharynx
<i>pmh</i>	Posterior marginal hooklets
<i>poes</i>	Posterior part of the oesophagus
<i>php</i>	Pharyngeal papillae
<i>pph</i>	Posterior section of the pharynx
<i>r₁ & r₂</i>	Rod-like sclerites of the ventral bar
<i>rs</i>	Receptaculum seminis
<i>s</i>	Sickle
<i>sp</i>	Spike-like process
<i>ss</i>	Small spine
<i>t</i>	Testis
<i>ut</i>	Uterus
<i>vb</i>	Ventral bar
<i>vd</i>	Vas deferens
<i>vs</i>	Vesicula seminalis

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إعادة وصف الطفيل وحيد العائل ماكروجيروداكتيلس كلارياس المتطفل على خياشيم سمك المياه العذبة كلارياس لازيرا في مصر

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تم في هذه الدراسة إعادة وصف ماكروجيروداكتيلس كلارياس، وهو من الطفيليات الوحيدة العائل التي تعيش على خياشيم سمك القرموط من نوع كلارياس لازيرا الموجود في مياه دلتا النيل.

أثبتت الدراسة أن هذه أول مرة يتم فيها تسجيل هذا الطفيل في مصر، كما أن خياشيم سمكة القرموط من نوع كلارياس لازيرا تعد موقعاً جديداً لهذا الطفيل، حيث أنه قد وجد سابقاً على زعانف وجلد هذا العائل.

كما أجريت دراسة تفصيلية للأجهزة الداخلية للطفيل وخاصة جهاز الالتصاق الأمامي والجهاز الهضمي والجهاز التناسلي. وكذلك الدعائم الصلبة لجهاز الالتصاق الخلفي. كما نوقشت الوظائف المحتملة لبعض أعضاء الأجهزة الداخلية.