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Monogeneans of the genus *Cichlidogyrus* Paperna, 1960 (Dactylogyridae: Ancyrocephalinae) from cichlid fishes of Lake Kariba (Zimbabwe) with descriptions of five new species

Laurence Douëllou
University Lake Kariba Research Station, University of Zimbabwe, PO Box 48, Kariba, Zimbabwe

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Abstract

The gills of six species of cichlid present in Lake Kariba (Zimbabwe) revealed the presence of twelve species of *Cichlidogyrus*, five being new species. The parasites were as follows: *C. halli* (Price & Kirk, 1967) in *Oreochromis mortimeri* (main host) and *Serranochromis macrocephalus* (occasional host); *C. tilapiae* Paperna, 1960 and *C. longicornis* Paperna & Thurston, 1969 in *O. mortimeri* only; *C. sclerosus* Paperna & Thurston, 1969 in *O. mortimeri* (main host) and in *S. macrocephalus* (occasional host); *C. haplochromii* Paperna & Thurston, 1969 in *Pharyngochromis darlingi* only; *C. tiberianus* Paperna, 1960 in *Tilapia rendalli* only; *C. dossoui* n. sp. in *T. rendalli* (type-host) and in *O. mortimeri* and *S. macrocephalus* (occasional hosts); *C. karibae* n. sp. in *S. codringtonii* (type-host) and in *O. mortimeri* (occasional host); *C. zambezensis* n. sp. in *S. macrocephalus* (type-host) and in *O. mortimeri* (occasional host); *C. quaestio* n. sp. in *T. rendalli* (type-host) and in *S. codringtonii* and *S. macrocephalus* (occasional hosts); *C. philander* n. sp. in *Pseudocrenilabrus philander*. *C. longicornis gravivaginus* Paperna & Thurston, 1969, found in *O. mortimeri*, is elevated to specific status.

Descriptions, measurements and drawings of the sclerotised parts are given for each species and compared with data in the literature. A key for the identification of the *Cichlidogyrus* species present in Lake Kariba is proposed.

Introduction

Research on monogeneans of cichlids has been pioneered by I. Paperna who carried out, among other studies, extensive descriptions and records of *Cichlidogyrus* species over the past thirty years. Other studies have been carried out giving more details, new drawings, and revealing the great number of species belonging to the genus (Price & Kirk, 1967; Price *et al.*, 1969; Thurston, 1970; Ergens, 1981; Dossou, 1982; Birgi & Euzet, 1983; Dossou & Birgi, 1984). However, as research and observations progressed, it became clear that, in addition to their small size and their diversity, the species are very similar morphologically with the consequence that several species were considered to be conspecific in the original descriptions. Moreover, the taxonomy of cichlids is still subject to frequent revision and the identification of the fish, as well as of the parasites, is far from an easy task. The lists of *Cichlidogyrus* species reported in Africa by Khalil (1971) and Paperna (1979) give a good picture of the abundance of the species in the genus and of the wide range of hosts from which they have been recorded.

No research has been undertaken on *Cichlidogyrus* in southern Africa except for the description of *C. halli* (Price & Kirk, 1967) from Malawi, a

species also present in Lake Kariba, the description of *C. papernastrema* Price, Peebles & Bamford, 1969 from South Africa and some records from Tanzania (Paperna, 1979). Therefore, the present study provides more information about the geographical distribution of some of the species already reported in various parts of Africa and worldwide as well as descriptions of newly discovered species from Lake Kariba.

Materials and methods

Fish were caught with gill-nets, seine nets, traps or rod and line in the Sanyati and Sengwa basins (Lake Kariba, Zimbabwe) from June 1989 to May 1991. Small fishes were kept in aquaria for short periods (maximum 3–4 days).

The fish examined were: *Oreochromis* (*Oreochromis*) *mortimeri* (Trewavas, 1966) Kariba tilapia, *Pharyngochromis darlingi* (Boulenger, 1911) Zambezi happy, *Pseudocrenilabrus philander* (M. Weber, 1897) southern mouthbrooder, *Serranochromis* (*Sargochromis*) *codringtonii* (Boulenger, 1908) green happy, *Serranochromis* (*Serranochromis*) *macrocephalus* (Boulenger, 1899) purpleface largemouth, and *Tilapia rendalli rendalli* (Boulenger, 1896) redbreast tilapia. Fish nomenclature follows Trewavas (1983) and Bell-Cross & Minshull (1988).

In the majority of cases, the gills were immediately removed and thoroughly examined with a dissection microscope, but some fish were kept in a deep freezer and the gills examined later. The monogeneans were mounted directly in Malmberg's solution (mixture of ammonium picrate and glycerine) (Malmberg, 1956) and the preparations sealed with the Lut de Rondeau du Noyer. Drawings were made with the aid of a camera lucida from fresh and mounted flattened specimens. The hamuli were measured according to Gusev (1955 in Bykhovskaya-Pavlovskaya *et al.*, 1964) and the bars according to Fig. 1. The numbering of hooklets is according to Euzet & Prost (1979). The designation of the hamuli and bar parts is according to Fig. 1.

For each species, minimum, maximum and average values from the camera lucida drawings of 15 different specimens (unless otherwise specified) are given in micrometres. For each specimen, both hamuli of each pair were measured (30 data for each measurement) whilst the mean value of the two measurements of the appendages of the dorsal bar and of the hooklets was calculated.

The specimens, holotypes and paratypes, are deposited in the Museum d'Histoire Naturelle de Paris (MNHN) and in the author's collection.

Results

The measurements of the sclerotised parts are given in the Tables I, II, III and IV. The general appearance of the parasites is represented in Fig. 2.

Cichlidogyrus halli (Price & Kirk, 1967) (Fig. 3) (MNHN: 126 HF)

Syns *Cleidodiscus halli* Price & Kirk, 1967; *Cichlidogyrus tubicirrus magnus* Paperna & Thurston, 1969 (*Cichlidogyrus tubicirrus magnum* Paperna & Thurston, 1969 in Paperna, 1969; Thurston, 1970 and Paperna, 1979); *Cichlidogyrus magnus* Paperna & Thurston, 1969 (Dossou, 1982); *Cichlidogyrus halli typicus* (Price & Kirk, 1967) Paperna, 1979.

Records

Malawi: *O. shiranus shiranus* (see Price & Kirk, 1967) (type-host), *O. s. chilwae* and *O. mossambicus* (see Kirk, 1979); Ghana: *Sarotherodon galilaeus* (see Paperna, 1968, 1969); Uganda: *O. leucosticus*, *O. niloticus niloticus*, *S. galilaeus* (see Paperna & Thurston, 1969), *O. variabilis* ? (see Thurston, 1970), *O. niloticus vulcani*, *O. spilurus spilurus* (see Paperna, 1979); Egypt: *T. zillii* (see Ergens, 1981; El-Naggar & Kearn, 1989; El-Naggar *et al.*, 1990), *O. n. niloticus*, *S. galilaeus* (see El-Naggar & Kearn, 1989; El-Naggar *et al.*, 1990); Benin: *S. melanotheron* (see Dossou, 1982); Zim-

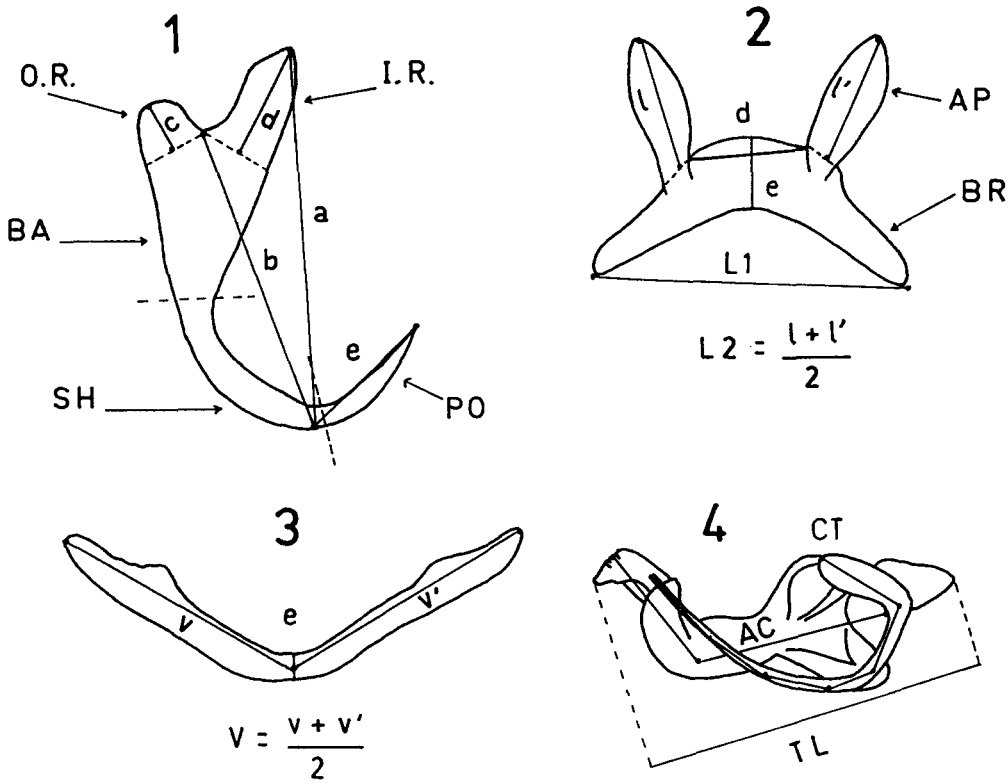

Fig. 1. Measurements of the sclerotised parts of *Cichlidogyrus*. 1. Hamulus; 2. Dorsal bar; 3. Ventral bar; 4. Copulatory organ. *Abbreviations* AP, appendage; BA, base; BR, branch; CT, copulatory tube; I.R., inner root; O.R., outer root; PO, point; SH, shaft.

babwe: *O. mortimeri* (main host), *S. macrocephalus* (occasional host) (present records).

Description

Very large parasite with only 2 eyes; haptor roundish, about same width as body and not quite distinct from body. Sclerotised parts of haptor also very large. Ventral hamuli robust and crude with massive base and comparatively short shaft and point; outer root broad and irregular in shape, inner root relatively short. Ventral bar very long, V-shaped with membranous extensions variable in size and shape; extremities rounded or blunt. Dorsal hamuli similar to ventral hamuli but smaller; base robust and rough; shaft and point short, outer root wide and irregular but comparatively narrower than in ventral hamuli; inner root narrower and much longer. Dorsal bar also large and massive; branches long and more or less pointed; section between appendages convex; appendages wide apart, broad and short. Hooklets long; pairs 1 and 2 similar in size but pair 1 with distinct, rounded, short base about 1/5 of total length; pair 2 slender with no distinct base visible; pair 4 longer than pair 3; former with base about 1/2 of total length and latter about 1/3; pairs 5 to 7 decreasing in size and with base approximately 1/2 of total length. Copulatory organ simple, long; copulatory tube S-shaped with constant width and an irregular basal portion variable in shape; accessory piece elongate, shorter than copulatory tube, ending with triangular extremity. No sclerotised vagina visible.

Remarks

C. halli was first observed by Price & Kirk (1967) in Malawi. Later, Paperna (1979) synonymised *C. halli* with *C. tubicirrus magnus* Paperna & Thurston, 1969 and differentiated two subspecies: *C.*

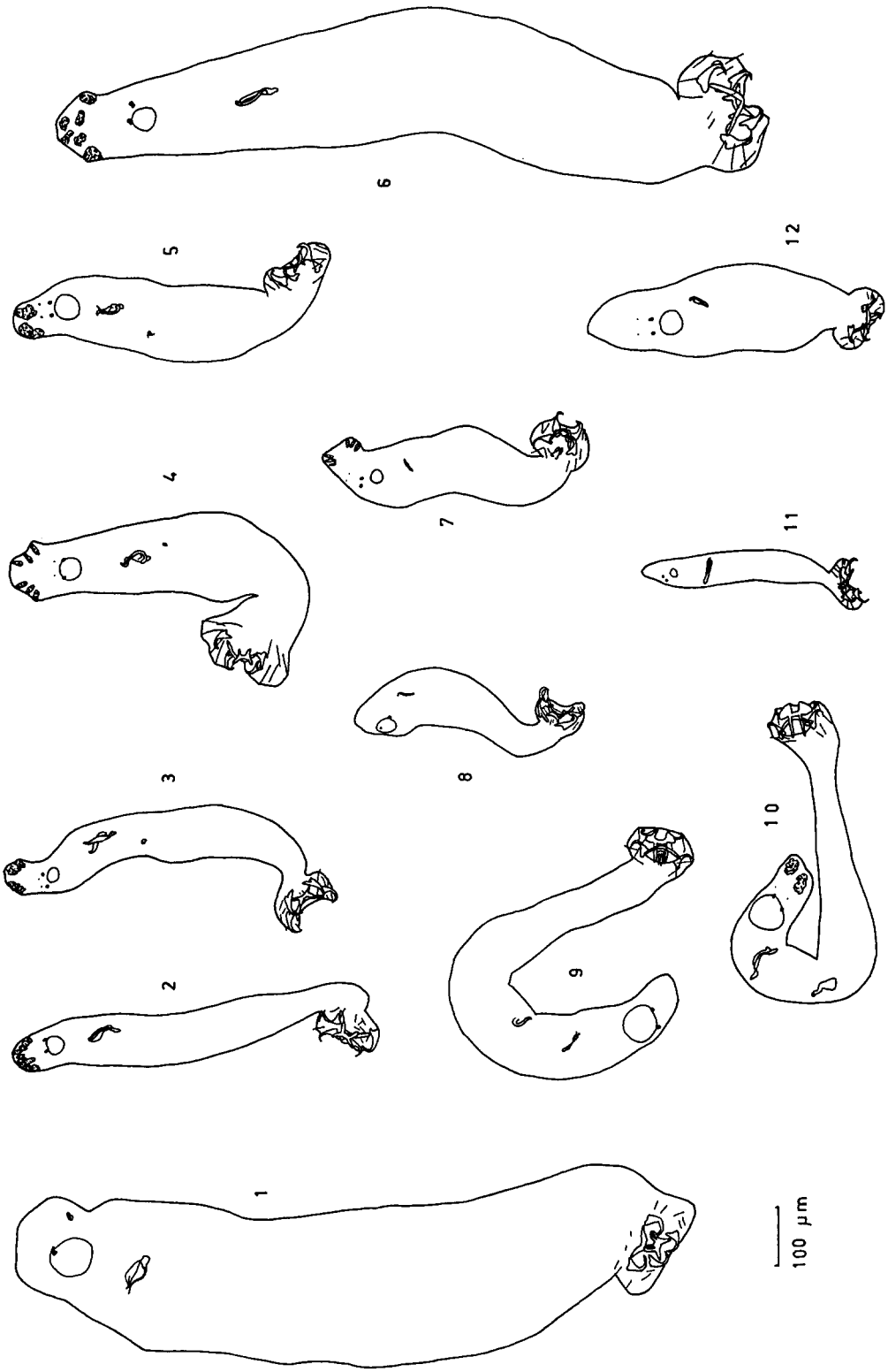

Fig. 2. Cichlidogyrus species, parasites of cichlids in Lake Kariba. 1. *C. sclerosus*. 2. *C. karibae*. 3. *C. zambezensis*. 4. *C. dossoui*. 5. *C. tiberianus*. 6. *C. halli*. 7. *C. quaestio*. 8. *C. tilapiae*. 9. *C. longicornis*. 10. *C. gravivaginus*. 11. *C. philander*. 12. *C. haplochromii*.

Table I. Measurements (in micrometres) of the sclerotised parts of *Cichlidogyrus halli* and its synonyms.

Names used	*C. halli*	*C. tubicirrus magnus*		*C. magnus*	*C. halli*
Host	*O. shiranus*	*O. n. niloticus*	*T. zillii*	*S. melanotheron*	*O. mortimeri*
Locality	Malawi	Uganda	Egypt	Benin	Zimbabwe
Source of data	Price & Kirk (1967)	Paperna & Thurston (1969)	Ergens (1981)	Dossou (1982)	Present material
n	8	2	3	–	15
Length	525–721	880–900	–	500–550	700–1,400
Width	160–205	200–250	–	150–170	220–340
Ventral bar	104–122	110–125	100–120	**80–90**	104–144
Dorsal bar L1	68–79	72–79	55–56	**47–52**	51–73
Dorsal bar L2	14*	13–15	9–13	10–12	**20–25**
Ventral hamuli	54–62	42–56	49–51	**42–45**	49–60
Dorsal hamuli	53–60	42–53	41–43	42–44	42–56
Hooklets 1	20–22	13–15	14	16–18	17–20
Hooklets 2	**20–22**	13–20	14	**12–13**	16–18
Other hooklets	35–44	33–37	31–34	29–31	29–43
Copulatory tube	82–86	66–79	75–77	**65**	66–96
Accessory piece	61–67	59–76	–	52–55	54–66

* Measurement taken from figure in Price & Kirk (1967). n, Number of specimens measured.
Values in bold indicate the main differences between the various records.

halli typicus and *C. halli victorianus*. The latter, whose first pair of hooklets is larger and possesses a very robust handle, parasitises *O. variabilis* and *O. esculentus* in Uganda. Ergens (1981) redescribed *C. tubicirrus magnus* from *T. zillii* in Egypt, as did Dossou (1982) from *S. melanotheron* in Benin. Dossou (1982) raised Paperna's subspecies *C. tubicirrus magnus* to full specific status and referred to it as *C. magnus*, but mentioned that the synonymy with *C. halli* would need further investigation before being accepted.

The general features and the measurements of the Kariba specimens fit with the description of Price & Kirk (1967) of *C. halli* although, according to their representation, the appendages of the dorsal bar are smaller in their specimens (c. 14 against 20–25 μm). It also fits with the descriptions of *C. tubicirrus magnus* by Ergens except for the appendages of the dorsal bar and the hooklets which are smaller in Ergens' specimens. Although identical in their general aspect, the specimens from Benin (Dossou, 1982) are significantly smaller, with smaller hooklets and a much smaller dorsal bar. However, despite minor differences in the measurements, the species observed in Lake Kariba is undoubtedly the same species as the one described by Paperna & Thurston (1969) in Uganda, by Ergens (1981) in Egypt and by Dossou (1982) in Benin. Hence, as Paperna (1979) has already proposed, the original name *C. halli* should be restored.

Price & Kirk (1967) collected *C. halli* in the Shire River which connects Lake Malawi to the Zambezi River. It is, therefore, not surprising to find it in Lake Kariba.

The subspecies *C. halli victorianus*, as described by Paperna (1979), is probably a distinct species. It is also likely that several species were included in the second subspecies, *C. halli typicus*. As a matter of fact, the measurements taken from the parasites of *O. n. vulcani* (see Paperna, 1979) differ greatly from the measurements taken from the parasites of the other fish species, and thus further observations would be necessary to clarify the taxonomy of *C. halli*. Despite the wide range of hosts recorded in the literature, in Lake Kariba the parasite was only observed in *O. mortimeri*.

El-Naggar & Kearn (1989) have studied the haptoral glands and El-Naggar *et al.* (1990) the ultrastructure of the oviduct, Mehlis' gland and oötype of this parasite.

This species can be differentiated from other species of *Cichlidogyrus* by its size, the large sclerotised structures, the solid hamuli and the characteristic shape of the copulatory organ.

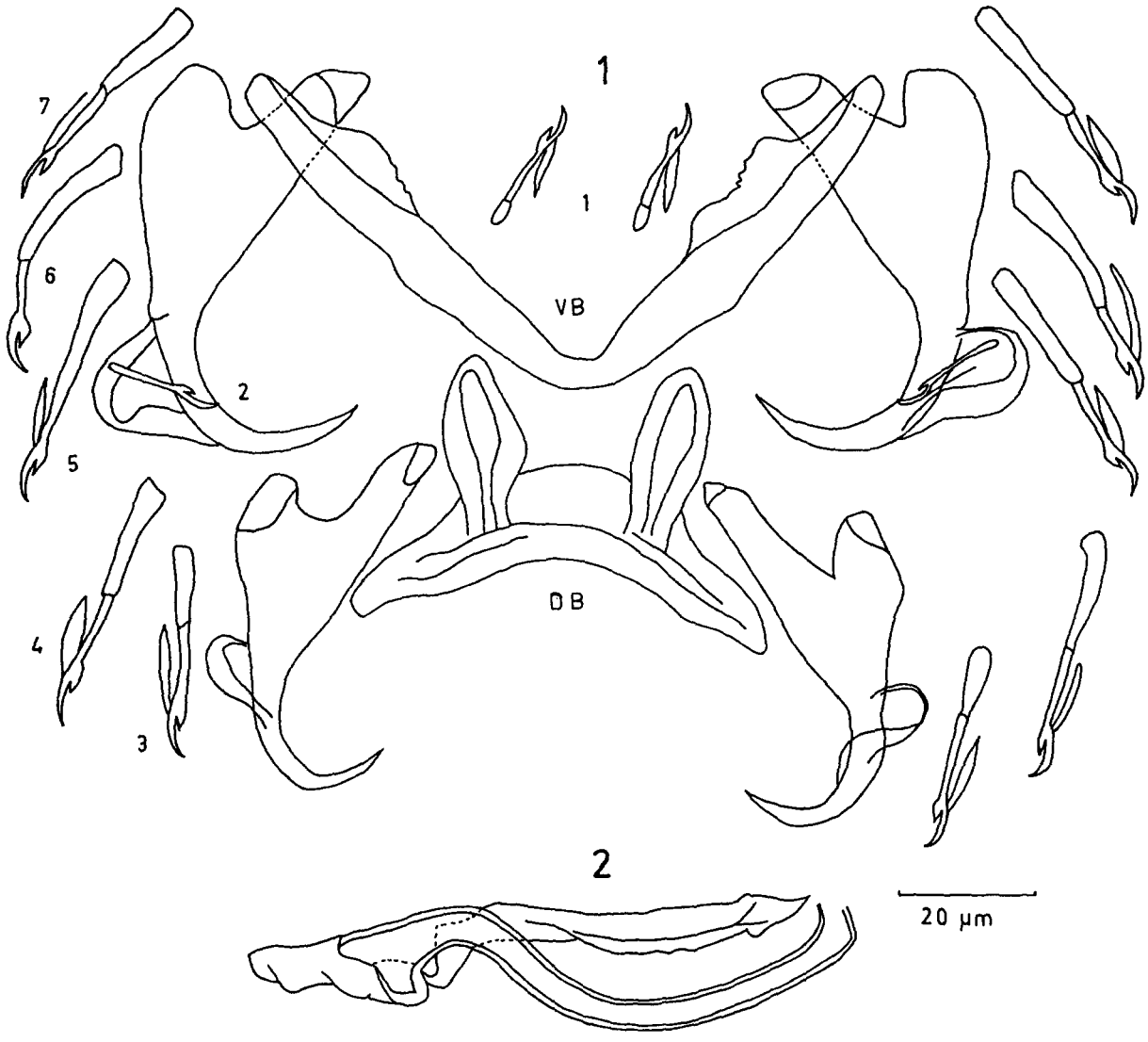

Fig. 3. Cichlidogyrus halli (Price & Kirk, 1967). 1. Haptoral armature. 2. Copulatory organ. *Abbreviations*: DB, dorsal bar; VB, ventral bar.

***Cichlidogyrus sclerosus* Paperna & Thurston, 1969** (Fig. 4) (MNHN: 127 HF)

Records

Africa: *O. mossambicus* (type-host), *O. n. niloticus*, *O. leucosticus*, *Haplochromis* sp. (see Paperna & Thurston, 1969; Paperna, 1979), *O. spilurus niger*, *T. zillii* (see Paperna, 1979) in Uganda; *O. mortimeri* (main host) and *S. macrocephalus* (occasional host) in Zimbabwe (present records). Middle East: *O. aureus* in Israel (Paperna & Lahav, 1971; Paperna, 1979). Asia: *O. mossambicus* in the Philippines (Duncan, 1973, Kabata, 1985), Hong Kong, Singapore and Thailand (Roberts & Sommerville, 1982). *O. niloticus* in the Philippines (Natividad *et al.*, 1986; Bondad-Reantaso & Arthur, 1990). Americas: *O. mossambicus* in Colombia (Kritsky & Thatcher, 1974), *O. urolepis hornorum* × *O. mossambicus* hybrid in Mexico (Lazaro-Chavez Mancilla, 1985) and Cuba (Prieto *et al.*, 1985; Prieto & Fajer, 1987). *O. aureus* and *O. u. hornorum* in Cuba (Prieto & Fajer, 1987).

Table II. Measurements (in micrometres) of the sclerotised parts of the *Cichlidogyrus* spp. parasitic on cichlids in Lake Kariba: minimum and maximum values obtained from 15 specimens of each species (except for *C. tilapiae*, 4 specimens only), both hamuli of each pair being measured; average given in parentheses.

	C. tilapiae	*C. haplochromii*	*C. sclerosus*	*C. longicornis*	*C. gravivaginus*
L	400–500 (446)	270–760 (570)	800–1400(1106)	585–1000 (795)	530–856 (709)
W	90–120 (100)	80–170 (142)	180–300 (251)	105–180 (130)	90–150 (116)
Ventral bar					
V	31–33 (32)	25–30 (27)	31–35 (34)	38–43 (40)	36–45 (40)
e	3–5 (4)	3–4 (3)	3–8 (5)	3–5 (4)	3–5 (4)
Dorsal bar					
L1	28–30 (29)	23–31 (26)	31–44 (37)	51–60 (57)	60–67 (63)
L2	13–17 (15)	7–10 (8)	13–17 (15)	34–41 (38)	39–45 (42)
d	12–16 (13)	7–9 (8)	10–13 (11)	13–17 (15)	13–16 (15)
e	5–6 (6)	4–7 (5)	7–10 (9)	4–6 (5)	4–8 (6)
Ventral hamuli					
a	32–36 (34)	26–28 (27)	33–36 (34)	33–37 (35)	31–36 (34)
b	29–31 (30)	20–24 (23)	32–36 (34)	32–35 (33)	29–34 (32)
c	3–5 (4)	3–7 (5)	3–8 (6)	3–6 (5)	3–7 (5)
d	10–14 (12)	7–11 (9)	9–14 (11)	7–11 (9)	7–12 (10)
e	9–12 (11)	8–10 (9)	12–15 (13)	9–14 (12)	10–15 (13)
Dorsal hamuli					
a	41–44 (42)	23–30 (26)	32–35 (33)	31–35 (33)	31–36 (33)
b	27–30 (28)	16–23 (19)	31–34 (32)	25–31 (28)	25–30 (27)
c	3–5 (4)	3–5 (4)	4–9 (7)	5–11 (7)	7–11 (8)
d	16–19 (18)	8–12 (10)	9–13 (11)	7–14 (11)	8–13 (10)
e	8–11 (10)	5–8 (7)	9–13 (11)	7–11 (9)	7–12 (9)
Hooklets					
1	13–14 (14)	10–12 (12)	13–17 (16)	15–18 (17)	15–18 (17)
2	9–12 (11)	9–12 (11)	12–14 (13)	12–14 (13)	12–14 (13)
3	13–17 (15)	12–15 (14)	15–19 (17)	25–28 (26)	24–28 (27)
4	16–17 (17)	17–20 (18)	17–20 (18)	26–28 (27)	25–29 (27)
5	16–19 (18)	16–20 (18)	16–20 (18)	28–33 (31)	28–34 (31)
6	17–18 (17)	14–20 (16)	14–18 (17)	28–33 (31)	29–33 (32)
7	14–16 (15)	12–15 (14)	14–18 (17)	27–32 (30)	27–31 (30)
Copulatory organ					
TL	–	–	66–83 (72)	43–49 (46)	73–83 (79)
C.t.	30–36 (32)	38–45 (42)	61–75 (69)	45–51 (48)	75–89 (83)
Ac.	31–33 (33)	36–39 (37)	49–62 (56)	34–40 (37)	57–65 (62)
Vagina					
L	–	–	36–50 (46)	33–47 (42)	36–50 (44)
W	–	–	3–7 (5)	3–5 (3)	18–23 (20)

Ac, accessory piece; C.t., copulatory tube; L, length; TL, total length; W, maximum width.
For other abbreviations see Fig. 1.

Description

Large parasite, about same length as *C. halli* (approximately 1000 μm), with 2 eyes; haptor hardly separated from body, rectangular, narrower than body. Ventral hamuli robust; shaft long; point more or less sharp; no distinct roots; base massive. Ventral bar massive, broad, almost U-shaped; extremities round. Dorsal hamuli identical in size to ventral hamuli; shaft long; point short and sharp; 2 bends present; roots hardly distinct; grooves present on base in most specimens. Dorsal bar characteristic, massive, X-shaped; branches wide with rounded extremities about same length as appendages; appendages broad, somewhat pyriform with rounded, sometimes indented ends. Hooklets short, pair 2 shortest and slender; others with reduced base about 1/5 of total length; pair 4 slightly longer than pair 3; other pairs similar in length. Copulatory organ very large; long, thin, arched copulatory tube with tapering end associated with a large serrated plate; accessory piece

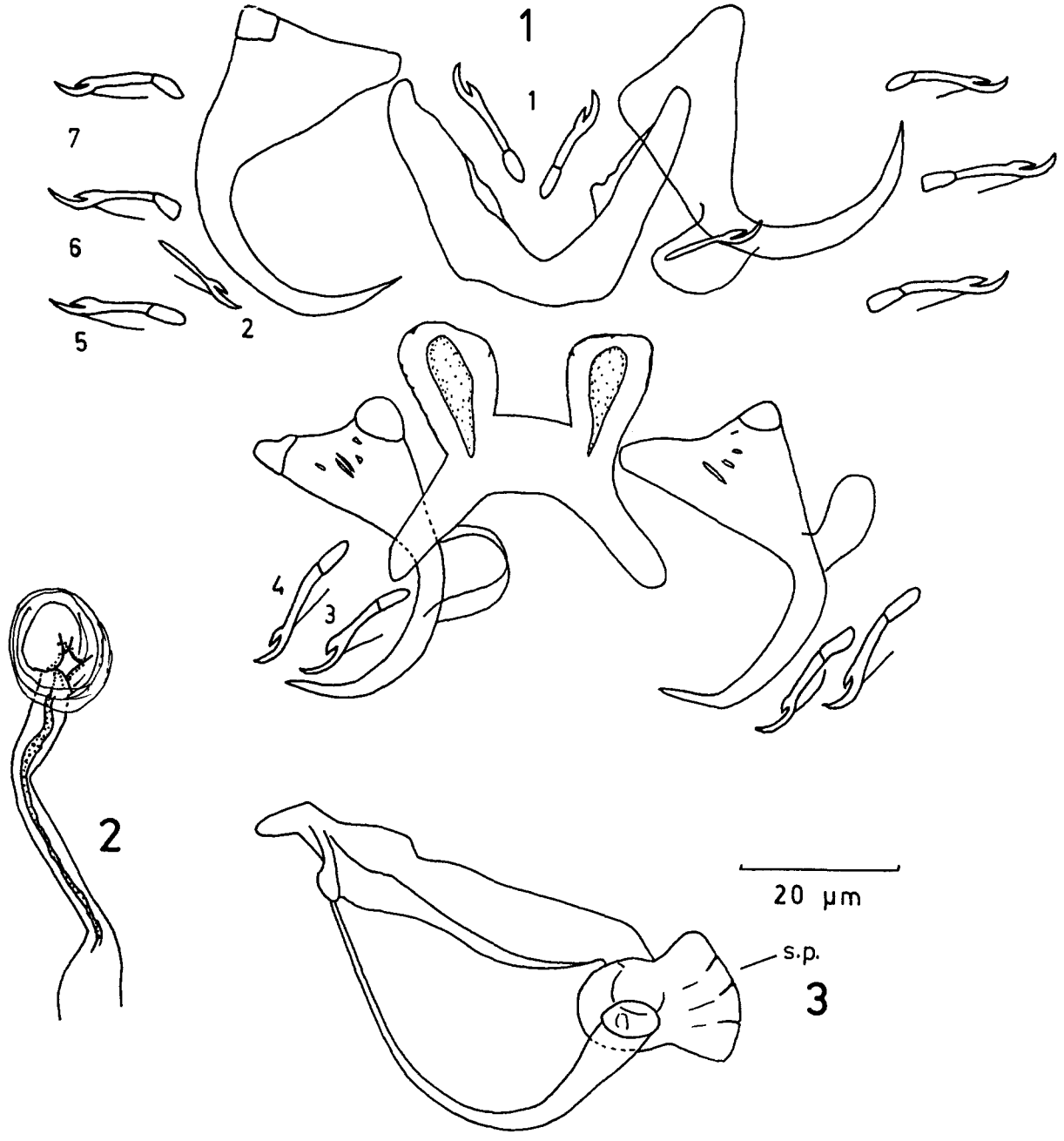

Fig. 4. Cichlidogyrus sclerosus Paperna & Thurston, 1969. 1. Haptoral armature. 2. Vagina. 3. Copulatory organ. *Abbreviation*: s.p., serrated plate.

massive with protruding finger-like extension ending beyond tapering distal end of copulatory tube. Vagina hardly visible, slightly sclerotised, assuming shape of long, distally-widened tube.

Remarks

Despite larger ventral hamuli with shorter roots and longer hooklets, this parasite was easily ident-

ified as *C. sclerosus* originally described by Paperna & Thurston (1969). In the original description, two types of copulatory organs are represented, being almost identical except for a serrated plate associated with the copulatory tube in the specimens parasitizing *O. n. niloticus* and missing in those found in *O. mossambicus*. Although *O. mossambicus* and *O. mortimeri* have close systematic affinities, all the parasites from Lake Kariba had a serrated plate.

Kritsky & Thatcher (1974) mentioned that the specimens obtained from *O. mossambicus* in Colombia differed from the original description in bearing hamuli with poorly developed roots and having points and shafts with two distinct bends; characters also present in Kariba specimens. These authors also gave a description of the vagina which is lacking in the original description and confirmed in the present study.

This parasite is as large as *C. halli* but with a smaller haptoral armature. It cannot be confused with any other species of *Cichlidogyrus*, the massive hamuli with almost no roots, the solid short bars, the pyriform appendages of the dorsal bar and the copulatory organ are characteristic.

***Cichlidogyrus tilapiae* Paperna, 1960** (Fig. 5)
(MNHN: 130 HF)

Records

Africa: Ghana: *S. galilaeus* (type-host), *O. n. niloticus* (see Paperna, 1965, 1968), *T. busumana*, *Hemichromis fasciatus* (see Paperna, 1968), *Pelmatochromis guentheri* (see Paperna, 1969); Uganda: *O. mossambicus*, *O. leucosticus*, *T. zillii*, *Haplochromis macrognathus* (see Paperna & Thurston, 1969), *O. n. niloticus* (see Thurston, 1970), *O. n. vulcani*, *O. s. niger*, *O. variabilis* (see Paperna, 1979); Tanzania: *O. urolepis urolepis* (see Paperna, 1979); Egypt: *O. n. niloticus*, *T. zillii* (see Ergens, 1981); Zimbabwe: *O. mortimeri* (present record). Middle East: Israel: *S. galilaeus*, *O. n. niloticus*, *Tristramella sacra* (see Paperna, 1960, 1964), *Tristramella simonis* (experimental infestations) (Paperna, 1960), *O. aureus* (see Paperna, 1979). Asia: Philippines: *O. n. niloticus* (see Natividad *et al.*, 1986; Bondad-Reantaso & Arthur, 1990). Americas: Colombia: *O. mossambicus* (see Kritsky & Thatcher, 1974); Cuba: *O. aureus*, *O. u. hornorum* and *O. u. hornorum* × *O. mossambicus* hybrid (see Prieto & Fajer, 1987).

Description

Small parasite, about half size of most of other *Cichlidogyrus* species present in Lake Kariba, with only 2 eyes; haptor hardly separated from body with tiny sclerotised parts. Ventral hamuli with broad base and shaft, short point; outer root narrow, reduced to knob; inner root broad and elongate. Ventral bar thin, U-shaped with well-developed indented membranous extensions and rounded ends. Dorsal hamuli slightly longer than ventral hamuli; base narrow; shaft broad; point short; inner root long and slender; outer either distinct or not; grooves present on base when outer root is not distinct; both types of roots may be present in same specimen. Dorsal bar only slightly arched; branches short and pointed; appendages much longer than branches, narrow, with rounded ends often slightly bent towards each other. Hooklets small; pair 2 shortest, pairs 1 and 3 identical in length but with base approximately 1/4 and 1/3 of total length, respectively; pair 4 longer than pair 3 and with longer base (about 1/3 of total length); pairs 5, 6 and 7 decreasing in length with base approximately 1/2, 2/5 and 1/3 of total length, respectively. Copulatory organ simple, copulatory tube straight, wider at base and without additional basal portion; accessory piece straight with swelling at about 2/3 of its length and ending with discrete sharp hook beyond end of copulatory tube. No vagina visible.

Remarks

This parasite was easily identified, and Kariba specimens agree in all respects with previous descriptions and measurements (Paperna, 1960; Ergens, 1981; and Kritsky & Thatcher, 1974). Despite

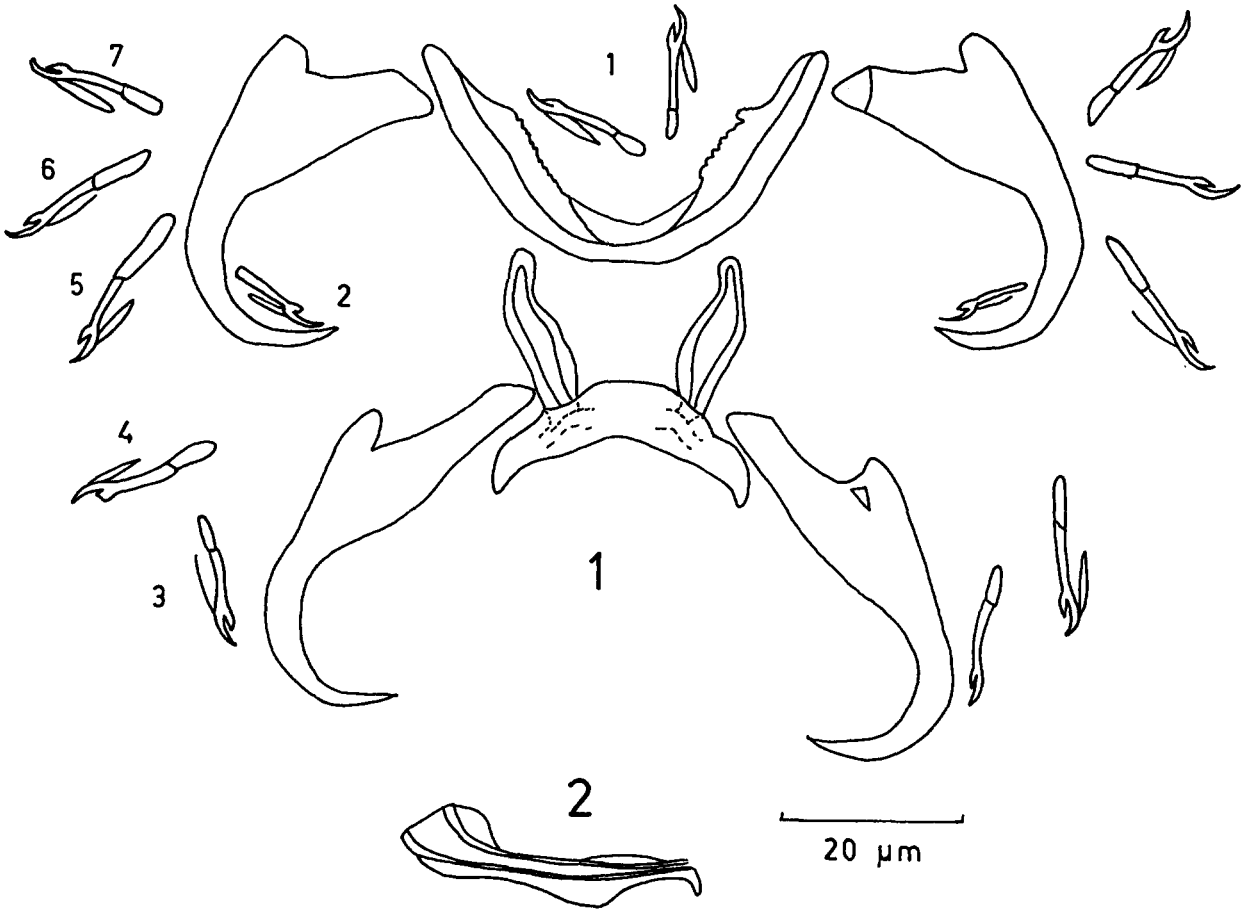

Fig. 5. Cichlidogyrus tilapiae Paperna, 1960. 1. Haptoral armature. 2. Copulatory organ.

the long list of hosts parasitised by *C. tilapiae* elsewhere, it was only observed in *O. mortimeri* and then rarely. It differs from other *Cichlidogyrus* spp. occurring in the lake by its small size and the short, simple copulatory organ.

***Cichlidogyrus haplochromii* Paperna & Thurston, 1969** (Fig. 6) (MNHN 134 HF)

Records

Uganda: *Haplochromis guiarti* (type-host), *H. macrognathus*, *H. nubilus*, *H. obliquidens*, *H. wingatti*, *H.* spp. (3 species), *Haplotilapia retrodens*, *Macropleurodus bicolor*, *Platytaeniodus degeni* (see Paperna & Thurston, 1969); Zimbabwe: *Pharyngochromis darlingi* (present record).

Description

Short, broad, squat parasite with 4 eyes; haptor short, separated from body by constriction, narrower than body; haptoral armature tiny, about same size as in *C. tilapiae*. Ventral hamuli short; base broad; shaft and point short; point sharp; roots well developed, inner narrower than outer and slightly elongate. Ventral bar V-shaped with constant width and rounded ends. Dorsal hamuli slightly smaller than ventral hamuli, with narrower base, shorter shaft and point, slimmer outer root and much longer inner root. Dorsal bar small; branches short with round ends; appendages reduced; section between appendages flat or slightly convex. Hooklets short; pairs 1 and 2 almost identical; pair 4 longer than pair 3 and similar in size to pair 5; pairs 5, 6 and 7 decreasing in

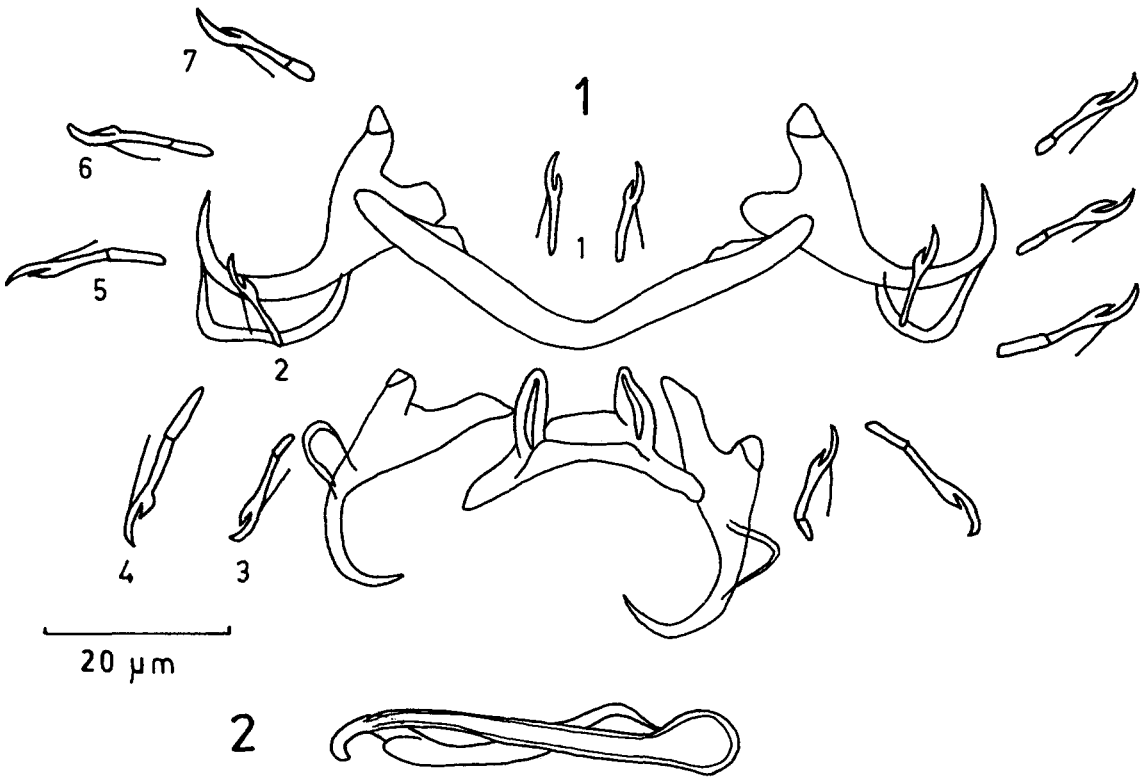

Fig. 6. Cichlidogyrus haplochromii Paperna & Thurston, 1969. 1. Haptoral armature. 2. Copulatory organ.

size; pairs 3 and 7 with reduced base of about 1/5 of total length compared with about 1/3 of total length in pairs 4 and 5, and 1/4 in pair 6. Copulatory organ simple; copulatory tube straight (slightly bent at its distal end in some specimens) and parallel sided except at its base, which is ball-like; accessory piece roughly S-shaped with swelling at about 3/4 of its length and ending in massive hook beyond end of copulatory tube. No vagina visible.

Remarks

According to the measurements of the sclerotised parts, the present specimens agree in most respects with *C. tilapiae* Paperna, 1960, *C. bifurcatus* Paperna, 1960, *C. tubicirrus* (=*C. tubicirrus minutus*) Paperna & Thurston, 1969 and *C. haplochromii* Paperna & Thurston, 1969. It differs however from *C. tilapiae* by having a much larger copulatory organ [38–45 µm *vs* 19–37 µm in Paperna (1960), 29 µm in Kritsky & Thatcher (1974) and 30–33 µm in Ergens (1981)] and a much smaller haptoral armature. Furthermore, although roughly similar in shape, the accessory piece of *C. tilapiae* is thin, simple, with a discrete swelling and a sharp hook; the appendages of the dorsal bar are also much longer.

C. bifurcatus has larger hamuli and hooklets, especially pair 4 which is very long, and the copulatory organ presents a serrate, plate-like appendage to the funnel of the copulatory tube which is lacking in Kariba specimens. The measurements taken from the present specimens are similar to those of *C. tubicirrus* (*C. t. minutus*) which Paperna & Thurston (1969) observed in *O. leucosticus*, *Haplotilapia* sp. and a number of *Haplochromis* spp. Nevertheless, these authors mentioned that the parasites observed on *O. leucosticus* were different from those observed on the various species of *Haplochromis*, both in the measurements and in the shape and size of the copulatory organ, and it is likely that two species at least were considered. The measurements taken

from the parasites obtained in Lake Kariba are very close to those of *C. tubicirrus* occurring in *Haplochromis* spp. in Uganda, but the copulatory organ is different: the copulatory tube is longer and bent in *C. tubicirrus* and the accessory piece overlaps the funnel of the copulatory tube, characters which are not observed in Kariba specimens.

C. haplochromii has been recorded from a number of fishes in Uganda by Paperna & Thurston (1969), who mentioned that differences in the measurements and the shape of the ventral bar occur according to the fish host. In *Haplochromis guiarti*, the ventral bar was stout and enlarged, whereas in *Macropleurodus bicolor* the parasite had and unenlarged ventral bar, smaller hamuli, longer hooklets and longer copulatory organ. On the other hand, when comparing the measurements taken from *C. haplochromii* in Lake Victoria and Lake Albert, Paperna (1979) showed that the parasite has smaller hamuli and bars in Lake Albert. Unfortunately, Paperna did not specify from which fish host the parasites he compared were obtained.

The specimens found in *P. darlingi* in Lake Kariba fit exactly the measurements given for *C. haplochromii* from Lake Albert by Paperna (1979) but do not have the stout enlarged ventral bar. In the drawing of *C. haplochromii* in Paperna & Thurston (1969) the copulatory organ is identical to that observed in the present specimens except for the relative length of the copulatory tube when compared to the length of the accessory piece, but this may depend on the preparations. The copulatory organ is identical to one of the drawings in Paperna (1979).

It is most probable that *C. haplochromii* includes several sub-species (or species) mostly differing in the shape of the ventral bar and this point needs further investigation. Paperna (1979) also noted that, due to similar morphological features, *C. haplochromii* might have been confused in previous studies with *C. bifurcatus* and *C. tubicirrus*.

Among the *Cichlidogyrus* spp. present in Lake Kariba, *C. haplochromii* is easily differentiated from *C. tilapiae*: the former is squat with a relatively large copulatory organ and a dorsal bar with short, distally rounded branches and reduced appendages, while the latter is thin, its copulatory organ is shorter (about three-quarters of the length of that of *C. haplochromii*) and the dorsal bar has short branches with pointed ends and long appendages.

***Cichlidogyrus longicornis* Paperna & Thurston, 1969** (Fig. 7) (MNHN 128 HF)

Records

Uganda: *O. n. niloticus* (see Paperna & Thurston, 1969); Ghana: *S. galilaeus*, *T. zillii* (see Paperna, 1968) (?), *O. n. niloticus* (see Paperna, 1969) (?); Egypt: *O. n. niloticus* (see Ergens, 1981) (?); Benin: *S. melanotheron* (see Dossou, 1982) (?); Zimbabwe: *O. mortimeri* (present record) (?); Philippines: *O. n. niloticus* (see Natividad *et al.*, 1986; Bondad-Reantaso & Arthur, 1990) (?).

Description

Long, slender parasite with 4 eyes, sometimes only 2; haptor broader than body, roundish, not separated from body by a constriction. Ventral hamuli with wide base, short shaft, sharp point and reduced rounded roots; inner root wider than outer root. Ventral bar arched, of constant width, with rounded extremities, associated with thin, sclerotised bar in form of vault above ventral bar and ending exactly at extremities of bar. This thin additional sclerotised bar supports heavily sclerotised, ribbed part reaching ventral bar and indistinct, membranous, fan-shaped portion attached to ventral bar; membranous structure about twice as wide as it is long (length 38–53 μm, average 43; width 70–84 μm, average 78), variable in shape but usually overlaps dorsal bar and its edge sometimes exhibits groove in middle extending to ventral bar. Ventral bar bearing 2 processes very variable in shape, one on each side of heavily sclerotised ribbed part. Dorsal hamuli similar in length to ventral hamuli, with extremely short shaft and small, curved point; roots well developed; deep groove separating inner and outer roots often present; outer root narrow; inner root

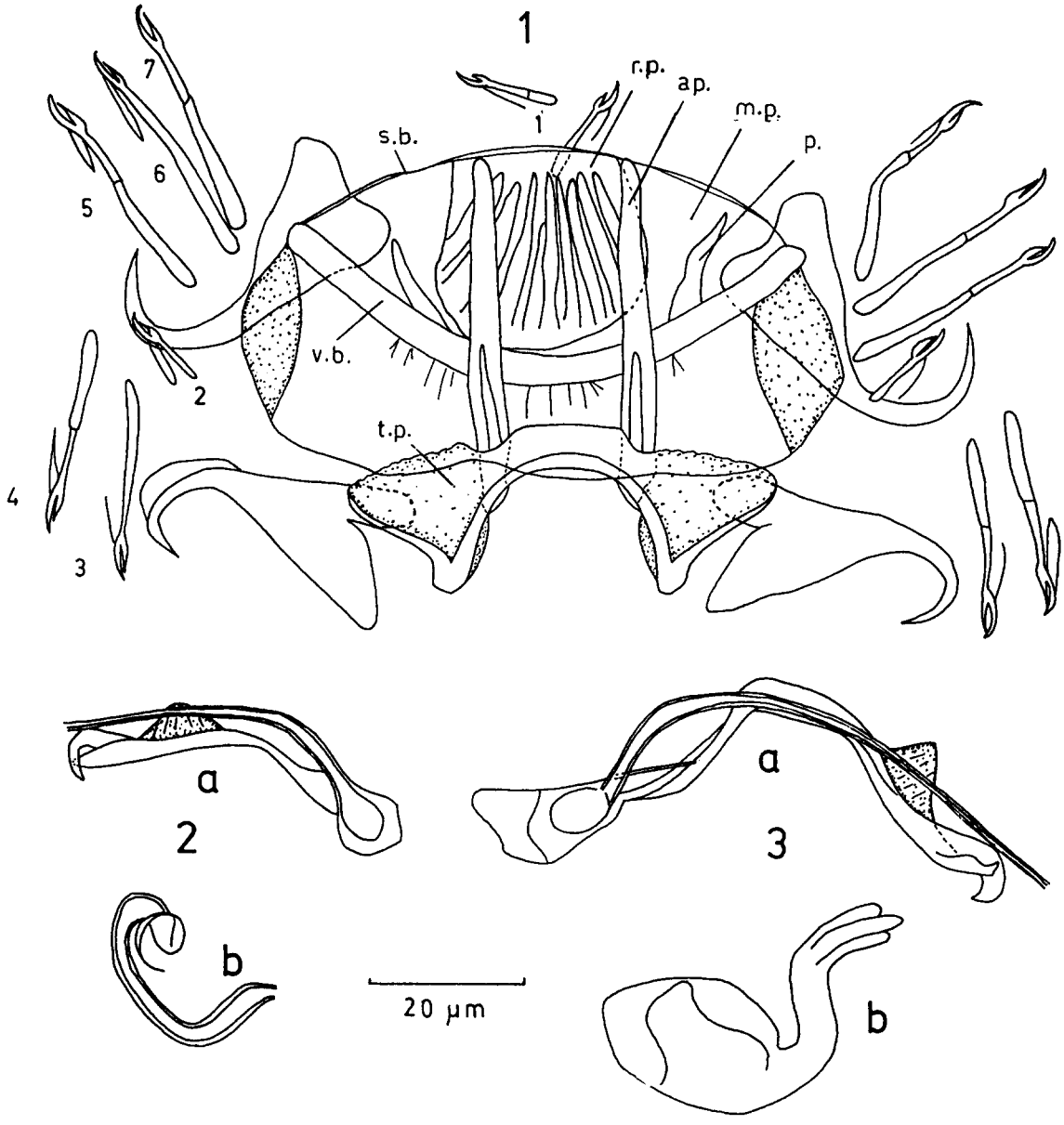

Fig. 7. Cichlidogyrus longicornis Paperna & Thurston, 1969 and *C. gravivaginus* Paperna & Thurston, 1969. 1. Haptoral armature (*C. longicornis*). 2. Reproductive organs of *C. longicornis*: a. Copulatory organ; b. Vagina. 3. Reproductive organs of *C. gravivaginus*: a. Copulatory organ; b. Vagina. *Abbreviations*: ap, appendage of dorsal bar; m.p., membranous portion; p., process; r.p., ribbed portion; s.b., sclerotised bar; t.p., triangular plate of dorsal bar; v.b., ventral bar.

broad and massive. Dorsal bar characteristic with distal ends assuming shape of wide, more or less triangular plates (height of plates 19–24 µm, average 22) connected by narrow bridge supporting 2 extremely long appendages with narrower and rounded extremities; base of dorsal bar heavily sclerotised, while triangular plates are thin with margin facing appendages sometimes very indistinct. Hooklets long; pair 2 shortest; pair 1 different in shape and shorter than remainder, with base approximatively 1/3 of total length; pairs 3 and 4 equal in size with base 2/5 to 1/2 of total length; pairs 5 to 7 equal in size, longer than pairs 3 and 4 and with base 1/2 to 3/4 of total length.

Hooklets 3 to 7 peculiar in that guard is very elongate, almost reaching tip of blade. Copulatory organ short consisting of slightly bent copulatory tube with reduced basal portion and a twisted accessory piece bearing well-sclerotised half-moon region in its distal half and with bifurcate extremity with one furca finger-like and second hook-like; accessory piece ending beyond or at same level as copulatory tube. Vagina in form of long, thin, curved tube flared distally.

Remarks

See *C. gravivaginus*.

***Cichlidogyrus gravivaginus* Paperna & Thurston, 1969, new status** (Fig. 7) (MNHN 129 HF)

Syn. *C. longicornis gravivaginus* Paperna & Thurston, 1969.

Records
Uganda: *O. leucosticus* (type-host) (see Paperna & Thurston, 1969), *O. variabilis* (see Thurston, 1970) (?); Zimbabwe: *O. mortimeri* (present record) (?).

Description

General aspect as in *C. longicornis* but parasite usually smaller; 2 or 4 eyes. Sclerotised parts of haptor identical to those of *C. longicornis* except for membranous structure associated with the ventral bar which is slightly larger (length 39–49 μm, average 44; width 77–94 μm, average 84), ventral bar which is enlarged at its extremities, and more massive dorsal bar (height of triangular plates 18–27 μm, average 23) with slightly longer appendages. Copulatory organ similar to that of *C. longicornis* but much larger (almost double in length) and with large more or less triangular basal portion associated with copulatory tube; accessory piece more or less as in *C. longicornis* but much larger, usually ending before or at same level as copulatory tube. Vagina completely different, heavily sclerotised and large with more or less round portion (diameter 18–23 μm, average 20) and broad, curved tube (length 25–32 μm, average 28; width 4–7 μm, average 5) ending with 3 finger-like extensions.

Remarks

The species *C. longicornis* was first recorded in Uganda By Paperna & Thurston (1969), who differentiated two subspecies, *C. longicornis longicornis* parasitising *O. n. niloticus* and *C. longicornis gravivaginus* parasitising *O. leucosticus*. In the original description, the major differences between the two subspecies were in the size of the parasite (*C. l. longicornis* being the largest), two pairs of eyes in *C. l. gravivaginus* and only one in *C. l. longicornis*, the sclerotised structure associated with the ventral bar (much larger and heavily sclerotised in *C. l. gravivaginus*) and different morphology of the copulatory organs and vaginas. Dossou (1982) described a third subspecies, *C. l. minus*, found on *S. melanotheron* in Benin, which exhibits features of both subspecies mentioned above.

In Kariba specimens, the main features separating the two species are the vaginas and the copulatory organs. Similar copulatory organs and vaginas are described by Paperna & Thurston (1969), but the identification of the species remains doubtful. Hence, according to the original description and representations, *C. l. longicornis* bears a vagina in the form of a delicate, narrow tube and a copulatory organ with a long twisted accessory piece and a long basal portion associated with the copulatory tube, whilst *C. l. gravivaginus* has a heavily sclerotised vagina consisting of two parts (a tube and a more or less rounded portion) and a copulatory organ with a short accessory piece and almost no basal portion associated with the copulatory tube (the copulatory organs are drawn but not mentioned in the text and their dimensions, given in a table, do not agree with the drawings).

In Kariba Lake specimens, the vagina is a narrow tube in those individuals having a short copulatory organ with a reduced basal portion associated with the copulatory tube. A heavily sclerotised vagina is observed in the specimens

with a long copulatory organ and a long basal portion associated with the copulatory tube. This contradicts the observations of Paperna & Thurston (1969).

The vagina of *C. l. longicornis*, as described by Ergens (1981) from Egypt is a long, fine tube (although the drawing shows a vagina similar to that of *C. gravivaginus* but much smaller) and the copulatory organ is similar in shape and size to that observed in Kariba in *C. longicornis*. The only difference is in the extremities of the ventral bar which are enlarged like those of *C. gravivaginus* of Lake Kariba.

As for *C. l. minus*, as described by Dossou (1982), there appears to be no difference which would justify the creation of a third subspecies between the specimens Dossou described in Benin and *C. l. longicornis*, as described by Ergens (1981). It is likely that Dossou was also confused by the original descriptions of the species. Moreover, he was the first to properly describe the membranous structure associated with the ventral bar which, being almost transparent, must have been misinterpreted by Paperna & Thurston (1969) and Ergens (1981). Compared to Kariba specimens of *C. longicornis*, the only difference is that the ventral bar and the dorsal hamuli are smaller in Dossou's specimens.

The specimens found on the gills of *O. mortimeri* in Lake Kariba present constant differences and their reproductive organs are different. Considering that the distinguishing features of the two subspecies, *C. l. longicornis* and *C. l. gravivaginus* were originally given as the degree of sclerotisation of the vagina, it is proposed to raise the two subspecies of Paperna & Thurston (1969) to the rank of species. *C. longicornis sensu stricto* would thus refer to the parasites having a short copulatory organ with or without a small basal portion and a tube-like vagina flared distally, and *C. gravivaginus* to the species having a large copulatory organ with a basal portion and a heavily sclerotised vagina with a rounded part and an elongate part ending with three finger-like extensions. Despite the similarity with Paperna & Thurston's drawings, this might not be appropriate, however, and a comparison with Uganda specimens from *O. leucosticus* and *O. n. niloticus* would be necessary in order to clarify the nomenclature of the type "*C. longicornis*".

C. longicornis and *C. gravivaginus* stand apart from all the other *Cichlidogyrus* spp. They are the only ones having a dorsal bar with triangular plates. Futhermore, the additional structure of the ventral bar is not present in other species and its role is not clearly understood. The two species are easily separated on the basis of the reproductive organs.

***Cichlidogyrus tiberianus* Paperna, 1960** (Fig. 8) (MNHN 140 HF)

Records

Israel: *T. zillii* (see Paperna, 1960, 1964) (type-host); Ghana: *T. zillii* (see Paperna, 1965, 1969, 1979), *S. galilaeus* (see Paperna, 1968, 1969); Uganda: *T. melanopleura* (originating from Zambia, syn = *T. rendalli*) (see Thurston, 1970), *T. zillii*, *T. rendalli*, *O. esculentus*, *O. n. niloticus* and *Haplochromis longirostris* (see Paperna, 1979); Egypt: *T. zillii* (see Ergens, 1981); Benin: *T. zillii* (see Dossou, 1982); Zimbabwe: *T. rendalli* (present record); Philippines: *O. niloticus* (see Natividad *et al.*, 1986; Bondad-Reantaso & Arthur, 1990).

N.B. As mentioned by Ergens (1981), records of *C. tiberianus* in *O. niloticus* and *H. longirostris* from Ghana (Paperna & Thurston, 1969) cannot be relied upon since the parasite was confused with *C. thurstonae* Ergens, 1981 and the same might also apply to some of Paperna's records.

Description

Small, wide parasite with 4 eyes; haptor hardly separated from and about same width as body. Ventral hamuli massive; base solid; shaft long; point sharp; roots reduced; outer root reduced to roundish expansion, inner slightly longer and broader. Ventral bar small, thin, usually V-shaped. Dorsal hamuli much smaller and different in shape to ventral hamuli; shaft and point short;

outer root almost at right angle with long inner root, inner generally broader than outer root. Dorsal bar small, slender; branches long, slender, often asymmetrical with rounded and narrower extremities; appendages reduced; section between appendages flat. Hooklets very long; pair 2 shortest; pair 1 only slightly longer than pair 2 with minute ball-like base; pair 4 longest; other pairs long and approximately equal in size; base of pairs 3 to 7 roughly 1/2 of total length. Copulatory organ complex; copulatory tube arched with curved basal enlargement and tapering end; accessory piece massive with basal portion partly overlapping base of copulatory tube and roughly S-shaped portion presenting finger-like extension and forked extremity. Vagina well sclerotised, with characteristic spiral shape.

Remarks

This parasite agrees in all respects with previous descriptions and measurements. It was not observed on cichlid species other than *T. rendalli*. This species is easily identifiable by the difference in the shape of the ventral and dorsal hamuli, the peculiar dorsal hamuli and by the characteristic reproductive organs, especially the spiral vagina.

***Cichlidogyrus dossoui* n. sp.** (Fig. 9) (MNHN 139 HF)

Type-host: *T. rendalli*
Occasional hosts: *O. mortimeri*, *Serranochromis macrocephalus*.
Type-locality: Lake Kariba, Zimbabwe.

Description

Long parasite with 2 eyes, sometimes 4; haptor broader than body, not separated from body by constriction. Ventral hamuli with narrow base, long shaft, long sharp point and well-developed roots; outer root elongate, variable in shape; inner root longer. Ventral bar almost U-shaped with rounded extremities, often with 2 knob-like structures facing each other at about 12 μm from each branch end. Dorsal hamuli smaller and with shorter inner root than ventral hamuli; outer about same length as inner root; shaft and point relatively shorter. Dorsal bar arched with long, thin branches, often asymmetrical, with rounded ends; appendages medium in size; section between appendages narrow, flat or slightly convex. Hooklets extremely long except pair 2 which is shortest; pair 1 different in size to others, with a reduced base approximately 1/3 of total length; other pairs much longer with long base, about 3/4 of total length; pair 4 slightly longer than pair 3; pairs 5 and 6 longest, equal in size; pair 7 shorter. Copulatory organ large; copulatory tube arched with curved, basal enlargement and tapering end; accessory piece massive, S-shaped with, at about 3/4 of its length, thick extension and finger-like extension; end slightly forked bearing denticles on convex part, reaching end of copulatory tube. Vagina well sclerotised.

N.B. The parasites obtained from *O. mortimeri* differ slightly from those found in *T. rendalli* and *S. macrocephalus* (Table III). In the parasites from *O. mortimeri*, the 2 bars, the dorsal hamuli and the 2 first pairs of hooklets are smaller. The dorsal hamuli are peculiar in that the inner and the outer roots are at right angles, a character rarely observed in *C. dossoui* parasitising the 2 other fish species. Likewise, the 2 knob-like structures of the ventral bar are present in all specimens from *O. mortimeri* and only in some of the specimens from *T. rendalli* and *S. macrocephalus*. The vagina also is different: in *T. rendalli* and *S. macrocephalus* it is massive, curved and pipe-like with a sclerotised arched bar at the distal end; in *O. mortimeri* the bar is heavily sclerotised and longer with sharp extremities, the massive part is shorter and an additional portion, variable in shape, is generally present.

Remarks

Several *Cichlidogyrus* spp. with long hooklets and a copulatory organ of this general aspect have been described: *C. tiberianus* Paperna, 1960, *C. aegypticus* Ergens, 1981, *C. thurstonae* Ergens,

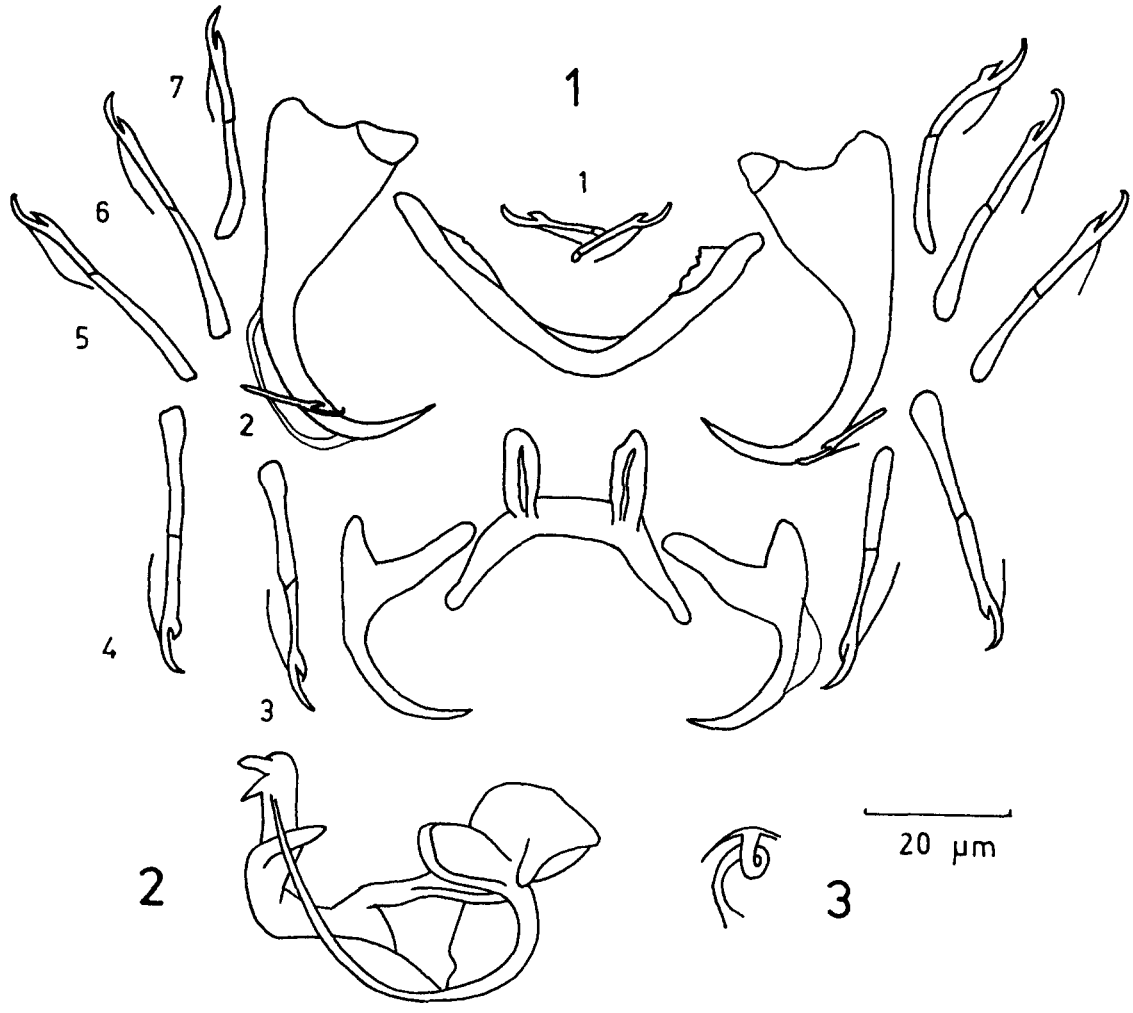

Fig. 8. Cichlidogyrus tiberianus Paperna, 1960. 1. Haptoral armature. 2. Copulatory organ. 3. Vagina.

1981, *C. ergensi* Dossou, 1982 [= *C.* sp. of Ergens (1981)], *C. anthemocolpos* Dossou, 1982 and *C. testificatus* Dossou, 1982. All of these have hooklets measuring 30–40 µm and a copulatory tube identical in shape. They mostly differ in the details of the accessory piece (which assumes the same general aspect) and different vaginas. None of the species already described has a vagina and an accessory piece similar to those of the present species.

The broad haptor not separated from the body and the long hooklets distinguish this species from other *Cichlidogyrus* spp. present in Lake Kariba. It differs from *C. tiberianus* in several points: the sclerotised parts are larger, the ventral hamuli have well-developed roots, the dorsal hamuli are different in shape and the hooklets are much longer. Finally, even if their copulatory organs may be confused, they are easily differentiated by their vaginas.

The species is named after Dr C. Dossou for his contribution to monogenean taxonomy.

***Cichlidogyrus karibae* n. sp.** (Fig. 10) (MNHN 136 HF)

Type-host: *Serranochromis codringtonii*.
Occasional host: *O. mortimeri*
Type-locality: Lake Kariba, Zimbabwe.

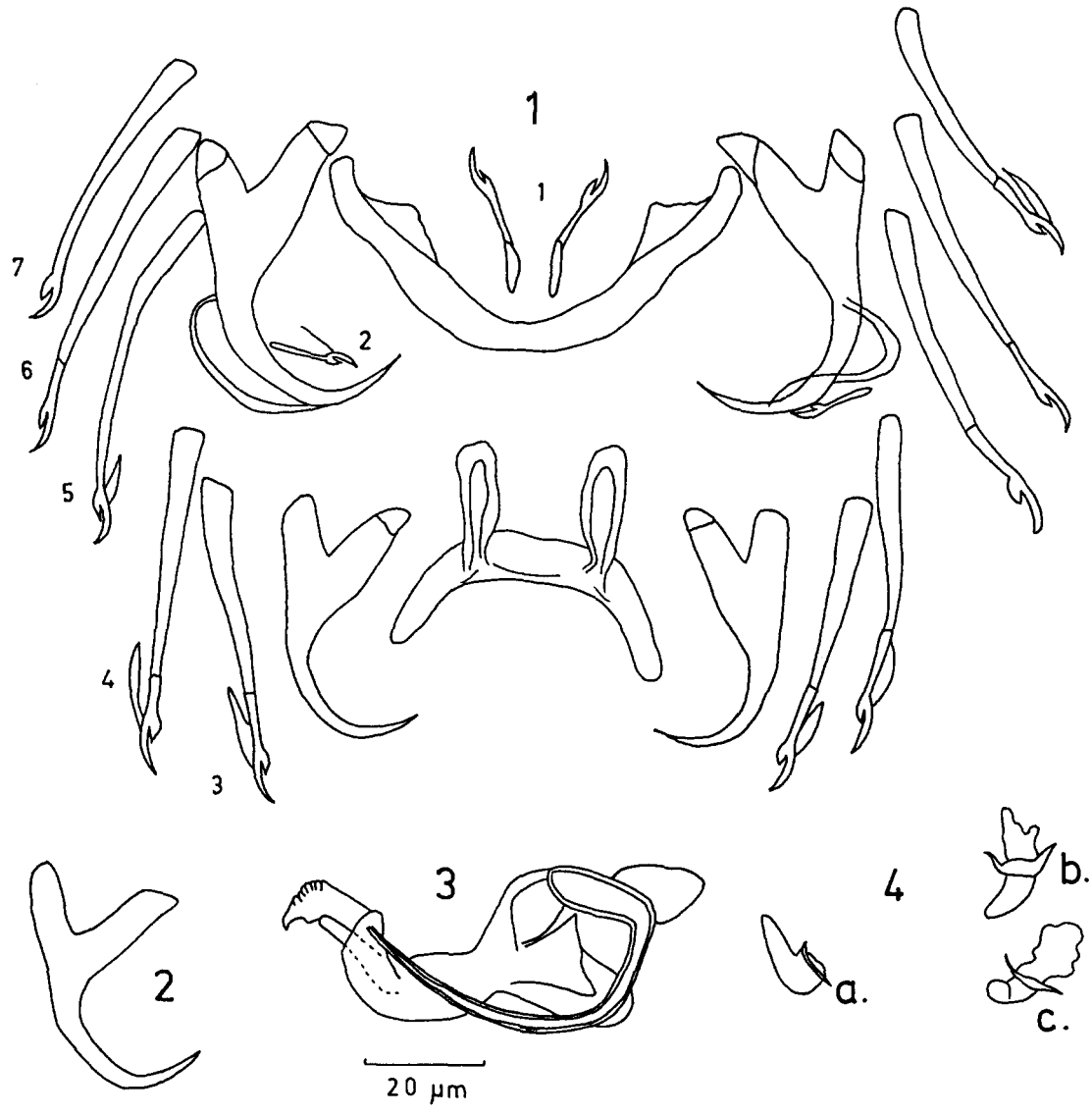

Fig. 9. Cichlidogyrus dossoui n. sp. 1. Haptoral armature (ex *T. rendalli*). 2. Ventral hamulus (ex *O. mortimeri*). 3. Copulatory organ, 4. Vagina: a. In parasites of *T. rendalli* and *S. macrocephalus*; b,c. In parasites of *O. mortimeri*.

Description

Long, slender parasite with 2 or 4 eyes; haptor broader than body and separated from body by constriction. Sclerotised parts of haptor as in *C. halli* but much smaller. Ventral hamuli with long shaft and long sharp point; outer root well developed, with wide base, variable in shape; inner root slightly broader than outer root. Ventral bar V-shaped; branches long, narrower distally but extremities slightly enlarged. Dorsal hamuli similar in length to ventral hamuli with narrower base and longer roots. Dorsal bar arched: branches with round or pointed extremities; appendages longer than branches. Hooklets short; pair 2 shortest; pair 5 longest; pair 1 smaller than remainder, with base approximately 1/4 to 1/3 of total length; pair 4 longer than pair 3, with bases 1/2 and 1/3 of total length respectively; pairs 5, 6 and 7 decreasing in length, with bases about 1/2 of total length. Copulatory organ with slightly curved copulatory tube, broad proximally and narrow dis-

Table III. Measurements (in micrometres) of the sclerotised parts of *Cichlidogyrus dossoui* n. sp. parasitising three species of cichlids in Lake Kariba (Zimbabwe).

	T. rendalli (n = 15)	*S. macrocephalus* (n = 7)	*O. mortimeri* (n = 15)
L	430–680 (559)	600–1000 (743)	800–1000 (858)
W	80–120 (108)	95–130 (114)	105–240 (143)
Ventral bar			
V	32–40 (35)	35–38 (37)	31–35 (32)
e	2–5 (3)	3–4 (4)	2–4 (3)
Dorsal bar			
L1	30–46 (38)	36–41 (38)	27–35 (31)
L2	12–18 (15)	15–20 (17)	14–16 (15)
d	10–15 (12)	11–15 (13)	8–13 (11)
e	4–8 (6)	4–6 (5)	4–6 (5)
Ventral hamuli			
a	34–37 (36)	35–39 (37)	32–39 (36)
b	29–32 (30)	29–33 (31)	27–32 (29)
c	6–9 (8)	7–11 (8)	7–13 (11)
d	12–15 (13)	13–17 (14)	12–18 (15)
e	10–14 (12)	12–14 (13)	9–13 (12)
Dorsal hamuli			
a	27–32 (29)	24–32 (29)	24–28 (26)
b	21–25 (23)	22–26 (24)	19–24 (22)
c	5–9 (8)	7–9 (8)	7–11 (9)
d	9–13 (11)	10–14 (12)	10–14 (13)
e	8–12 (10)	7–12 (10)	7–13 (9)
Hooklets			
1	17–20 (18)	17–20 (19)	12–15 (13)
2	12–15 (14)	13–15 (14)	12–13 (12)
3	36–45 (39)	41–44 (42)	38–45 (42)
4	38–46 (42)	41–47 (44)	43–50 (46)
5	41–49 (45)	43–50 (46)	40–47 (43)
6	40–48 (46)	42–49 (47)	42–46 (44)
7	36–42 (39)	41–48 (43)	38–44 (41)
Copulatory organ			
LT	46–56 (52)	51–55 (53)	46–51 (48)
C.t.	54–68 (61)	61–66 (65)	54–66 (61)
Ac.	42–50 (46)	46–54 (49)	40–48 (44)
Vagina			
L	8–15 (12)	9–17 (13)	12–22 (16)
W	3–8 (5)	3–5 (4)	4–10 (7)

Ac., accessory piece; C.t. copulatory tube; L, length; LT, total length; n, number of parasites measured; W, maximum width. For other abbreviations see Fig. 1.

tally, without basal portion; partition of tube where accessory piece and copulatory tube are joined appears to be only external; copulatory tube narrowing at about mid-length and at about 10 μm from proximal end, i.e. region where copulatory tube and accessory piece unite; accessory piece S-shaped, very narrow basally and stout, hook-shaped with large swelling on convex margin and small swelling on the concave margin at distal end; accessory piece ending beyond or at same level as copulatory tube. Vagina distinguishable, assuming shape of short, narrow tube.

Remarks

In the shape of the sclerotised parts of the haptor, this parasite generally resembles *C. tilapiae* Paperna, 1960 and *C. bifurcatus* Paperna, 1960. It differs from these species by its size, the copulatory organ and the large haptoral armature. *C. karibae* n. sp. is closely related to the type-material of *C. tubicirrus*, all of the sclerotised parts being similar in their general aspect. In the original description of *C. tubicirrus* from Uganda, Paperna & Thurston (1969) differentiated three subspecies, *C. tubicirrus magnus*, *C. tubicirrus minutus* and *C. tubicirrus longipenis*. Subsequently, Paperna (1979) synonymised *C. tubicirrus magnus* and *C. halli* and raised the two other subspecies to the rank of species, *C. tubicirrus* thus referring to *C. t. minutus* and *C. longipenis* to *C. t. longipenis*. *C. karibae* obviously differs from *C. halli* in body size and the size of the sclerotised parts and from *C. longipenis* by the shape of the copulatory organ. It is similar to *C. tubicirrus* in most aspects but the copulatory organs differ.

Paperna & Thurston (1969) reported that both the measurements of the sclerotised parts and the copulatory organ morphology were different in *C. tubicirrus* collected from *O. leucosticus* and from *Haplochromis* spp., and it is probable that at least two different species were present. The measurements taken from Kariba specimens are closer to those of *C. tubicirrus* parasitising *O. leucosticus* in Uganda, but the ventral bar, the ventral hamuli and the appendages of the dorsal bar are larger (82–96 μm as compared to 53–66, 37–45 to 33–36 and 18–23 to 12–13 respectively). In comparison with *C. tubicirrus* described from *Haplochromis* spp., all of the sclerotised parts are larger in *C. karibae*.

The main features characterising *C. karibae* are the long appendages of the dorsal bar and the morphology of the vagina and copulatory organ.

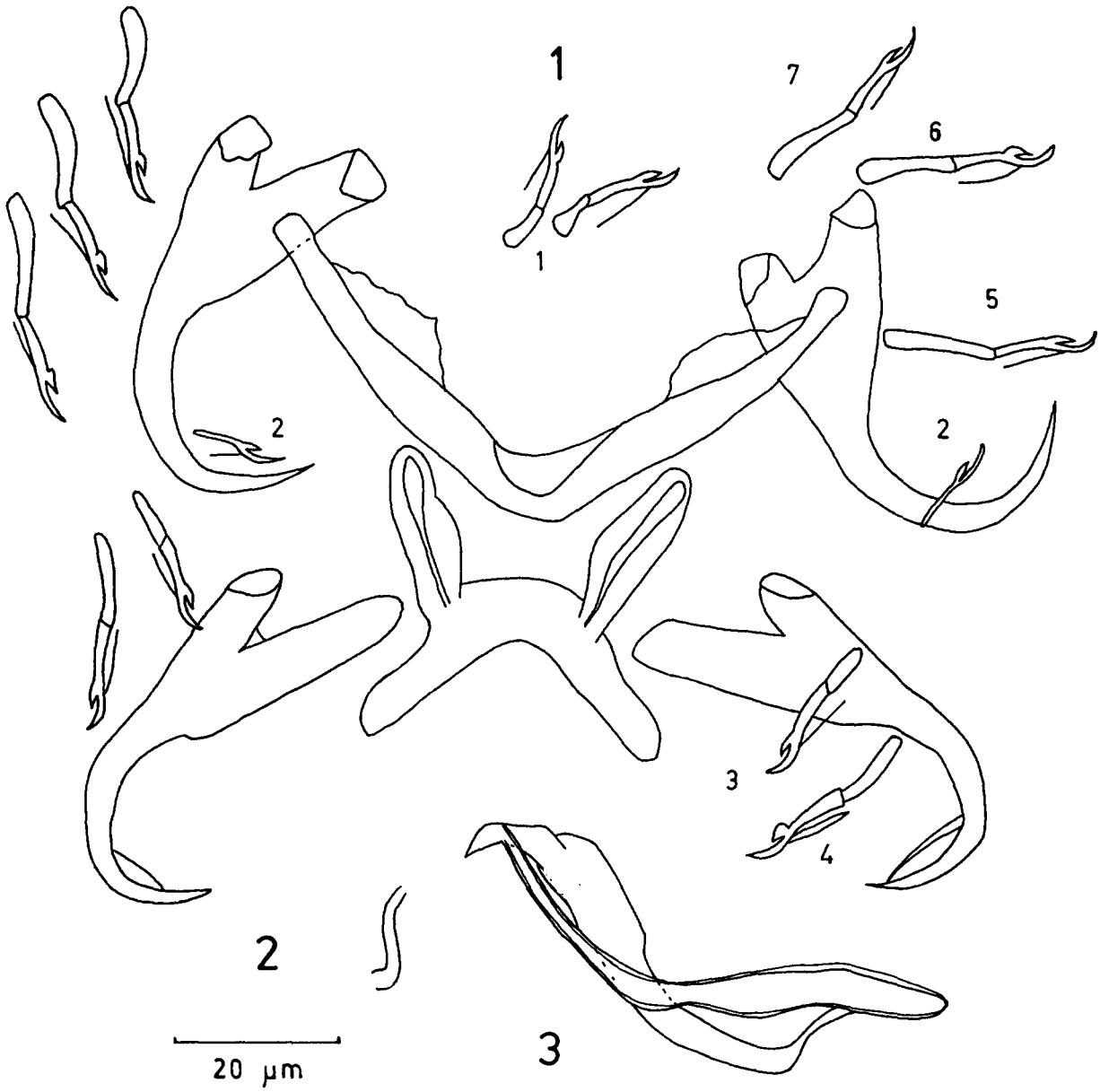

Fig. 10. Cichlidogyrus karibae n. sp. 1. Haptoral armature. 2. Vagina. 3. Copulatory organ.

***Cichlidogyrus zambezensis* n. sp.** (Fig. 11)
(MNHN 138 HF)

Type-host: *S. macrocephalus*.
Occasional host: *O. mortimeri*.
Type-locality: Lake Kariba, Zimbabwe.

Description

Long and slender parasite, similar to *C. karibae*, with 2 eyes, sometimes 4, and haptor separated from body by constriction. Sclerotised parts of haptor similar to those of *C. karibae*. Ventral hamuli with long shaft and long, sharp point; outer and inner roots well developed; inner slightly broader than outer. Ventral bar V-shaped; branches wider at mid-length, with rounded end and membranous extensions reduced. Dorsal hamuli slightly longer than ventral but slimmer, with long shaft, sharp point, narrow outer root and long, narrow inner root; groove often present at base of outer root. Dorsal bar arched; branches

Table IV. Measurements (in micrometres) of the sclerotised parts of the *Cichlidogyrus* spp. parasitic on cichlids in Lake kariba: minimum and maximum values obtained from 15 specimens of each species, both hamuli of each pair being measured; average given in parentheses.

	C. tiberianus	*C. karibae*	*C. zambezensis*	*C. quaestio*	*C. philander*
L	480–600 (536)	560–1000 (791)	560–1080 (776)	335–690 (503)	260–400 (312)
W	90–160 (122)	90–150 (124)	135–160 (129)	65–160 (103)	55–80 (69)
Ventral bar					
V	24–29 (27)	41–48 (44)	34–41 (37)	31–39 (36)	25–29 (28)
e	2–4 (3)	6–8 (8)	4–7 (5)	2–5 (3)	3–5 (4)
Dorsal bar					
L1	24–31 (28)	37–49 (43)	32–38 (35)	28–35 (32)	24–31 (28)
L2	8–10 (9)	18–23 (21)	14–17 (15)	9–17 (12)	10–12 (11)
d	7–10 (9)	12–18 (15)	11–15 (13)	9–14 (12)	7–12 (9)
e	3–5 (4)	8–9 (8)	8–10 (8)	5–7 (6)	4–6 (5)
Ventral hamuli					
a	30–37 (34)	37–45 (40)	37–42 (39)	28–39 (33)	28–32 (30)
b	30–36 (33)	32–38 (35)	32–36 (34)	24–38 (29)	23–27 (25)
c	2–5 (4)	4–10 (7)	4–7 (6)	3–7 (5)	4–7 (5)
d	6–10 (8)	8–15 (12)	9–13 (12)	8–12 (10)	8–12 (10)
e	9–13 (11)	9–16 (15)	13–17 (16)	10–17 (13)	8–11 (10)
Dorsal hamuli					
a	22–27 (24)	42–49 (45)	41–45 (43)	33–44 (39)	29–36 (33)
b	17–22 (20)	30–36 (34)	29–35 (32)	21–32 (25)	18–23 (21)
c	3–6 (5)	3–11 (6)	3–8 (5)	4–10 (6)	3–7 (5)
d	7–12 (10)	12–22 (16)	13–18 (16)	13–21 (17)	12–16 (14)
e	5–10 (7)	10–15 (16)	10–14 (13)	7–14 (9)	6–9 (7)
Hooklets					
1	12–15 (13)	16–19 (17)	18–20 (19)	23–31 (27)	22–24 (23)
2	11–14 (13)	11–13 (12)	12–13 (13)	10–12 (11)	10–11 (10)
3	25–31 (28)	18–22 (19)	18–20 (19)	16–20 (17)	15–17 (16)
4	27–34 (31)	22–25 (23)	23–25 (24)	18–22 (20)	19–20 (20)
5	27–32 (29)	24–27 (26)	23–27 (24)	21–25 (23)	22–25 (23)
6	26–32 (29)	22–26 (24)	23–26 (24)	21–26 (23)	20–22 (21)
7	25–31 (28)	18–25 (23)	19–23 (21)	18–22 (21)	18–20 (19)
Copulatory organ					
TL	34–46 (41)	60–70 (66)	–	–	–
C.t.	50–65 (59)	57–65 (62)	60–65 (62)	27–32 (30)	44–50 (46)
Ac.	30–43 (38)	51–63 (56)	46–50 (48)	22–27 (25)	27–35 (32)
Vagina					
L	8–14 (11)	9–16 (12)	12–22 (18)	–	–
W	4–8 (7)	2–4 (2)	–	–	–

Ac., accessory piece; C.t., copulatory tube; L, length; TL, total length; M, maximum width.
For other abbreviations see Fig. 1.

narrow, short, pointed; appendages medium in size, slightly longer than branches; section between appendages broader than in *C. karibae*. Hooklets pair 2 shortest and slenderest; pairs 1 and 3 similar in length and shape, with base about 1/3 of total length; pairs 4, 5, 6 and 7 longer than others, with base about 2/5 to 1/2 of total length; pair 7 shorter than pairs 4 to 6. Copulatory tube of approximately same length as in *C. karibae* but assuming characteristically different shape: base large followed by narrow constriction and exhibiting enlargement at mid-length forming swelling; end narrow, curved, tapering; base with additional heavily sclerotised portion on which accessory piece is articulated; thin connection between this portion and accessory piece visible in some specimens. Accessory piece massive with small finger-like extension at about 3/4 of its length, ending with hook; proximal end rounded and articulated on additional portion of the base of copulatory tube. Vaginal orifice well sclerotised, triangular, hat-like (height: 5–8 μm, aver-

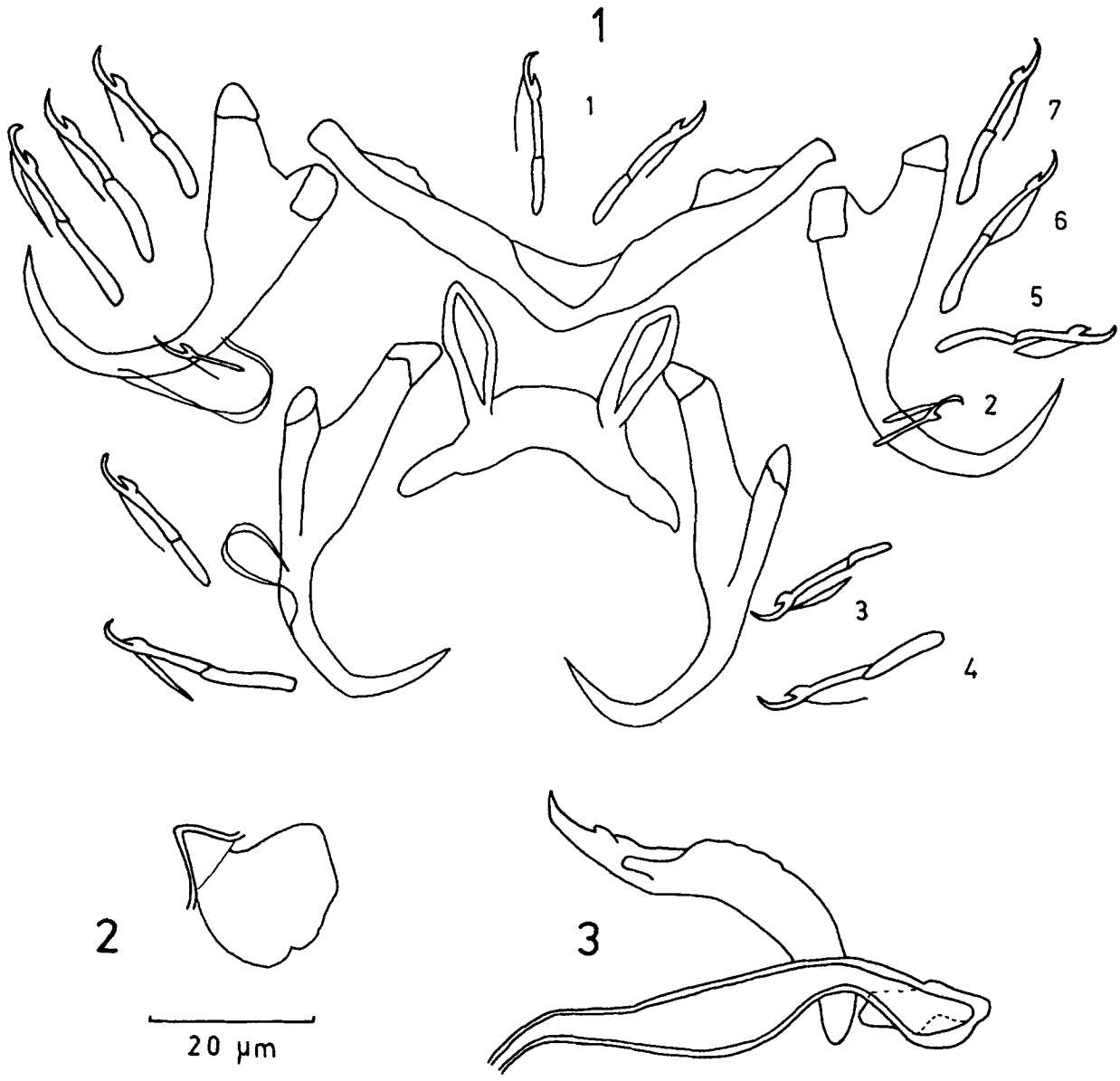

Fig. 11. Cichlidogyrus zambezensis n. sp. 1. Haptoral armature. 2. Vagina. 3. Copulatory organ.

age 8; width of base: 7–11 µm, average 8); irregular part variable in size and shape but usually more or less round often present.

Remarks

Due to its close resemblance to *C. karibae*, the remarks made above also apply to *C. zambezensis* n. sp. Considering that these two species can only be separated by a thorough observation of the copulatory organs and vaginas, it supports the hypothesis that several species might have been included in the original description of *C. tubicirrus*.

The fact that the accessory piece seems articulated to the copulatory tube must be emphasised: in other *Cichlidogyrus* spp. it is usually joined to the base of the copulatory tube. It is interesting to note that the copulatory organ is identical in its appearance to that of *C. papernastrema* Price *et al.*, 1969, but it is the only character common

to the two species, *C. papernastrema* having much smaller sclerotised parts and, above all, large and massive first pair of hooklets. It was recorded from *T. sparrmanii* in South Africa.

***Cichlidogyrus quaestio* n. sp** (Fig. 12) (MNHN 137 HF)

Type-host: *T. rendalli*.
Occasional hosts: *S. codringtonii*, *S. macrocephalus*.
Type-locality: Lake Kariba, Zimbabwe.

Description

Small, wide parasite with 2 or 4 eyes; haptor well separated from body and almost round in shape. Ventral hamuli with short, broad base, long shaft and long, sharp point; outer root reduced, inner slightly narrower than outer. Ventral bar thin, long, with ball-like extremities in most specimens and reduced membranous extensions. Dorsal hamuli similar in length to ventral hamuli but different in shape, base narrower and longer, shaft shorter, and long, sharp point; outer root narrow, long; inner root much longer and more pointed than in ventral hamuli. Dorsal bar small, only slightly arched, with peculiar branches irregular in width because of presence of narrow constriction at about mid-length followed by enlargement; extremities of branches tapering; section between appendages broad; appendages with pointed ends. Hooklets long; pair 2 smallest; pair 1 massive and large; pairs 5 and 6 equal in size and longer than pair 7; base about 1/3 of total length in pairs 3 and 4, 1/3 to 2/5 of total length in pairs 5 to 7. Copulatory organ small; copulatory tube slightly curved with wide base capped with regular, almost square, portion and followed by narrow, straight tunnel with tapering end. Accessory piece slightly S-shaped with solid hook-like extremity, sclerotised outer border and thumb-like extension at about 4/5 of length of copulatory organ present in most specimens; accessory piece ending beyond copulatory tube. No vagina visible.

Remarks

Several species of *Cichlidogyrus* with large, solid hooklets of pair 1 have been described and eight of them have a simple tubuliform penis, which is neither spiral or curved: *C. dionchus* Paperna, 1968; *C. brevicirrus* Paperna & Thurston, 1969; *C.* cf. *brevicirrus* Paperna, 1969; *C. halinus* Paperna, 1969; *C. papernastrema* Price, Peebles & Bamford, 1969; *C. digitatus* Dossou, 1982; *C. erectus* Dossou, 1982; and *C. falsifer* Dossou & Birgi, 1984.

The present species clearly differs from *C. halinus*, *C. papernastrema*, *C. digitatus* and *C. falsifer* in the shape of the copulatory organ, but comparison with the remaining species is rather difficult because, as Dossou (1982) rightly pointed out, confusion occurs over these species. The species *C. brevicirrus* and *C.* cf. *brevicirrus* were synonymised with *C. dionchus* by Paperna (1979). If this were correct, the species would then parasitise eleven different species of cichlids. Dossou & Birgi (1984) showed that in the original description of *C. dionchus* one of the drawings of the copulatory organ is actually from *C. falsifer*. Measurements and drawings of the three species are different. It is likely, therefore, that the concept of *C. dionchus* is a complex of several different species whose diagnostic criteria still remain to be defined. In agreement with Dossou (1982), it is considered that *C. brevicirrus* differs from *C. dionchus*. Moreover, in the original description of *C. brevicirrus*, Paperna & Thurston gave the measurements of the parasite obtained from *Tilapia zillii* and *Haplochromis* spp., and these measurements are different, especially in the size of the ventral hamuli and the copulatory organs. It seems likely that theses authors included two species under the same name.

According to the measurements of the sclerotised parts of the haptor, *C. quaestio* n. sp. agrees most closely with *C. brevicirrus* from *T. zillii*, but the copulatory organs are different. It is also closely related to *C. erectus*, but several differences occur: the sclerotised parts of the haptor are larger in *C. erectus* (ventral bar 80–84 μm, *vs* 62–78; dorsal bar 38–40, *vs* 28–35; ventral hamu-

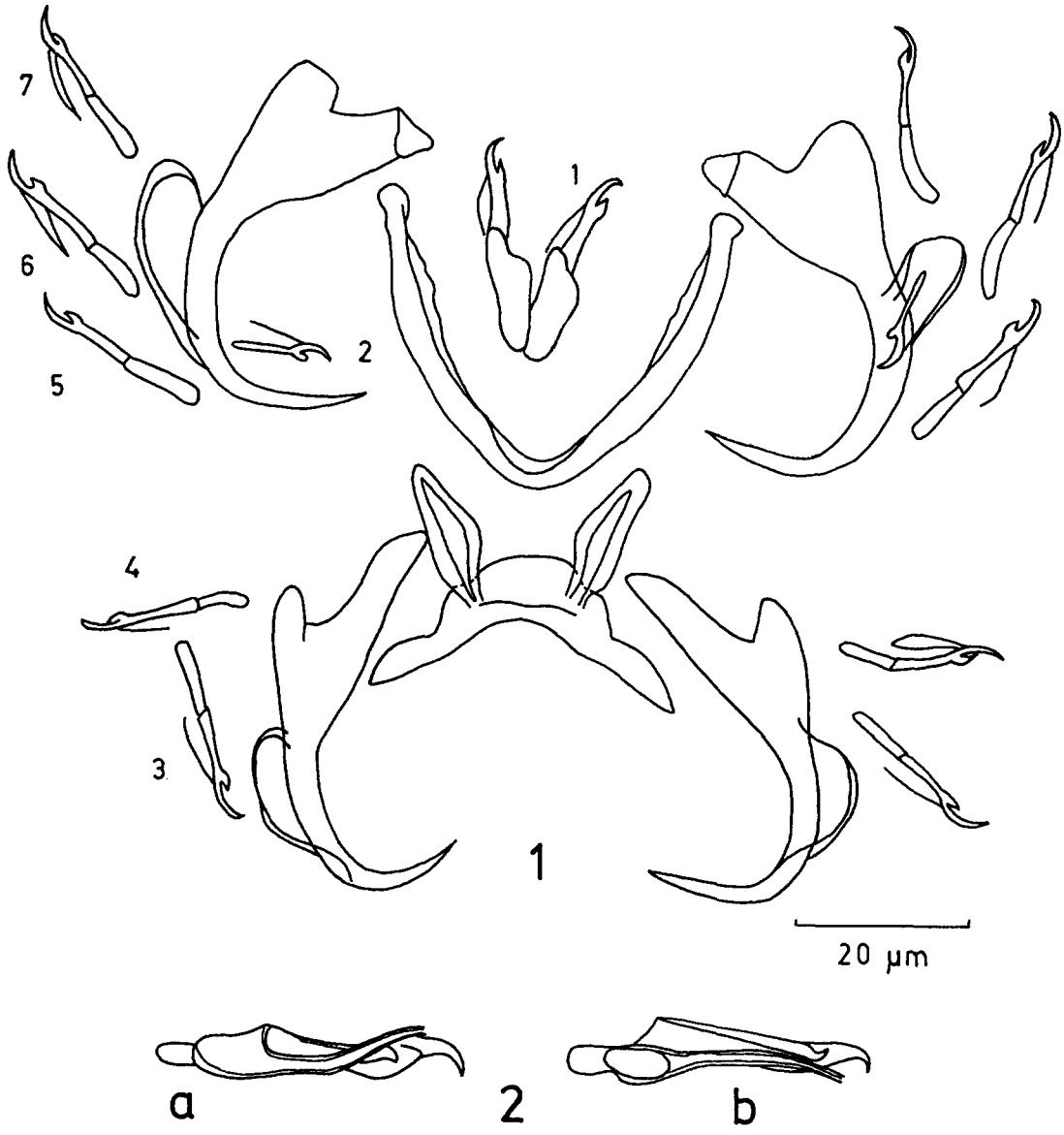

Fig. 12. Cichlidogyrus quaestio n. sp. 1. Haptoral armature. 2. Copulatory organ.

lus 42–44, *vs* 28–39; dorsal hamulus 51–53, *vs* 33–44); the ventral hamuli have a different shape with a smaller base and much longer shafts and points in Kariba specimens; and the copulatory organs are similar in their general aspect and in size but differ in details, the basal portion associated with the ejaculator being much larger and the sclerotised outer border of the accessory piece being absent in *C. erectus*. The present material possesses characters not represented in the other species with a large first pair of hooklets, and since the copulatory organ resembles a question mark, the name *C. quaestio* n. sp. is proposed.

In Uganda, Thurston (1970) observed *C. brevicirrus* on a strain of *T. rendalli* originating from Zambia. *C. brevicirrus* was not found in Lake Kariba, but, considering the similarity between this parasite and *C. quaestio*, it is possible that it

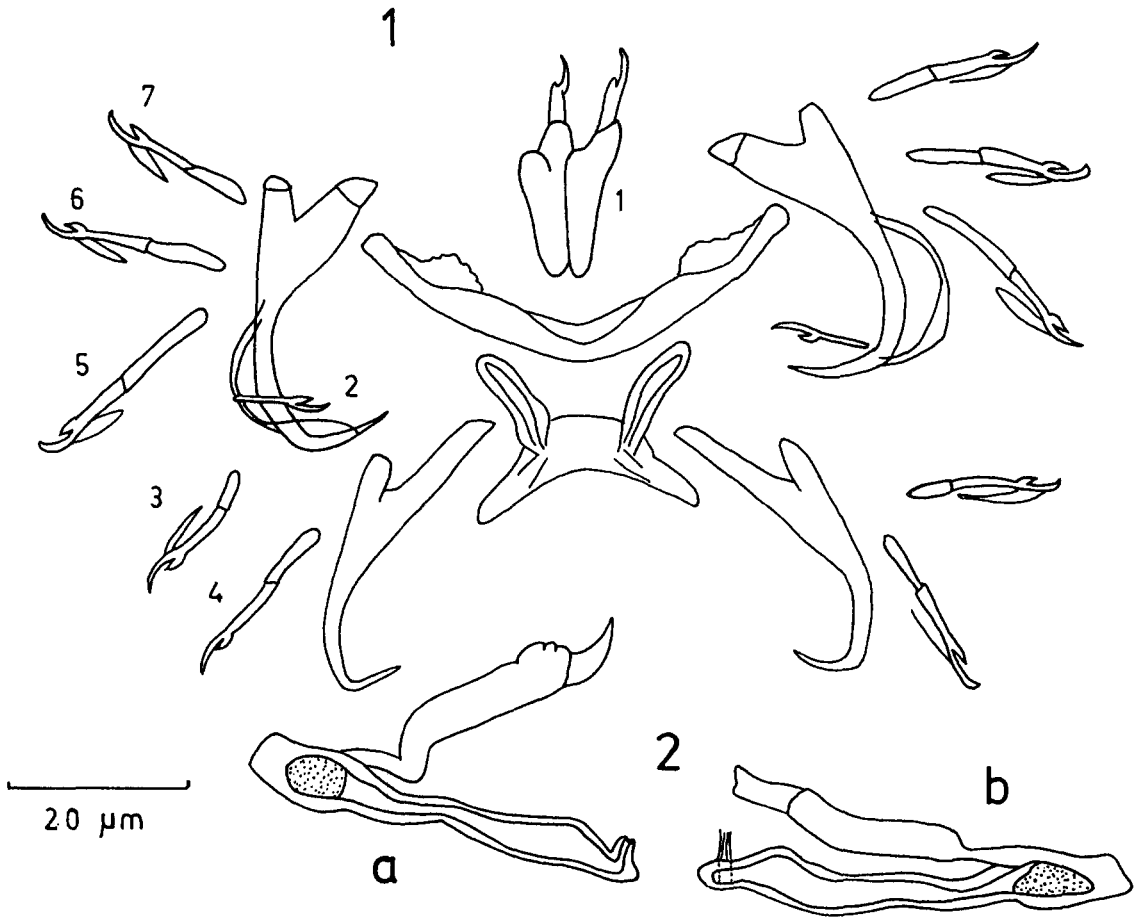

Fig. 13. Cichlidogyrus philander n. sp. 1. Haptoral armature. 2. a,b. Different views of copulatory organ.

was actually *C. quaestio* that Thurston found on *T. rendalli*.

***Cichlidogyrus philander* n. sp.** (Fig. 13) (MNHN 135 HF)

Type-host: *Pseudocrenilabrus philander*.
Type-locality: Lake Kariba, Zimbabwe.

Description

Minute parasite (the smallest of the *Cichlidogyrus* observed in Lake Kariba); 2 eyes, sometimes 4; haptor well separated from body and much broader than body. Sclerotised parts of haptor very small. Ventral hamuli with short, narrow base, long, thin shaft, long, sharp point and well-developed roots; outer root narrow; inner much wider than outer. Ventral bar short with slight constriction towards extremities; extremities slightly expanded. Dorsal hamuli longer than ventral, different in shape; base slender; shaft and point short; outer root well-developed; inner root narrow and very long. Dorsal bar small, only slightly arched; short branches with pointed ends; appendages longer than branches; section between appendages usually flat, sometimes slightly convex. Hooklets long; pair 1 stout and large; pair 2 smallest and most slender; pairs 5, 6 and 7 decreasing in size; pairs 3 and 4 with base about 1/3 to 2/3 of total length; base approximately 1/2 of total length in pairs 5 to 7. Copulatory organ comparatively large consisting of straight, broad copulatory tube with reduced basal portion, having constriction at about 1/3 of its length and

ending in bend which, depending on preparations, may appear as sharp, lateral termination; accessory piece as wide as, and reaching end of, copulatory tube, with rough hook-like extremity which, depending on angle view point, may appear dented terminally. No vagina visible.

Remarks

C. philander n. sp. can be differentiated from all other described *Cichlidogyrus* spp. with large first pair of hooklets by the small size of the sclerotised parts of the haptor and by the shape of the copulatory organ. It was only observed in *Pseudocrenilabrus philander*, and no other monogenean was found on the gills of this fish. Hence, the name *C. philander* is proposed.

Among the *Cichlidogyrus* observed in Lake Kariba, *C. quaestio* and *C. philander* are the only ones to have a large, solid first pair of hooklets. They also have in common the dissimilar ventral and dorsal hamuli, the long shaft and points of the ventral hamuli, the narrow base and the long inner root of the dorsal hamuli. The haptoral armature is much smaller in *C. philander*, especially the ventral bar, and the two species are easily differentiated by their copulatory organs.

Key to the identification of the *Cichlidogyrus* spp. present in Lake Kariba

1 Dorsal bar with triangular distal ends and appendages >30 μm long. Ventral bar associated with a sclerotised bar supporting membranous, fan-shaped structure 2
– Dorsal bar with distal ends which are not triangular. No sclerotised structure associated with ventral bar..... 3
2 Copulatory organ short with a reduced basal portion. Vagina in the form of a long, thin, curved tube flared distally .... *C. longicornis*
– Copulatory organ long with a large basal portion. Vagina well sclerotised, in two parts, a broad, curved tube ending with three finger-like extensions and a more or less round portion..... *C. gravivaginus*
3 First pair of hooklets large and stout 4
– First pair of hooklets thin 5
4 Copulatory tube slightly curved with a wide base capped with a basal portion; accessory piece with a hook-like extremity and a sclerotised outer border, exceeding length of copulatory tube ..... *C. quaestio*
– Copulatory tube straight without a basal portion, ending with a bend; accessory piece reaching end of copulatory tube and ending with a massive hook ..... *P. philander*
5 Copulatory organ large and wide; copulatory tube arched with an enlarged bent base and a tapering end; accessory piece roughly S-shaped, very large and broad..... 6
– Copulatory organ not as above 7
6 Marginal hooklets >35 μm long. Appendages of dorsal bar >12 μm long. Dorsal hamuli slightly smaller than ventral hamuli. Vagina bent, pipe-like or with a thin sclerotised bar . ..... *C. dossoui*
– Marginal hooklets about 30 μm long. Appendages of dorsal bar less than 10 μm long. Dorsal hamuli much smaller than ventral hamuli. Vagina in a spiral ..... *C. tiberianus*
7 Dorsal and ventral bars short and stout. Dorsal and ventral hamuli with reduced roots .... *C. sclerosus*
– Dorsal and ventral bars thin. Dorsal and ventral hamuli with long inner roots..... 8
8 Sclerotized parts of haptor very large; ventral bar >100 μm long; dorsal bar >50 μm wide. Copulatory tube S-shaped with a constant width and no tapering end; accessory piece not ending with a hook ..... *C. halli*
– Sclerotised parts medium or small in size. Copulatory tube with a tapering end; accessory piece ending with a hook 9
9 Sclerotized parts of haptor medium in size; ventral bar 70–100 μm long; dorsal bar 30–50 μm wide. Copulatory organ up to 70 μm long. Vagina present..... 10
– Sclerotised parts of haptor small in size; ventral bar <70 μm long; dorsal bar <30 μm wide. Copulatory organ less than 40 μm long. Vagina not visible..... 11
10 Copulatory tube slightly arched; accessory

piece very narrow proximally and enlarged, hook-like distally. Vagina narrow short tube . ..... *C. karibae*

– Copulatory tube with a median enlargement and a curved, tapering end. Vagina in two parts, one hat-like and one more or less round ..... *C. zambezensis*

11 Appendages of dorsal bar >12 μm. Hooklets of pair 1 longer than pair 2. Copulatory organ less than 40 μm long; accessory piece with a discrete swelling at 2/3 of its length and a thin hook at its end ..... *C. tilapiae*

– Appendages of dorsal bar <10 μm. Hooklets of pairs 1 and 2 similar; pairs 3 and 7 with reduced base. Copulatory organ over 40 μm long; accessory piece with a swelling at about 3/4 of its length and ending with a massive hook..... *C. haplochromii*

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