# Redescription of Three Cichlidogyrids (Monogenea: Ancyrocephalidae) and One Gyrodactylid (Monogenea: Gyrodactylidae) Infecting *Oreochromis niloticus* (Cichlidae) From the River Nile

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**Abstract:** In the present study, the morphology and morphometric characterization of four species of monogenean gill parasites infecting the skin and gills of *Oreochromis niloticus* belonging to family Cichlidae collected from the River Nile at Giza governorates, Egypt were described by means of light microscopy. Thirty six out of 68 specimens of this fish were found to be naturally infected at a rate of 53%. Two Cichlidogyrids (family: Ancyrocephalidae) and one Gyrodactylid (family: Gyrodactylidae) were identified. *CIchlidogyrus tilapiae* Paperna, 1960 was characterized by a copulatory organ found in the midline of the body, with accessory sclerite situated roughly parallel with the copulatory tube and never seen completely isolated from it. In all worms examined, the proximal end of the accessory sclerite was found in contact with the base of the copulatory tube, indicating that there was a connection between the base of the copuatory tube and the proximal part of the accessory sclerite. *Cichlidogyrus longicornis longicornis* which was characterized from all species of this genus by having two long projections of the complex bar and its copulatory organ had a slightly long ejaculatory tube. *Cichlidogyrus tubicerrus magnus* possessed a haptor with two pairs of anchors, its ventral anchor was attached to the V-shaped bar that had a number of tooth – like projections on the inner margin. The dorsal anchor was attached to a complex bar (dorsal bar), which consists of three articulated pieces. The central piece was slightly bent and the other two pieces were attached to the central one in such away that their points of attachments divide the bar in three equal parts. *Gyrodactylus cichlidarum* Paperna, 1968 possessed a haptor resembled a cub holding a variety of hamuli, bars and supportive additional sclerites. The hamuli withdrawn inside a transparent tegumental sheath, the hamulus blade emerged from an opening decorating the distal area of a cone- shaped, transparent, tegunental sheath. *Oreochromis niloticus* fish represents a normal host for all these species except for *Cichlidogyrus tubicerrus magnus* which represented as a new host for this parasite. These species were redescribed by using light micrographs, line drawings and measurements which can be used as a guide material for the identification of these species by following researchers.
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**Key words:** Monogenea - *Oreochromis niloticus* - *Cichlidogyrus* spp. - *Gyrodactylus* spp.- Light microscopy.

## 1 Introduction

Fish are important members of aquatic ecosystems and an important source of human food. Increased interest in fish culture has also increased awareness of and experience with parasites that affect fish health, growth and survival. The Nile *O. niloticus* is one of the most highly valued main cultured fish in Egypt where the environment mainly the water temperature, is adequate 13–28°C. The disease caused by monogenean parasites produces serious problems in aquaculture (Okamoto, 1963; Ogawa and Inouye, 1997; Yoshinaga *et al*., 2000, 2001, 2009; Mushiake *et al.*, 2001; Nakayasu *et al*., 2002) with obvious pathogenicity and its susceptibility to chemicals is low. Immature worms of these parasites attach to the gill filaments of their hosts and migrate to the buccal cavity wall for maturation, as the worms ingest blood from the gills of host fish, heavily infected wild and cultured fish become anaemic (Anshary *et al.*, 2001; Yoshinaga *et al*., 2009). The public has become increasingly aware in recent years that aquatic ecosystems around the world are deteriorating from deposition of anthropogenic pollutants. Early warning systems are being developed in response, and fish parasites have been proposed as effective bioindicators of environmental pollution (Lafferty, 1997; Sures, 2004, 2006; Marcogliese, 2005). The logic underlying the use of fish parasites is based on the fact that both parasites and their hosts are exposed and, therefore, may respond to pollution in aquatic environments (Williams and Mackenzie, 2003; Khan and Payne, 2004). Monogenean parasites are recognized as useful bioindicators of environmental quality because of their predictable numerical response to chemical pollution (Khan and Thulin, 1991; MacKenzie, 1999). Monogeneans are the most abundant ectoparasitic flukes of fish; with a great diversity of species, occurring in tropics than in temperate regions of the world (Rohde, 1982).The Monogenea is a class of platyhelminths parasitic mostly on external surfaces and gills of freshwater and marine fish (Morsy, 2012). Few genera of these parasites were recorded to be endoparasites in the

blood stream, urinary system, body cavity and the gut of fish. Generally, monogenean parasites possess a flattened, leaf-like body; they range in length from less than one millimeter to not more than few centimeters. The body has an anterior and a posterior attachment organ, which play a major role during attachment, detachment and relocation on the available microhabitats of the host. To date, more than 4000 monogenean species have been described (Whittington and Cribb, 1998). According to Pariselle & Euzet (1997) Ancyrocephalidae is characterized by the presence of three pairs of cephalic glands, two posterior ocellae with crystalline lenses, two small inconsistent anterior ocellae, intestinal caeca which is unbranched, joined posteriorly, two pairs of anchors, one dorsal and one ventral, two transverse bars, one dorsal with two auricles and a ventral V-shaped one, median posterior testis, vas deferens on right side, not encircling intestinal caecum. Male copulatory complex with penis and accessory piece. Median pre-testicular ovary. Sub-median vaginal dextral opening. Vagina sclerotised or not. Seminal receptacle present. Through the family Ancyrocephalidae, the genus *Cichlidogyrus* Paperna, 1960 (infecting the gills) is host specific to diverse cichlid fish species from Africa (Paperna, 1969). Of the possible parasitic disease-causing organisms, ectoparasitic *Gyrodactylus* Nordmann, 1832 (Monogenea) species are of potential significance to tilapia culture. Clinical outbreaks of gyrodactylosis have been recorded world wide in pond-reared tilapia (Fryer and Iles, 1972; Roberts and Sommerville, 1980) where the species in the latter seven cases were confirmed morphologically by the present authors to be *G. cichlidarum* Paperna, 1968. Monogeneans have been reported to cause severe mortalities in fish hatcheries in Nigeria (Obiakezie and Taege, 1991) and South Africa in catfish, black bass and freshwater ornamental fish. Overcrowding of fish into culture ponds or tanks together with different environmental and management factors, promote heavy infestation, which can lead to productive losses, tissue damages and in some cases mortality (Hecht & Endemann, 1998).The present investigation aims to study the prevalence of natural infection with monogenetic trematodes in addition to the morphological and morphometric characteristics of the recovered monogenean species by means of light microscopy.

**2 Material and Methods**

Samples of 68 individual *O. niloticus* (F: Cichlidae) collected throughout the whole year of 2011 from different fish farmers at the River Nile in Giza Governorates, Egypt. Fish were immediately transported in water tanks to the Parasitology laboratory at the Zoology Department, Faculty of Science, Cairo University. They are identified and examined for monogenean parasites infection. Skin surface, fins and gills were examined by naked eyes and with the help of dissecting microscope for any attached parasites, lesions or external changes. After removing opercula and exposing gill arches, each gill was removed carefully from the fish, immersed in normal saline to remove any excess gill mucus. Monogenean parasites were collected with a Pasteur pipette using a dissecting binocular microscope. The monogeneans were fixed in 10% formalin and the worms were washed with distilled water to remove excess fixative. Acetic acid alum carmine was used for staining according to Carleton (1967) for 5-10 minutes for permanent whole mount preparations. Dehydration was maintained by passing in ascending series of ethyl alcohol. Specimens were cleared in clove oil and xylene then mounted in Canada balsam. For each manogenean parasite, the sclerotized parts, namely haptors, copulatory organs, were drawn using Camera Lucida. All measurments, in mm, are given as mean± standard deviation (minimum-maximum), as proposed by Gussev (1962). The sclerotized parts were measured using a measuring ocular micrometer calibrated against a stage micrometer slide according to Gusev, 1955 (in Bychovskaya Pavlovskaya *et al*., 1964) and the bars according to Douellou (1993). The process of numbering of (marginal hooklets) is adopted according to Euzet & Prost (1981).

**3 Results**

Examination of the collected fish samples indicated that 36 out of 68 fish samples (53% infection rate) were infected with monogenetic trematodes (the intensity of infection was about ten worms per fish in general). Positive correlation was observed between the increase in size and age of the infected fish and parasite abundance. Most of the infected fish had very pale gills and showed symptoms of anaemia. Given measurements of worms were based on the mean of 20 specimens. During this study, three species of mongenean parasites including two Cichlidogyrids and one Gyrodactylid were identified. These are *Cichlidogyrus tilapiae, Cichlidogyrus longicornis longicornis*, *C. tubicerrus magnus*, and *Gyroductylus cichlidarum*.

***Cichlidogyrus tilapiae***

**Paperna, 1960 (Figs. 1-6&20A)**

**Description:** The body of adult worm was elongated with a total length 0.580 – 0.631 (0.600 ± 0.020) mm, maximum body width was 0.120 – 0.160 (0.140 ± 0.020) mm. The prohaptor possessed three pairs of cephalic glands, two pairs of eyes were present on the dorsal body region anterior to the pharynx. Also, two posterior ocellei with crystalline lenses and two small inconstant anterior ocellei were present. The muscular pharynx was 0.026 – 0.029 (0.028 ± 0.001) mm in diameter. The subterminal

mouth was found ventrally between the two pairs of eyes, and delayed behind the muscular pharynx. The two simple intestinal branches were united posteriorly near the margin of the opisthaptor. The copulatory organ was found in the midline of the body, posterior to the pharynx. The accessory sclerite situated roughly parallel to the copulatory tube and never seen completely isolated from the copulatory tube. In all worms examined, the proximal end of the accessory sclerite was found in contact with the base of the copulatory tube, indicating that there was a connection between the base of the copuatory tube and the proximal part of the accessory sclerite. The copulatory tube was 0.060 – 0.070 (0.063 ± 0.001) mm, the accessory piece was 0.059 – 0.064 (0.062± 0.001) mm in length.

Haptor delicate with two pairs of anchors, strongly developed. The total length of ventral anchor was 0.040- 0.044 (0.041 ± 0.002) mm, its shaft length was 0.034 – 0.039 (0.037 ± 0.002) mm, the point length was 0.011 – 0.015 (0.014 ± 0.002), the inner root was 0.009 – 0.014 (0.010 ± 0.002) mm, and the outer root was 0.004 – 0.007 (0.006 ± 0.001) mm in length. Ventral anchor was attached to V- shaped bar, which has a number of teeth – like projections on the inner margin. The total length of this bar was 0.053- 0.059 (0.058 ± 0.002) mm and 0.008- 0.013 (0.010 ± 0.002) mm in width. The total length of dorsal anchor was 0.039 – 0.043 (0.041± 0.002) mm, the shaft length was 0.025 – 0.031 (0.030 ± 0.002) mm, while the point length was 0.009- 0.013 (0.010 ± 0.002) mm. The inner root length was 0.014-0.019 (0.015±0.002) mm, and the outer root length was 0.003 – 0.007 (0.005 ± 0.001) mm. The dorsal anchor was attached to a complex bar (dorsal anchor) which consisted of three articulated pieces, the central piece was slightly bent and measured 0.056 – 0.061 (0.058 ± 0.002) mm in length. The other two pieces were attached to the central piece in such a way that their points of attachment divide the bar into three equal parts, the length of the pieces was 0.013- 0.017 (0.016 ± 0.001) mm and the connection between them was 0.023 – 0.028 (0.025 ±0.002) mm. The opisthaptor containing marginal hooklets, usually (14). The marginal hooklets of the first pair of anchors measured 0.022 – 0.025 (0.024 ± 0.001) mm, and those of the second pair were 0.010 – 0.016 (0.13± 0.002) mm in length.

**Remarks**

***CIchlidogyrus tilapiae*** was reported from *O. niloticus, S. galilaeus* and *T. simonis* in Israel and Southern Ghana by Paperna, 1960 and 1965. Paperna, 1969 reported this type in *T. mosambica* from Ghana. By comparison of the recorded measurements herein with those recorded by previous studies, we found that dimensions of sclerites were generally larger in our species.

***Cichlidogyrus tubicerrus magnus***

**Paperna et Thurston, 1969 (Figs 8-10&20B)**

**Description:** The body was elongated with total length of 0.42 – 0.48 (0.43 ± 0.02) mm and the maximum width was 0.12 – 0.17 (0.15 ± 0.02) mm. The length of the muscular pharynx was 0.025- 0.030 (0.026 ± 0.002) mm, and was located in the prohaptor, behind the margins of the posterior pair of eyes. The copulatory organ was 0.081 – 0.085 (0.084 ± 0.001) mm in length and was s-shaped, wide with a constant width and an irregular basal portion variable in shape. The accessory piece measured 0.043- 0.049 (0.047 ± 0.002) mm in length. Haptor with two pairs of anchors strongly developed. The total length of ventral anchor was 0.041 – 0.046 (0.044 ± 0.001) mm, the shaft length was 0.038 – 0.041 (0.04 ± 0.001) mm, the point length was 0.013-.018 (.014±0.002) mm, and the outer root length was 0.006 - 0.009 (0.007 ± 0.001) mm. The ventral anchor was attached to the V-shaped bar that had a number of teeth – like projections on the inner margin. The total length of this bar was 0.043 - 0.050 (0.045 ± 0.002) mm, and its width was 0.005 - 0.008 (0.007 ±0.001) mm. The total length of dorsal anchor was 0.040 - 0.046 (0.042 ±0.002) mm. The shaft length was 0.022 - 0.027 (0.025± 0.002) mm and the point length was 0.009-0.014 (0.011 ± 0.002) mm. The inner root was 0.017-0.024 (0.020±0.003) mm and the outer one was 0.006-0.009 (0.008 ± 0.001) mm. The dorsal anchor was attached to a complex bar (dorsal bar), which consisted of three articulated pieces, the central piece was slightly bent and measured 0.045 - 0.050 (0.047 ± 0.002) mm in length. The other two pieces were attached to the central one in such away that their points of attachments divided the bar in three equal parts. The piece length was 0.010 – 0.016 (0.014± 0.002) mm and the connection between them was 0.015 – 0.019 (0.017 ± 0.001) mm. The marginal hooklets of the first pair of anchors were 0.014 – 0.019 (0.017 ± 0.002) mm and those of the second pair were 0.021 – 0.025 (0.023 ± 0.001).

**Remarks**

*Cichlidogyrus tubicirrus magnus* was found for the first time on gills of *O. niloticus* in Uganda by Paperna and Thurston (1969) then was reported from *Tilapia zilli* Gervais, 1848 in Egypt by Ergens (1981) as a new host. The examination of the type specimen showed that measurements of the haptoral pieces correspond nearly to those of the original description, while those for the ventral anchor length and its shaft, shaft length of dorsal bar, ventral bar length differed in the present description (smaller than original description). This specimen, regarding the drawings and measurements, shows no significant differences with the original study as described by Paperna and

Thurston (1969), the great differences was in the measurements of some haptor sclerites.

***Cichlidogyrus longicornis longicornis***

**Paperna et Thurston, 1969 (Figs. 11-14&20C)**

**Description:** The body of adult worm was medium sized with a total length measured 0.280 – 0.350 (0.320 ± 0.02) mm, and a maximum body width 0.080- 0.140 (0.110 ± 0.02) mm. The prohaptor had three pairs of cephalic glands. Two pairs of eyes were present on the dorsal body region anterior to the pharynx. The length of the muscular pharynx was 0.032-0.036 (0.033 ± 0.001) mm at the widest point. It was located in the prohaptor behind the margins of the posterior pair of eyes. Mouth was subterminal, found ventrally between the two pairs of eyes and delayed behind the muscular pharynx to simple intestinal branches, which united posteriorly near the margin of the opisthohaptor. The copulatory organ was 0.050 - 0.055 (0.052 ± 0.002) mm in total length, consisted of an oval basic portion, a branched supporting portion measured 0.033-0.043 (0.040± 0.002) mm and a fine copulatory tube. Haptor with two pairs of anchors was strongly developed. The total length of the ventral anchor was 0.028-0.036 (0.032± 0.003) mm, its shaft length was 0.023-0.027 (0.024 ± 0.001) mm, the point length was 0.009-0.014 (0.011± 0.002) mm, the inner root length was 0.012-0.017 (0.014 ± 0.002) mm, and the outer root length was 0.007-0.011 (0.009 ± 0.001) mm. The ventral anchor attached to the V- shaped bar, which had a number of tooth–like projections on the inner margin. The total length of this bar was 0.038-0.043 (0.040± 0.002) mm, and its width was 0.004-0.007 (0.005±0.001) mm. The total length of dorsal anchor was 0.030 – 0.036 (0.034 ± 0.002) mm, its shaft length was 0.023- 0.028 (0.026 ± 0.002) mm, and the point length was 0.006-0.010 (0.007 ± 0.001) mm, while its inner root length was 0.009-0.015 (0.012 ± 0.002) mm and its outer one was 0.005 – 0.009 (0.007 ± 0.001) mm. The dorsal anchor was attached to a complex (dorsal) bar with a characteristic shape, its middle portion 0.004 - 0.008 (0.006 ± 0.002) mm, and with markedly widened margins of 0.050-0.054 (0.052 ± 0.002) mm in length. The two pieces attached to the complex bar are long appendages measured 0.033-0.038 (0.035 ± 0.002) mm in length.

***Remarks***

This parasite corresponds to *Cichlidogyrus longicornis longicornis* described also on O. *niloticus* by Papema and Thurston (1969) and to *C. longicornis* described by Douëllou (1993) on O. *mortimeri*. Also, this parasite was obtained from the gills of O. *niloticus* caught from the River Nile by Ergens, 1981. The same parasite species has been reported only from O. *niloticus* in Uganda by Paperna and Thurston 1969 and from O. *niloticus, Sarotherodon. galilaeus* and *T. Zilli* in Ghana (Paperna, 1968). This *Cichlidogyrus* sp. is characterized from all species of this genus by having two long projections of the complex bar and its copulatory organ has a slightly long ejaculatory tube and its smaller total length of the ventral bar.

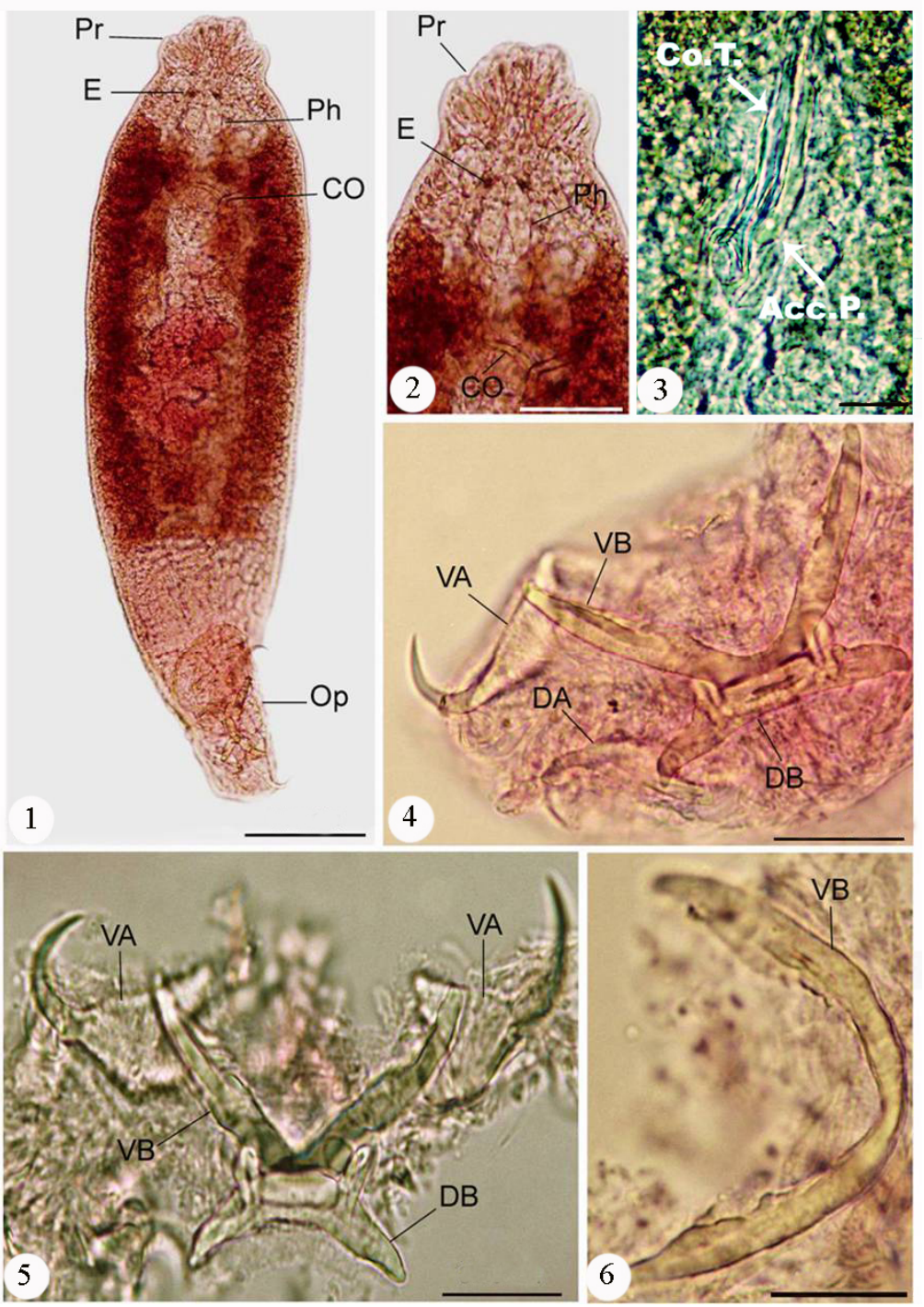
***Gyrodactylus cichlidarum***

**Paperna, 1968 (Figs. 15-19& 20)**

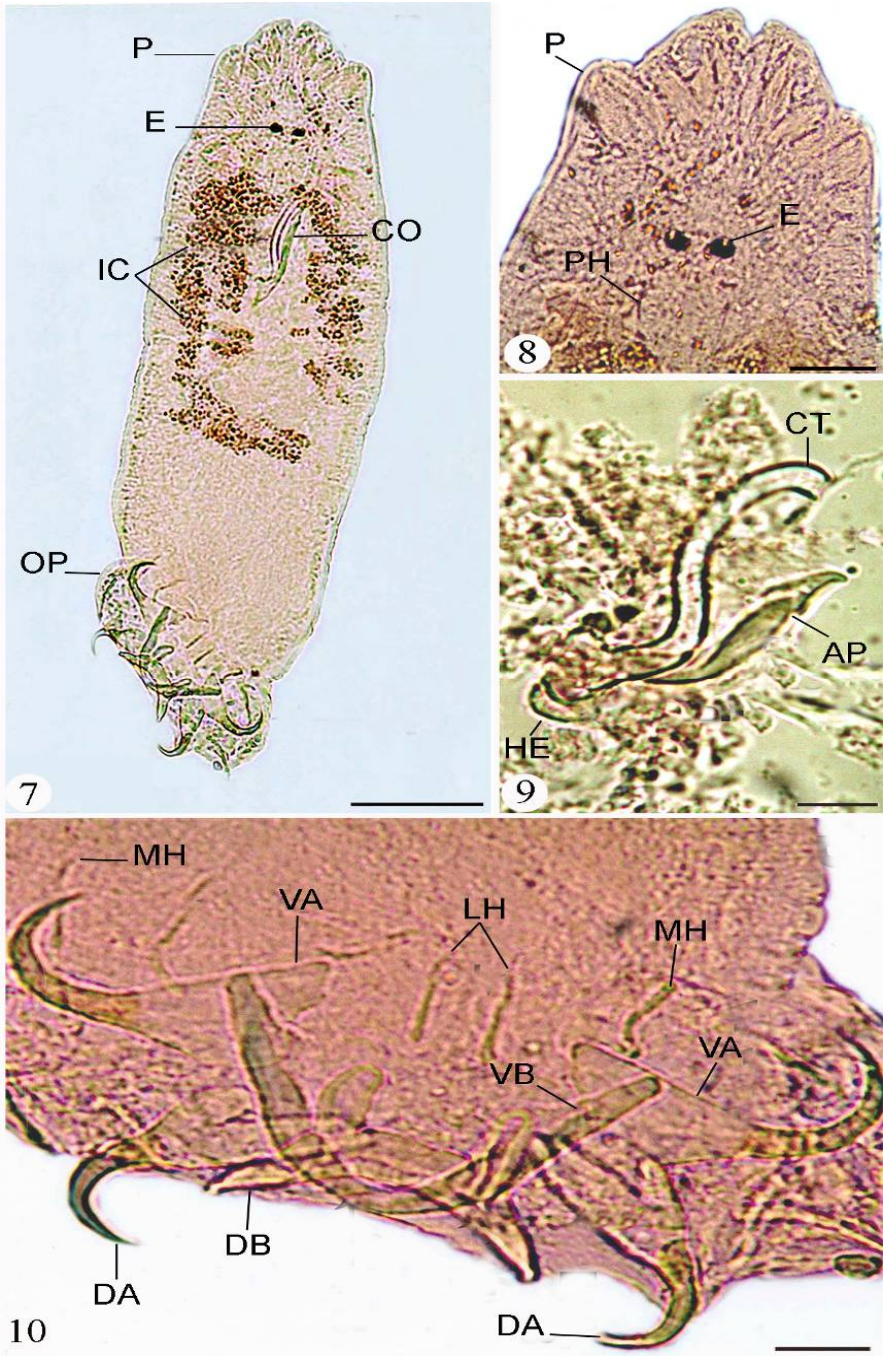
The total body length was 0.33 – 0.38 (0.35 ± 0.02) mm and the maximum body width measured 0.050 – 0.090 (0.070 ± 0.02) mm. The diameter of opisthohaptor was 0.090 – 0.130 (0.110 ± 0.01) mm. In the prohaptor, the glands located anterior to the pharynx, were more developed than those located lateroposteriorly. The pharynx consisted of 8-10 basal large cells and a layer of smaller elongated apical cells inserted in the membranous wall of the buccal cavity. Cirrus pouch possessed five spines arranged in one circle, and a large apical hook with a short spike and a wide base. The haptor resembled a cub holding a variety of hamuli, bars and supportive additional sclerites. The hamuli withdrawn inside a transparent tegumental sheath, the hamulus blade emerges from an opening decorating the distal area of a cone-shaped, transparent, tegunental sheath. The hamulus length was 0.095 – 0.115 (0.108 ± 0.05) mm, the shaft length was 0.060 – 0.090 (0.08 ± 0.005) mm. The hamulus roots length was 0.03 – 0.05 (0.04 ± 0.008) mm, the point length of the ventral bar was 0.020 – 0.025 (0.022 ± 0.002) mm. The dorsal bar length was 0.024 000– 0.028 (0.026 ± 0.002) mm, and 0.003 – 0.006 (0.004 ± 0.001) mm in width. The length of marginal hooklets was 0.026 – 0.030 (0.028± 0.002) mm.

**Remarks**

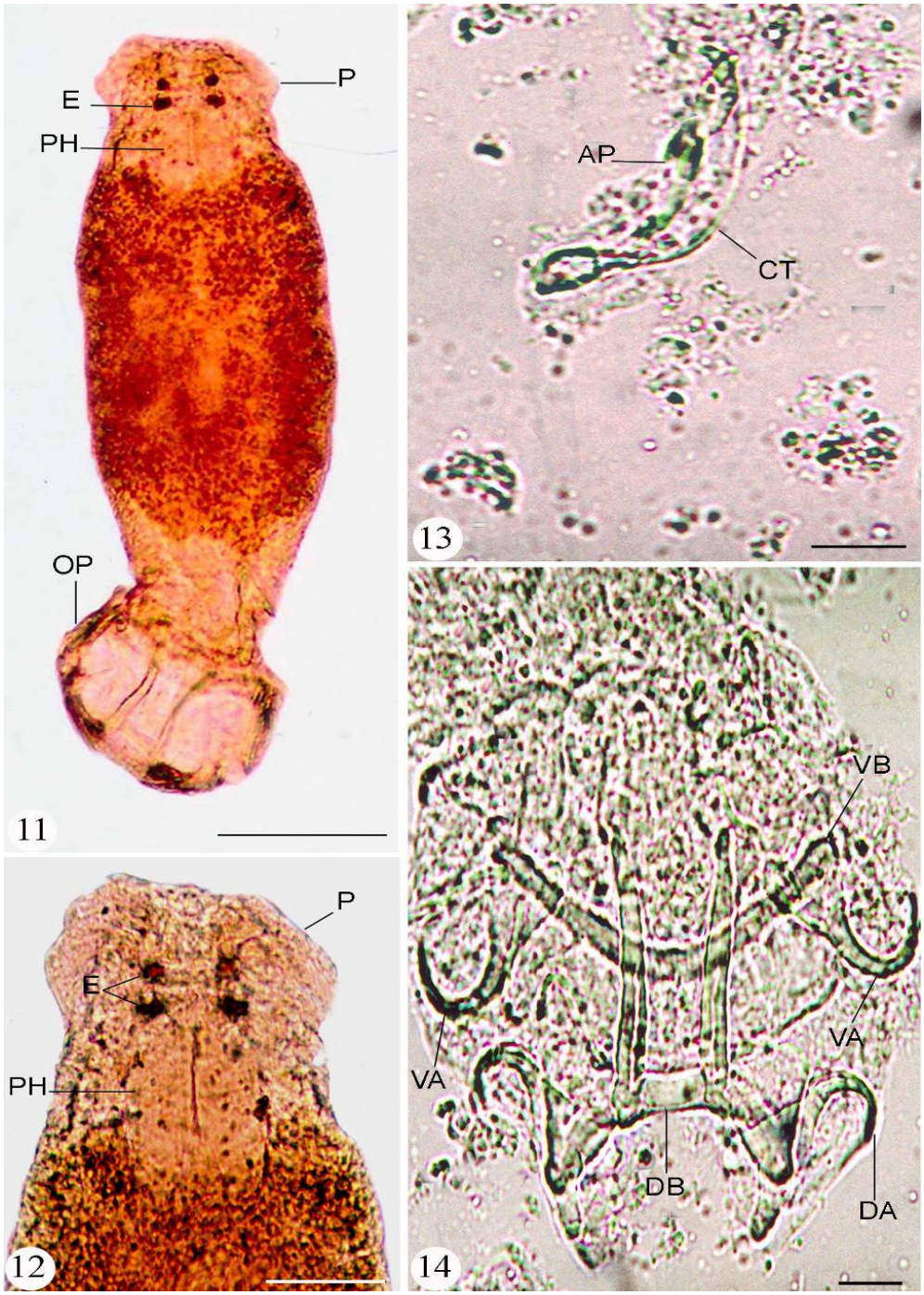
*Gyrodactylus cichlidarum* was originally described from *Sarotherodon galilaeus galilaeus* (L.) (syn. *Tilapia galilaea*) from the Accra plains and Akuse lagoon, Lower Volta, Ghana, but has also been recorded from *Tilapia zillii* (Gervais) (syn. *Chromis zillii*), *Hemichromis fasciatus* Peters and *H. bimaculatus* Gill from various locations around the Volta Lake (Paperna, 1968). Paperna (1979) cited additional hosts and locations for *G. cichlidarum* namely *Sarotherodon melanotheron heudelotii* (Duméril) and *Tilapia guineensis* (Günther) from coastal saline lagoons in Ghana; *T. zillii*, *S. galilaeus galilaeus* and *Oreochromis aureus* (Steindachner) from coastal Israel and Jordan systems; and *Haplochromis flaviijosephi*. The examination of the type specimen showed that measurements of the haptoral pieces correspond nearly to those of the original description by Paperna, 1969, while those for the copulatory organ were more or less different.



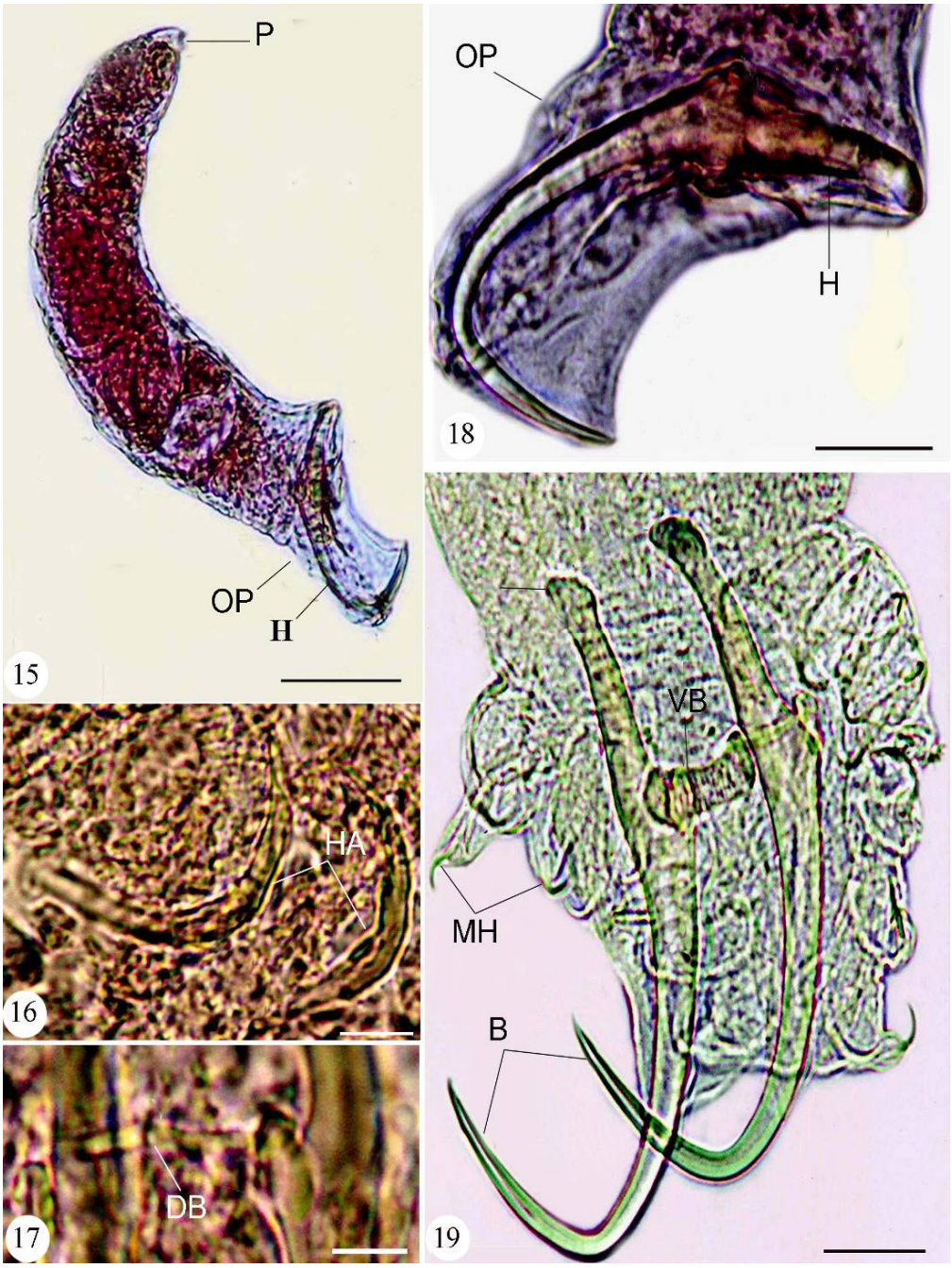

**Figs. 1-6: Photomicrographs of *Cichlidogyrus tilapiae*.** 1 Whole mount preparation of the adult worm with its anterior attachement organ or prohaptor (P), two pairs of eyes (E), pharynx (PH). The worm terminates at a posterior attachment organ or opisthohaptor (OP). (Scale bar 0.1 mm) 2 High magnification of the anterior attachement organ or prohaptor (P) surrounding two pairs of eyes (E), pharynx (PH) and the copulatory organ of the worm (CO). (Scale bar 0.04 mm) 3 High magnification of the copulatory organ (CO), it is composed of a coulatory tube (CT) and an accessory sclerite (AP). (Scale bar 0.02 mm) 4,5 High magnification of the posterior attachment organ or opisthohaptor (OP) showing its haptoral sclerites, a ventral bar (VB), V shaped and one pair of ventral anchors (VA) a dorsal bar (DB), with two short appendages and one pair of dorsal anchors (DA) (Scale bar 0.03 mm) 6 High magnification of the a ventral bar (VB). (Scale bar 0.02 mm).



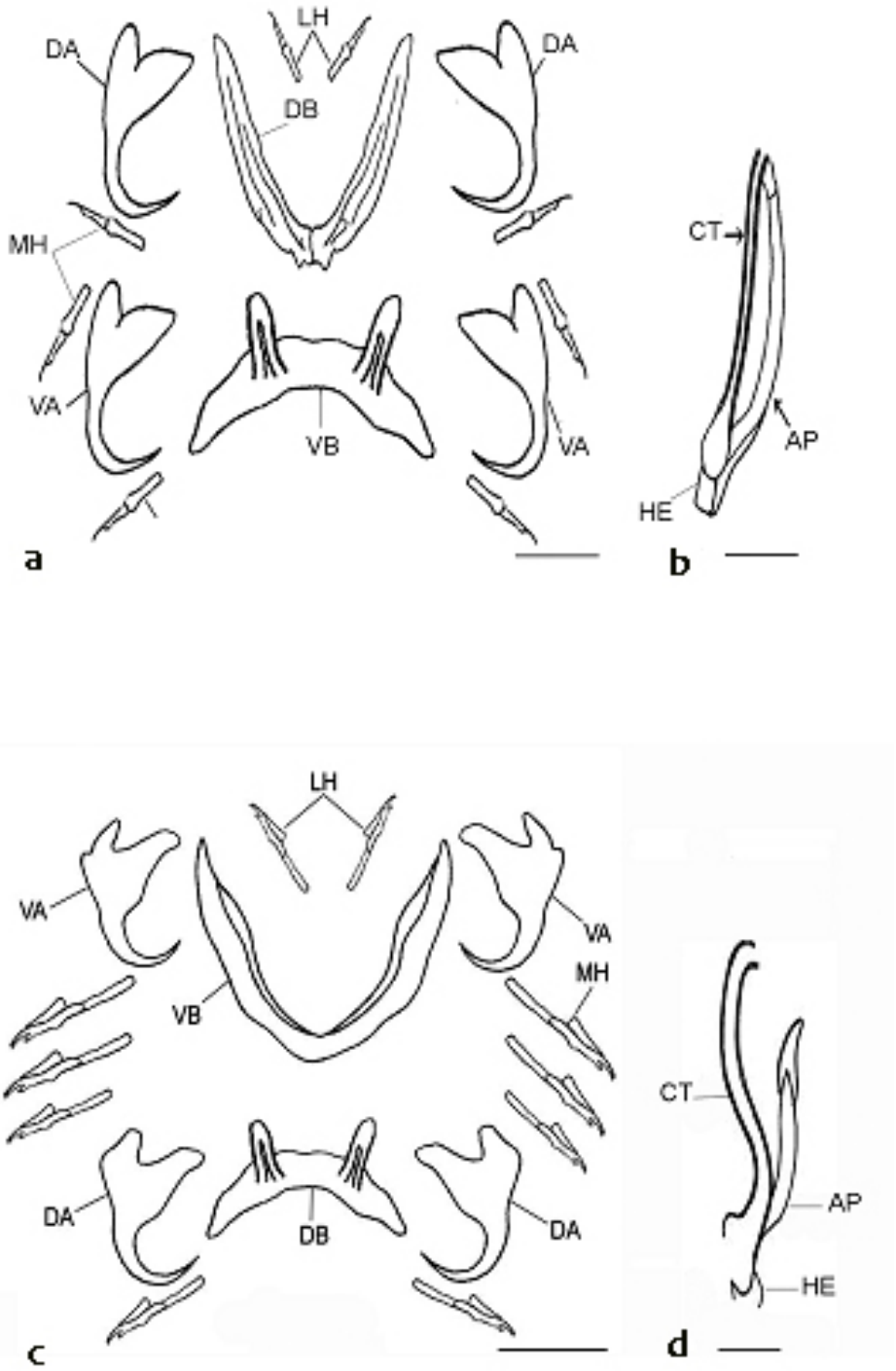

**Figs. 7-10: Photomicrographs of *Cichlidogyrus tubicerrus magnus***. 7 Whole mount preparation of the adult worm with its anterior attachment organ or prohaptor (P), eyes (E), pharynx (PH) and clearly visible copulatory organ (CO). The worm terminates at a posterior attachment organ or opisthohaptor (OP). (Scale bar 0.1 mm) 8 High magnification of the anterior attachment organ or prohaptor (P) surrounding eyes (E), pharynx (PH). (Scale bar 0.02 mm) 9 High magnification of the copulatory organ (CO), it is composed of a coulatory tube (CT), terminates at the heel (HE) and an accessory piece (AP). (Scale bar 0.02 mm) 10 High magnification of the posterior attachment organ or opisthohaptor showing its haptoral sclerites, a ventral bar (VB), V shaped and one pair of ventral anchors (VA) a dorsal bar (DB), with two short appendages and one pair of dorsal anchors (DA),6 High magnification of the a ventral bar (VB), there are two types of hooklets, one pair of larval hooklets (LH) and marginal hooklets (MH). (Scale bar 0.02 mm)



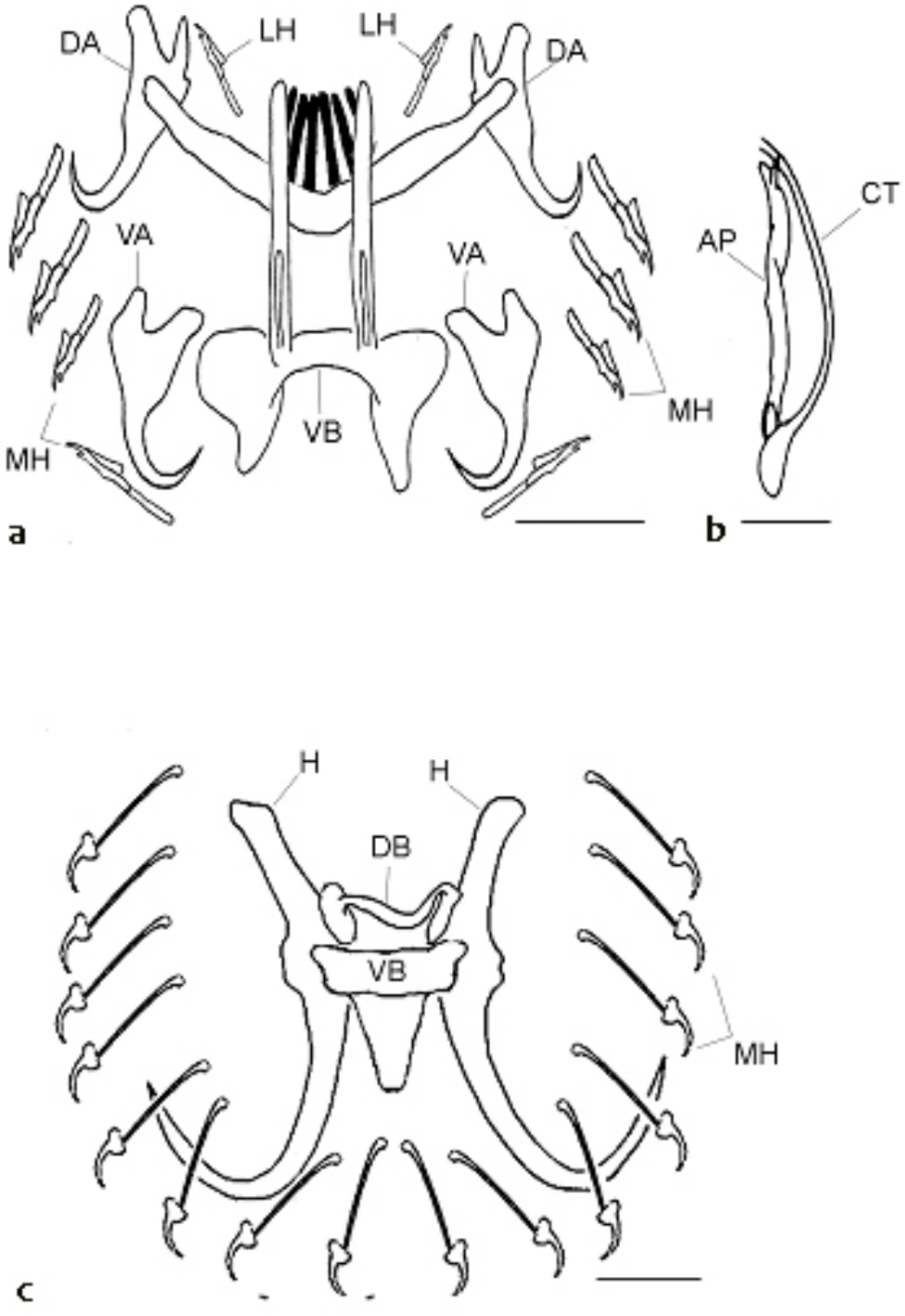

**Figs. 11-14: Photomicrographs of *Cichlidogyrus longicornis longicrnis***. 11 Whole mount preparation of the adult worm showing its anterior attachement organ or prohaptor (P), two pairs of eyes (E), pharynx (PH). The worm terminates at a posterior attachment organ or opisthohaptor (OP). (Scale bar 0.1 mm) 12 High magnification of the anterior worm body showing its prohaptor region (P) surrounding eyes (E), pharynx (PH). (Scale bar 0.02 mm) 13 High magnification of the copulatory organ (CO) of a adult worm, it is composed of a coulatory tube (CT), terminates at a heel piece (HE) and an accessory piece (AP). (Scale bar 0.02 mm) 14 High magnification of the posterior attachment organ or opisthohaptor showing its haptoral sclerites, a ventral bar (VB) is a V-shaped and one pair of ventral anchors (VA) a dorsal bar (DB), fan shaped with two long appendages and one pair of dorsal anchors (DA). (Scale bar 0.02 mm)




**Figs. 15-19: Photomicrographs of *Gyrodactylus cichlidarum***. 15 Whole mount preparation of the adult worm with its anterior attachment organ or prohaptor (P), the posterior attachment organ or opisthohaptor (OP) is composed of two long hamuli (H). (Scale bar 0.1 mm) 16- 19 High magnifications of 16 haptors of embryo (HA) (Scale bar 0.02 mm) 17 Dorsal bar (DB) (Scale bar 0.02 mm) 18 Opisthohaptor showing hamuli (H) (Scale bar 0.01 mm) 19 Opisthohaptor (OP) showing its two hamuli (H), blades (B), Ventral bar (VB) and marginal hooklets (MH) (Scale bar 0.01 mm)




**Figs. 20:** Semi schematic drawing showing the structures of both haptors (a,c) and copulatory organs (b,d) of *Cichlidogyrus tilapiae* (a,b) and *Cichlidogyrus tubicerrus magnus*. (Scale bars a 0.03; b, c, d 0.02 mm)




**Figs 21**: Semi schematic drawing showing the structures of both haptors (a,c) and copulatory organs (b,d) of *Cichlidogyrus longicornis longicrnis* (a,b) and *Gyrodactylus cichlidarum*. (Scale bars a-d 0.02 mm)

## 4. Discussion

Two hypotheses may be speculated to explain the morphological differences between these described species above: these different morphologies have been patterned by the adaptation to specific microhabitats on the gills (i.e. adaptation resulting from interspecific competition), or patterned only by the ontogeny (i.e. limited by the energy available to build the hard parts of the haptor). No answer could actually be given, but microhabitat segregation between monogenean species on the gills is well documented (Lambert and Millard, 1974, Wooten, 1974, Cloutman, 1975, Fernando and Hanek, 1976, Hanek and Fernando, 1978, Sanfilippo, 1978, Silan, 1984, Ramasamy *et al.,* 1985, Koskivaara *et al*., 1992). Further studies have to be done to confirm this segregation in the present tilappiine monogeneans model (see Bilong Bilong *et al*., 1999) to highlight the link between the morphology of haptoral sclerites and specific microhabitat, and finally to conclude about the determining factor in monogenean site selection (Pariselle and Euzet, 2003).

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