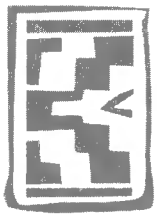

The African monogenean gyrodactylid genus *Macrogyrodactylus* Malmberg, 1957, and the reporting of three species of the genus on *Clarias gariepinus* in South Africa

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ABSTRACT

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Three different species of the genus *Macrogyrodactylus* Malmberg, 1957, collected from the gills and skin of *Clarias gariepinus* (Burchell, 1822) from the Middle Letaba Dam and Mokgoma-Matlala Dam in South Africa were examined and identified. This is the first record of a species of the genus in South Africa. The three species are *M. congolensis* (Prudhoe, 1957)—found on the skin, *M. clarii* Gussev, 1961 and *M. karibae* Douellou & Chishawa, 1995—found on the gills. The last species is elevated to the status of a species having been described previously as a subspecies of *M. congolensis.*

The present study presents and discusses the value of some of the taxonomic characters which can be used to differentiate the species of the genus. The shape and size of the sclerites of the haptor are found to be the most reliable characters. Only four species of the genus, namely *M. polypteri* and the three above-named species are regarded to be valid. Three species, namely *M. latesi* Paperna, 1969, *M. anabantii* Paperna, 1973 and *M. ctenopomii* Paperna, 1973 are regarded as *species inquirenda.* Generic diagnoses, measurements and illustrations of the sclerites of the four valid species are presented and a key for their differentiation is provided. The development of the gyrodactylid population on *C. gariepinus* during the filling of the Middle Letaba Dam in South Africa is discussed.

Keywords: *Clarias gariepinus, Macrogyrodactylus,* Monogenea: Gyrodactylidae, South Africa

INTRODUCTION

Species of three gyrodactylid genera are found on African freshwater fishes. The cosmopolitan genus *Gyrodactylus* van Nordmann, 1832 is represented by 16 different species. The other two genera, endemic to Africa and not found anywhere else, are the genus *Afrogyrodactylus* Paperna, 1968 with only one species and the genus *Macrogyrodactylus* Malmberg, 1957 represented by six species and a subspecies. No previous records of any species of *Macrogyrodactylus* from South Africa exist, but three different species belonging to this genus have been found on *Clarias gariepinus* (Burchell, 1822) caught in the Middle Letaba and Mokgoma Matlala Dams of South Africa. The attempt to identify these species led to a critical examination of the validity of some of the species of the genus, and an assessment of the significance of the various characters used for species identification.

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MATERIALS AND METHODS

Specimens of *C. gariepinus* were collected from Middle Letaba (30°24′15″E; 23°16′20″S) and Mokgoma Matlala (24°46′S; 29°25′E) Dams by either gill nets or beach seine nets. Fish were transported alive to the field laboratory and kept in well aerated water containers. Killing was done individually immediately prior to examination. Gills were removed and examined for parasites using a stereomicroscope. Para-

sites were also collected from the skin using a soft brush. Collected parasites were killed and fixed in 4% buffered formaldehyde solution and preserved in 70% alcohol. Some specimens were stained in alum carmine and mounted in Canada Balsam. Some specimens were subsequently stained in Horen's trichrome and cleared in lactophenol. Specimens were also mounted in glycerine jelly or Berlese fluid. An Olympus BH2 interference microscope was used for light microscopy and drawings were made with the help of a drawing tube. Specimens of *Macrogyrodactylus polypteri* previously collected from *Polypterus senegalus* in the Sudan were also examined, (for methods see Khalil 1970). All measurements are in millimetres. The scale for all the figures is 0,1 mm.

Four mounted specimens of the co-types of *Macrogyrodactylus congolensis* (Prudhoe, 1957) borrowed from the Natural History Museum in London (no. 1960, 5, 27, 1–15) were also examined.

REVIEW OF THE LITERATURE

Although the date on the offprint for the description of *M. polypteri*, the type species of the genus, is 4 December 1956, apparently the journal was not published until 15 April 1957. In the same year but on 6 July, Prudhoe (1957) unaware of Malmberg's genus, described a new genus and species *Neogyrodactylus congolensis,* which is identical to the genus *Macrogyrodactylus.* This led Yamaguti (1963) to consider *Neogyrodactylus* to be a synonym of *Macrogyrodactylus.*

M. polypteri Malmberg, 1957 was found on the skin and fins of *P. senegalus* from Gambia. Khalil (1964, 1969, 1970) detected this species on the same host in the Sudan and gave a detailed account of its biology. Amirthalingham (1965) and Saoud & Mageed (1969) found it in the Sudan on *Polypterus senegalus* and *P. bichir*, respectively. Schmahl & El-Wasila (1992) investigated the spermatogensis of this species. Harris (1993) recorded its presence on *P. senegalus* imported from West Africa. Harris, Cable & Tinsley (1995) reported that histochemical and ultrastructural studies of this species showed that the characteristically black banded pigmented gut is as a result of melanin derived from the host's epidermis, and that the pigment granules are sequestred in the parasite gut cells, although the mechanism and adaptive significance of their deposition in bands is not understood. Harris (1993) briefly gave an account of the population dynamics and reproductive biology of this species. Cable, Harris & Tinsley (1996) described on the ultrastructural adaptations of its female reproductive system for viviparity.

Prudhoe (1957) described *M. congolensis* (= *Neogyrodactylus congolensis)* found on the skin of *Clarias lazera* in Zaire. Thurston (1970) recorded this species from *Clarias mossambicus* in Uganda, but she mistakenly reported the name of the genus as *Neodactylogyrus.* Douellou & Chishawa (1995) described a subspecies which they named *Macrogyrodactylus. congolensis karibae* from the gills of *C. gariepinus* from Lake Kariba in Zimbabwe.

Gussev (1961) described *Macrogyrodactylus clarii* on the gills of *Clarias* sp. in Ehtiopia. Paperna (1979) reported this species from *C. lazera* in Uganda, and El-Naggar & Serag (1987) gave a detailed redescription of the species on the gills of the same host in Egypt. Faisal (1988) gave an account of the prevalence of this species on *C. lazera* in Egypt. El-Naggar (1993) using scanning electron microscopy, studied the head lobes and haptors of this species. Obiekerzie & Ajah (1994) reported that Praziquantel at 0,2 mg/ℓ for 90 min proved most effective for the treatment against infestation of this species on *C. lazera* and *Heterobanchus longifilis* in culture. *C. lazera* is now regarded as a synonym of *C. gariepinus.*

Paperna (1969), on the basis of a single specimen found on the skin of *Lates niloticus* in Ghana, briefly described *Macrogyrodactylus latesi.* He also (1973) very briefly recorded the presence of *Macrogyrodactylus anabantii* and *M. ctenopomii* on the gills of *Ctenopoma murieri* in Uganda, each based on only one specimen, the former species being a juvenile specimen. He subsequently (1979) provided drawings of the sclerites of these two species.

CHARACTERISTICS OF TAXONOMIC SIGNIFICANCE

Species of the genus *Macrogyrodactylus* have elongated bodies that are capable of great extension and contraction. As a result of this, the total length of the body and its shape are of limited taxonomic significance. The internal anatomy of the various species is very similar, apart from the hard parts of the cirrus, and consequently cannot provide characters for the differentiation of the species. In some species, however, it was found that the digestive system may be either completely coloured, or banded by dark brown granules. Of the four species of the genus found to be valid by this study, only two have these granules, and these species occur on the skin of their hosts.

Like most genera of the family Gyrodactylidae, the hard structures of the haptor of the various species of *Macrogyrodactylus* can provide reliable characters for the differentiation of the species. The shape and size of the hamuli and the ventral and dorsal bars (Fig. 2) are relatively stable within a certain range, and can be used for the differentiation of the species. However, to provide a meaningful comparison between the various species, the method of measuring the various parts should be standardised for all

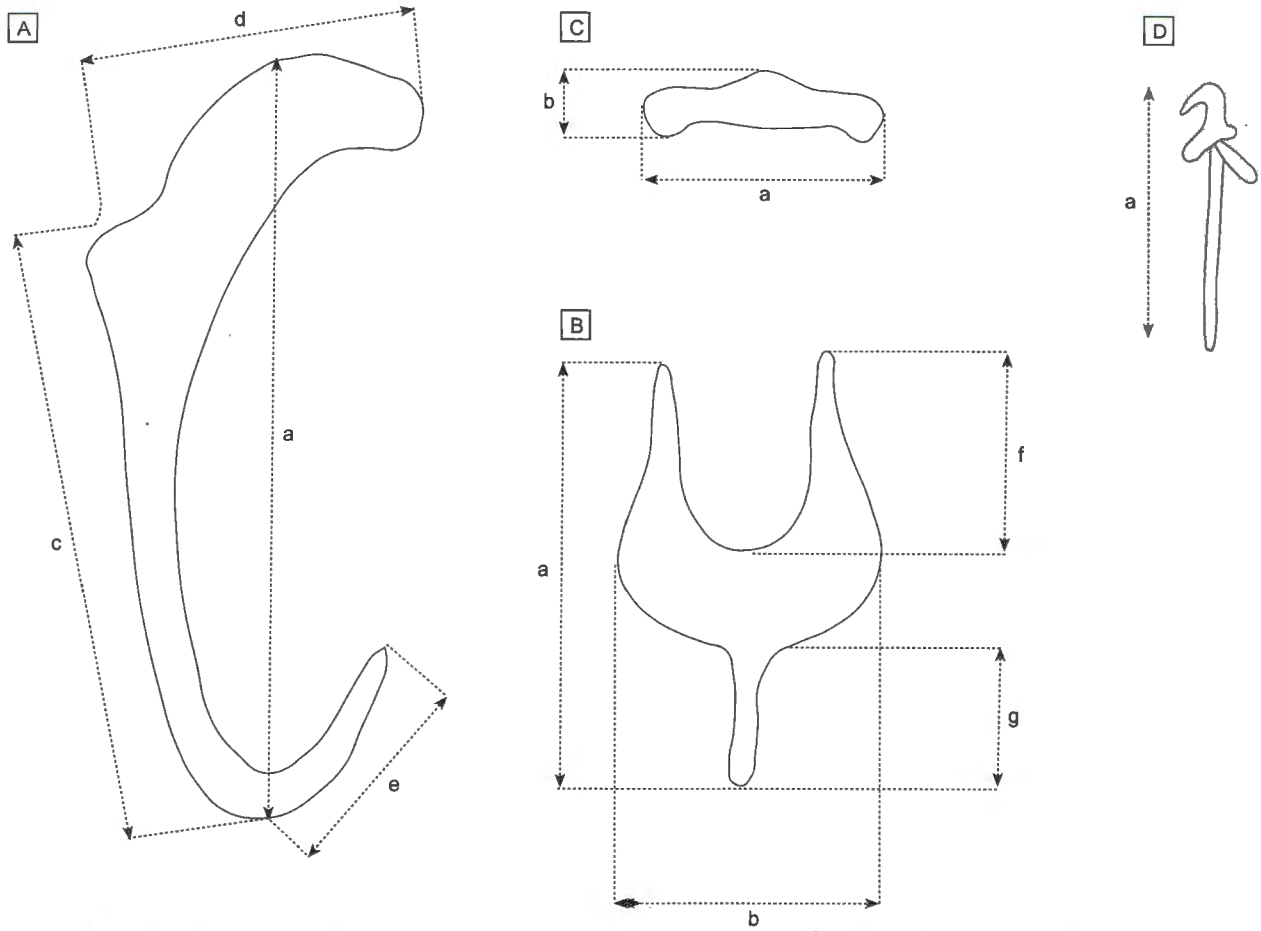

FIG. 1 Measurements of the various sclerites: (A) hamulus, (B) ventral bar, (C) dorsal bar, (D) marginal hook
(a) Total length, (b) maximum width, (c) length of shaft, (d) length of root, (e) length of point, (f) length of anterior lateral arm, (g) length of posterior central arm

the species. The methods used in this study are illustrated in (Fig. 1).

MACROGYRODACTYLUS MALMBERG, 1957

DIAGNOSIS: GYRODACTYLIDAE

Comparatively large elongated body. Head region notched anteriorly to form two lobes, each bearing adhesive area, terminating in a single spike-like process. The haptor is constricted from the body and is provided with a variety of sclerites including one pair of large hamuli, two connecting bars, accessory sclerites and 16 marginal hooks. The two hamuli in the centre of the haptor are large, each formed of a single root, a shaft and a point. The ventral bar is complex, Y-shaped. The dorsal bar is small, may be divided into two parts. At least two pairs of accessory sclerites, two of which articulate with the ventral bar. Two of the marginal hooks occur on anterolateral lobes while the remaining hooks are placed along the posterior margin of the haptor on a fan-shaped, posterodorsal terminal lobe.

Mouth opens into a well developed pharynx. The short oesophagus leads into two simple intestinal caeca which extend to near the posterior end of the body. Single globular testis in the posterior part of the body. Vas deferens, parallel to intestinal caecum, dilates anteriorly to form a seminal vesicle. Cirrus lies ventrally in the oesophageal region, bulbus, with a large straight spine surrounded by a number of smaller spines. Two dorsally situated ovaries posterior to testis. Vitellaria-like structures situated lateral to intestinal caeca. Uterus located between intestinal caeca containing embryos. Viviparous. Parasitic on gills, skin and fins of African freshwater fishes.

Type species: *M. polypteri* Malmberg, 1957

M. polypteri Malmberg, 1957 (Fig. 3)

(All measurements in millimetres)

Body length 2,5–4,5, maximum width 0,29–0,31; hamuli 0,275–0,31 long, shaft 0,234–0,251, root 0,084–0,109, point 0,062–0,065; ventral bar 0,062–0,071 long, 0,078–0,081 wide, anterior lateral arm

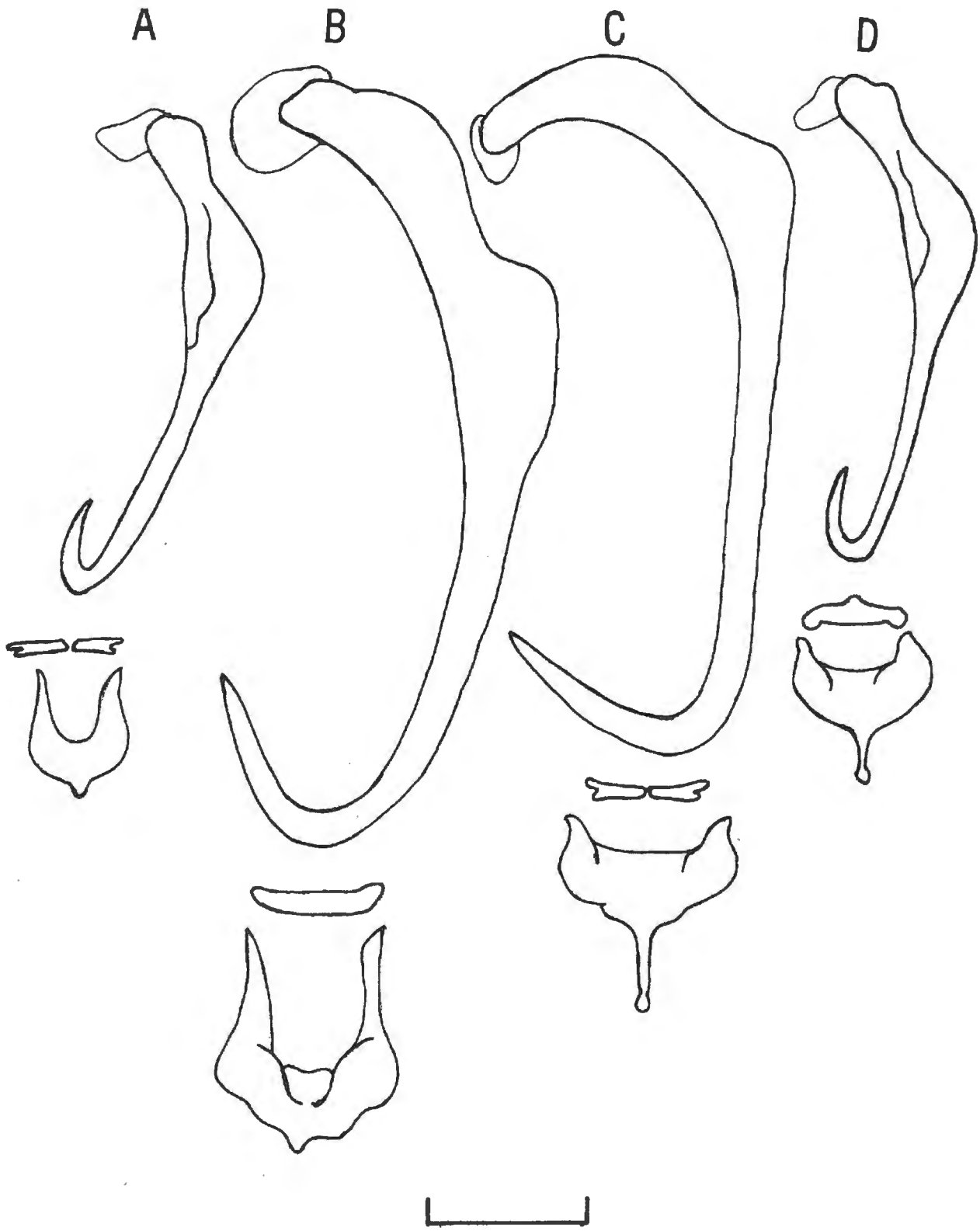

FIG. 2 Hamuli, ventral bars and dorsal bars of (A) *Macrogyrodactylus polypteri,* (B) *M. congolensis,* (C) *M. clarii,* (D) *M. karibae*
Scale = 0,1 mm

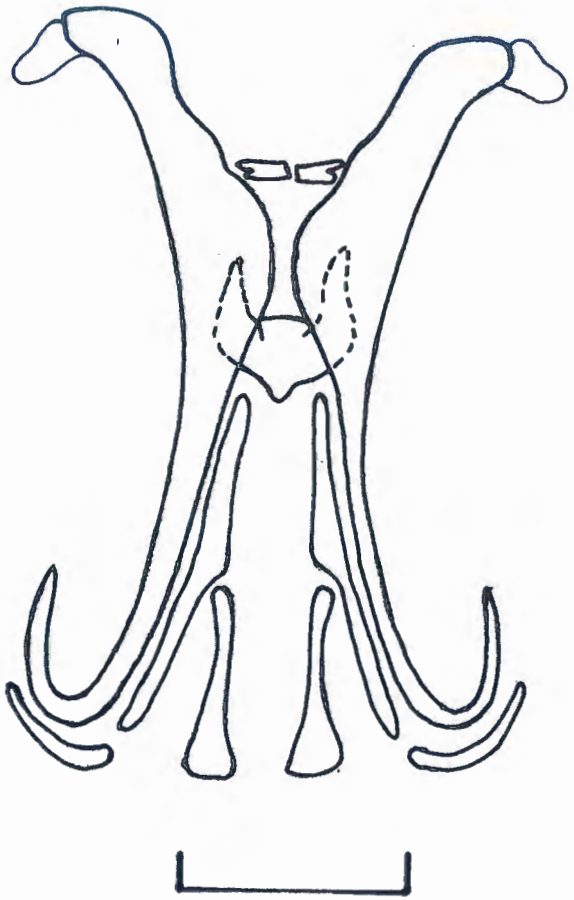

FIG. 3 Sclerites of the haptor of *M. polypteri*
Scale = 0,1 mm

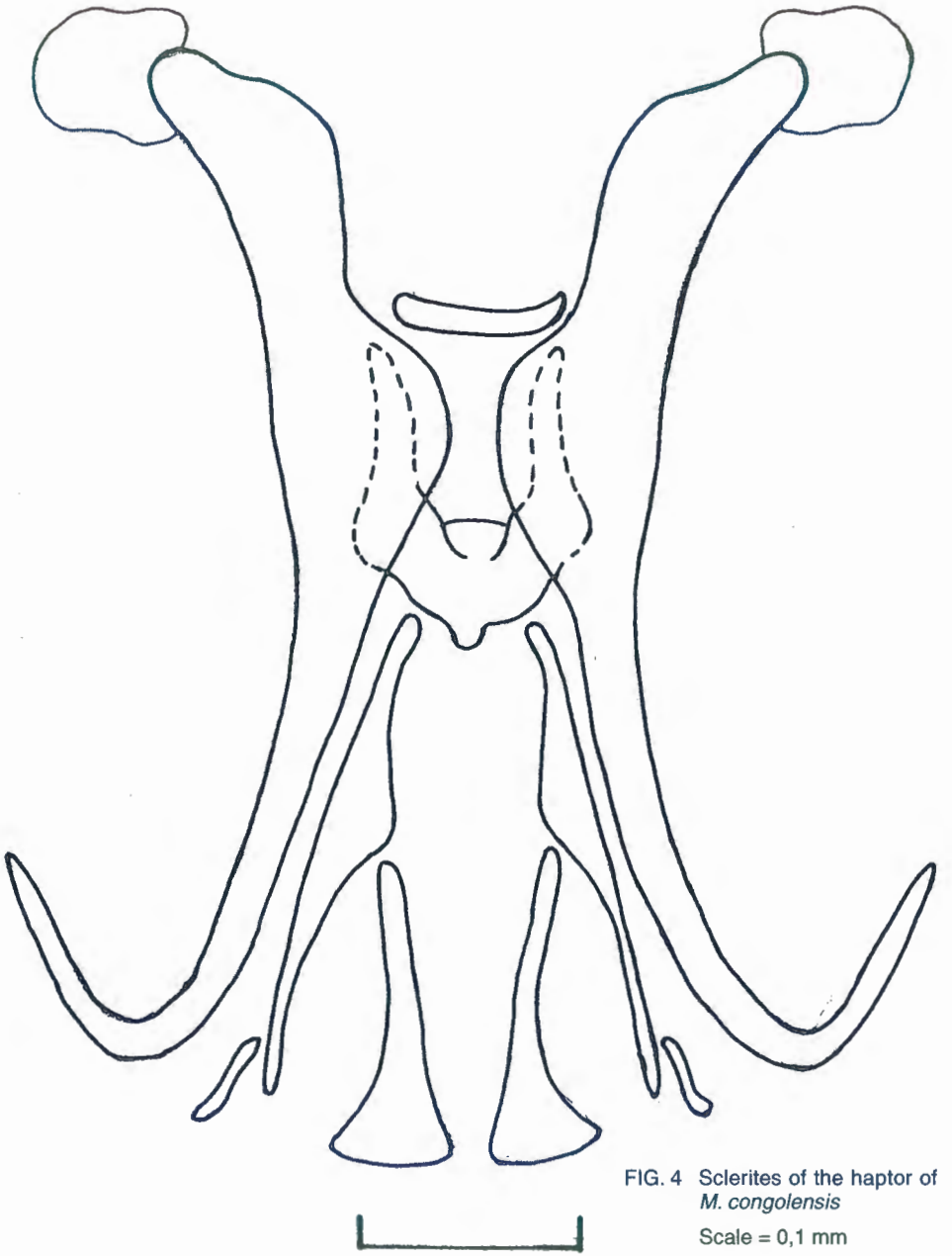

FIG. 4 Sclerites of the haptor of *M. congolensis*
Scale = 0,1 mm

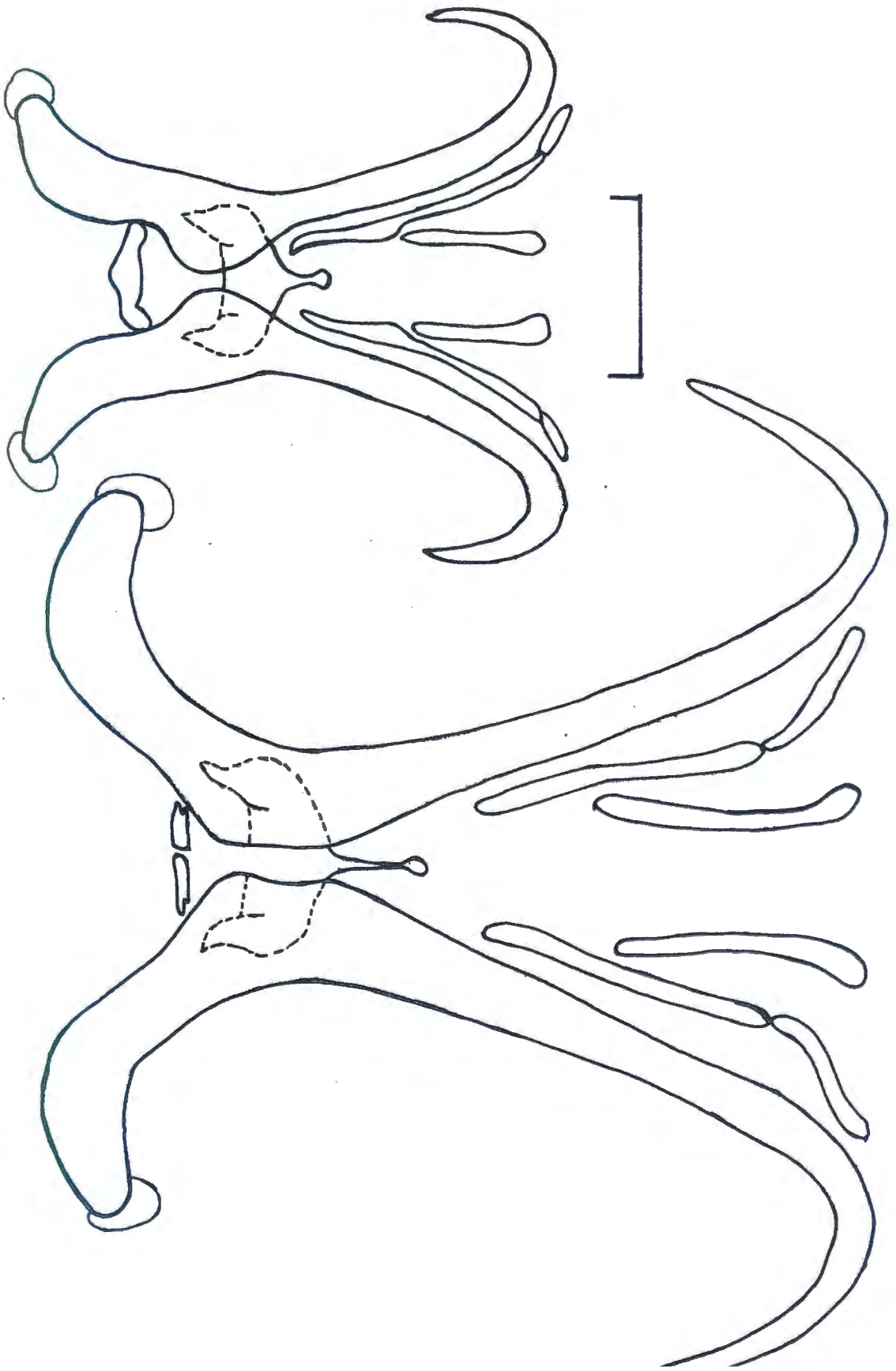

Fig. 6 Sclerites of the haptor of *M. karibae*
Scale = 0,1 mm

FIG. 5 Sclerites of the haptor of *M. clarii*
Scale = 0,1 mm

0,032–0,034, posterior central arm 0,012–0,015; dorsal bar divided, 0,046–0,051 long, 0,012–0,015 wide; marginal hooks 0,046–0,059 long; cirrus with 10–11 minute spines; on skin and fins. Hosts: *Polypterus senegalus, P. bichir.*

M. congolensis (Prudhoe, 1957) (Fig. 4)

Body length 1.7–2.8, maximum width 0,22–0,58; hamuli 0,49–0,53 long, shaft 0,296–0,312, root 0,251–0,287, point 0,030–0,109; ventral bar 0,14–0,162 long, 0,12–0,134 wide, anterior lateral arm 0,084–0,093, posterior central arm 0,012–0,015; dorsal bar undivided 0,109–0,125 long, 0,015–0,018 wide; marginal hooks 0,081–0,087 long; cirrus with 14–15 minute spines; on skin. Host: *Clarias gariepinus.*

M. clarii Gussev, 1961 (Fig. 5)

Body length 1.8–2.6, maximum width 0,32–0,44; hamuli 0,437–0,453 long, shaft 0,381–0,406, root 0,193–0,203, point 0,131–0,140; ventral bar 0,140–0,147 long, 0,109–0,118 wide, anterior lateral arm 0,021–0,031, posterior central arm 0,046–0,055, dorsal bar divided, 0,068–0,075 long, 0,015–0,018 wide; marginal hooks 0,109–0,125 long; cirrus with 12–13 minute spines; on gills. Host: *Clarias gariepinus.*

M. karibae Douellow & Chishawa, 1955 (Fig. 6)

Body length 1,2–3,95, maximum width 0,39–0,68; hamuli 0,296–0,375 long, shaft 0,251–0,296, root 0,125–0,156, point 0,068–0,093; ventral bar 0,084–0,111 long, 0,078–0,111 wide, anterior lateral arm 0,021–0,031, posterior central arm 0,024–0,040; dorsal bar undivided, 0,068–0,078 long, 0,015–0,021 wide, marginal hooks 0,068–0,078 long; cirrus with 14–15 minute spines, on gills. Host: *Clarias gariepinus.*

KEY TO SPECIES OF *MACROGYRODACTYLUS*

1a Skin parasites, gut of adults with dark brown granules 2

1b Gill parasites, gut of adults without dark brown granules 3

2a Dorsal bar divided, anterior lateral arms of ventral bar small, gut with banded dark areas, cirrus with 10–11 minute spines .... *M. polypteri*

2b Dorsal bar not divided, anterior lateral arms of ventral bar comparatively large, gut dark throughout all its length, cirrus with 14-15 minute spines ..... *M. congolensis*

3a Dorsal bar divided, posterior central arm of ventral bar comparatively long, cirrus with 12–13 minute spines ..... *M. clarii*

3b Dorsal bar not divided, posterior central arm of central bar comparatively short, cirrus with 14–15 minute spines ..... *M. karibae*

DISCUSSION

Three species of the genus *Macrogyrodactylus* are described on basis of one specimen each. *M. latesi* Paperna, 1969, was reported from the skin of *L. nilotica* in Ghana and very briefly described. It was not disclosed if this specimen is adult or immature and, as no details of the cirrus were given, it is probable that this specimen is immature. The presence of one specimen each of *Macrogyrodactylus anabantii* and *M. ctenopomii* was recorded by Paperna in 1973 on the gills of *C. murieri* in Uganda but no drawings were provided. However, in 1979, he provided drawings of the sclerites of the haptor of both species. He also mentioned that the recording of *M. anabantii* is based on a juvenile specimen, but provided a drawing of the cirrus. As Khalil (1970) has mentioned the cirrus in *M. polypteri* does not develop in juvenile specimens. It is therefore unlikely that this specimen is juvenile. In spite of the extensive work on the helminth parasites of freshwater fishes in Africa, none of these three species has been encountered again. Based on the available descriptions, these species cannot be identified with certainty. For these reasons, the three species should be regarded for the time-being as *species inquirenda* until further specimens are available for critical examination.

Prudhoe (1957) did not provide detailed measurements of the sclerites of *M. congolensis* reported from the skin of *C. lazera* in Zaire (Congo). Examination of the co-types of this species deposited in the Natural History Museum in London and that of the present specimens has provided the opportunity to give detailed measurements of the sclerites. It was also noticed that the intestinal caeca of adult specimens of this species contain dark brown granules throughout all their length and this was confirmed in both the co-type specimens and the present specimens. This is in contrast to the banded gut of *M. polypteri.* Both *M. congolensis* and *M. polypteri* occur on the skin of their hosts while other species of the genus are found on gills. Harris *et al.* (1995) documented that histochemical and ultrastructural studies of *M. polypteri* revealed this pigmented gut is due to melanin derived from the epidermis of the skin of the host. Other species of the genus found on the gills of their hosts lack pigmented guts.

Douellou & Chishwa (1995) described and illustrated specimens of *Macrogyrodactylus* recovered from the gills of *C. gariepinus* from Lake Kariba in Zimbabwe. They identified their specimens as a new sub-species and named it *M. congolensis karibae.* They noticed a difference in the shape of the dorsal bar, but were unable to compare the measurements of the sclerites as Prudhoe (1957) did not provide any measurements. Our present specimens recovered from the gills of *C. gariepinus* in South Africa agree with the description of this subspecies to a very great extent. We believe however, that there are enough

differences to separate these specimens from *M. congolensis.* The shape of the ventral bar, the difference in the shape and size of hamuli, the absence of pigments in the gut and the presence of this species on the gills justify the separation of these two species. We therefore propose the elevation of this subspecies to the status of a species named *M. karibae.*

C. gariepinus is a very valued food fish which is cultured in great quantities in various parts of South Africa. It is of specific significance to note that the parasites collected from fish from Middle Letaba Dam were later identified as *M. clarii* and *M. karibae.* Those collected from Mokgoma-Matlala Dam were found to be *M. congolensis.* The presence of three large different species of gyrodactylid monogeneans on the skin and gills of this host species will affect its culture in ponds and tanks. Khalil (1964, 1970) reported the death of *P. senegalus* in tanks when infested with *M. polypteri* as this viviparous parasite has a tremendous reproductive capacity, and infections can build up rapidly to produce a large number of parasites capable of killing their hosts.

The development of the gyrodactylid population on *C. gariepinus* during the filling of the newly constructed dam, Middle Letaba, is noteworthy. Immediately after the closure of the dam wall in 1984 *C. gariepinus* was found to be parasited by very few *M. clarii* specimens (mean intensity 1,00). Thereafter the intensity increased tremendously, reaching a peak during the 1986/87 summer season (mean intensity 700,00) and then declined becoming very scarce after January 1988 (mean intensity 1,00).

As the infection by *M. clarii* decreased the second parasite *M. karibae* appeared on *C. gariepinus* initially in low intensities. The population of *M. karibae* also increased in intensity (mean intensity 150,00) but not to the same extent as *M. clarii* and then decreased to become very scarce by the second half of 1988.

It was initially thought that this situation could be ascribed to the greater volume of water in the dam as a result of good summer rains during the December 1987/January 1988 season causing a decline in the relative density of the hosts which resulted in reduced contact amongst the fish. Paperna (1980) argued that since gyrodactylids have no free-swimming larval stage, infection between individual fish is probably by direct contact, i.e. intensity-dependent. However, Harris (1993), who studied the population dynamics of *M. polypteri* on *senegalus* in tanks, states that infections persist for at least 9 months, initially growing very rapidly before being limited by a host response. He further points out that, at their peak, populations contain several hundred individuals but then drop to less than 20 following the host response. He went on to indicate that the host reaction results in the detachment of the flukes from the fish as has been described for *Gyrodactylus alexanderi* by Lester & Adams (1974) which survive attached to the substrate for a few days. Harris (1993) further stated that the host reaction also suppresses reproduction in the parasite in addition to furthering its detachment.

After their peak periods, the infections on *C. gariepinus* remained very light, less than five individuals on each infected fish, and this correlates with observations of wild fishes which bear light infections of *M. polypteri* (Khalil 1970).

During the period of peak intensity of infection in Middle Letaba Dam, infected fish developed a thick layer of greyish-white mucous over the entire skin. According to Paperna (1980), this is caused by severe irritation of the skin. He also mentioned the following pathological charges during mild to severe infections: extensive proliferation of epithelial cells around the point of attachment of parasites, erosion of the skin at the point of attachment, and fading of colour of hosts. These changes should be taken into consideration when farming of *C. gariepinus* is undertaken.

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