

## ***Cichlidogyrus* Paperna, 1960 (Monogenea, Ancyrocephalidae): gill parasites from West African Cichlidae of the subgenus *Coptodon* Regan, 1920 (Pisces), with descriptions of six new species**

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### **Abstract**

A study of gill parasites from fishes of the subgenus *Coptodon* Regan, 1920 (Cichlidae), namely *Tilapia coffea* Thys van den Audenaerde, *T. dageti* Thys van den Audenaerde, *T. guineensis* (Bleeker), *T. louka* Thys van den Audenaerde, *T. walteri* Thys van den Audenaerde and *T. zillii* (Gervais), from different locations in West Africa (Burkina Fasso, Congo, Ivory Coast, Guinea, Mali and Senegal), revealed the presence of 19 species of *Cichlidogyrus* Paperna, 1960 (Monogenea, Ancyrocephalidae). Six are considered new species: *C. amphoratus* n. sp., *C. levequei* n. sp., *C. microscutus* n. sp., *C. ornatus* n. sp., *C. ouedraogoi* n. sp. and *C. yanni* n. sp. The host-specificity of these parasites is discussed.

### **Résumé**

Une étude des parasites branchiaux de Poissons appartenant au sous-genre *Coptodon* Regan, 1920 (Cichlidae): *Tilapia coffea* Thys van den Audenaerde; *T. dageti* Thys van den Audenaerde; *T. guineensis* (Bleeker); *T. louka* Thys van den Audenaerde; *T. walteri* Thys van den Audenaerde; and *T. zillii* (Gervais); provenant de différentes localités en Afrique de l'Ouest (Burkina Fasso, Congo, Côte d'Ivoire, Guinée, Mali et Sénégal) a révélé la présence de 19 espèces du genre *Cichlidogyrus* Paperna, 1960 (Monogenea, Ancyrocephalidae). Six sont considérées comme nouvelles: *C. amphoratus* n. sp., *C. levequei* n. sp., *C. microscutus* n. sp., *C. ornatus* n. sp., *C. ouedraogoi* n. sp. et *C. yanni* n. sp. Nous discutons de la spécificité de ces parasites.

### **Introduction**

Six species of fishes belonging to the subgenus *Coptodon* Regan, 1920 (Cichlidae), present in West Africa (Burkina Fasso, Congo, Ivory Coast, Guinea, Mali and Senegal), were examined for gill monogeneans. Two, *Tilapia guineensis* (Bleeker) and *Tilapia zillii* (Gervais), have been previously examined (Paperna, 1960, 1965, 1968, 1969, 1979; Paperna & Thurston, 1969; Ergens, 1981; Dossou, 1982; Pariselle & Euzet, 1995). Four, *Tilapia coffea* Thys van den Audenaerde, *T. dageti* Thys van den Audenaerde, *T. louka* Thys van den Audenaerde and *T. walteri* Thys

van den Audenaerde, have never been examined for parasites.

### **Materials and methods**

Fish were caught in various rivers and lagoons of Burkina Fasso, Congo, Guinea, Ivory Coast, Mali and Senegal using gill or cast nets, or after poisoning with Rotenone. The fish were either dissected on site immediately after capture or kept fresh and dissected later in the laboratory. In both cases, the left branchial arches, separated by dorsal and ventral section, were frozen

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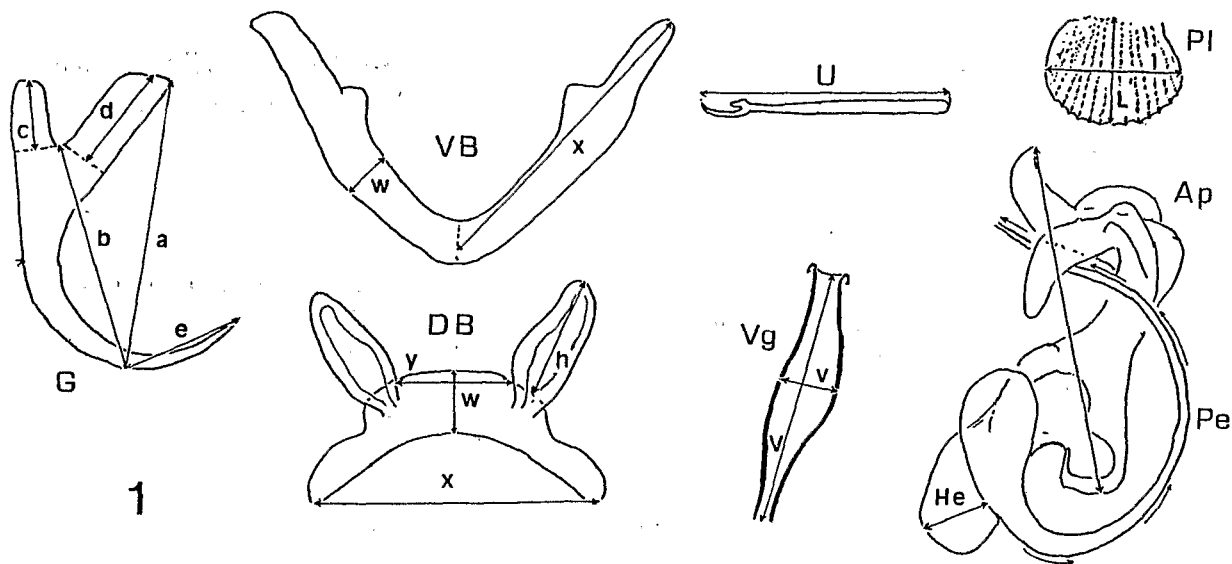


Figure 1. Measurements used in this study. Abbreviations: Ap, accessory piece; DB, dorsal transverse bar; G, gripus; He, heel; Pe, penis; Pi, auxiliary plate; U, uncinulus; VB, ventral transverse bar; Vg, vagina.

at  $-20^{\circ}\text{C}$  or in liquid nitrogen, until examination. To verify the specific identity of the host fishes, the carcasses were numbered, then fixed and preserved in formalin. After thawing, the parasites were detached from the gill, using a strong water current, and transferred individually onto a slide with a mounted needle directly into a drop of ammonium picrate-glycerine (mixture described by Malmberg, 1957). The preparation was then covered with a round cover slip and after several hours, necessary for the proper impregnation by the mounting medium, the cover slip was sealed with Glyceel (GURR-BDH Chemicals Ltd.). From these preparations, drawings were made of the sclerotised pieces of the haptor, the male copulatory complex and the vagina (stained with the ammonium picrate) using a camera lucida. All measurements were made with a digitiser. The measurements are those proposed by Gusev (1962) (Figure 1) and are expressed in micrometres as the mean  $\pm$  the standard deviation followed by the range in parentheses. The method of numbering of the haptoral pieces is that adopted at ICOPA IV (Euzet & Prost, 1981) and the method of naming is that proposed by Pariselle & Euzet (1995): uncinulus for the small marginal hooks, gripus for the large median hooks.

## Results

Nineteen species of *Cichlidogyrus* Paperna, 1960 (Monogenea, Ancyrocephalidae) were found. Thirteen have been previously recorded from *Tilapia guineensis* and/or *T. zillii*: *Cichlidogyrus aegypticus* Ergens, 1981; *C. agnesi* Pariselle & Euzet, 1995; *C. anthemocolpos* Dossou, 1982; *C. arthracanthus* Paperna, 1960; *C. bilongi* Pariselle & Euzet, 1995; *C. cubitus* Dossou, 1982; *C. digitatus* Dossou, 1982; *C. ergensi* Dossou, 1982; *C. flexicolpos* Pariselle & Euzet, 1995; *C. galus* Pariselle & Euzet, 1995; *C. louipaysani* Pariselle & Euzet, 1995; *C. tiberianus* Paperna, 1960; and *C. vexus* Pariselle & Euzet, 1995. The large number of *Cichlidogyrus* specimens observed on different species of cichlid host collected from several locations in West Africa permits us to give precise data on the morpho-anatomical variations in *C. aegypticus* and in *C. digitatus*. The careful examination of the type of *Cichlidogyrus halinus* Paperna, 1969 (M.R.A.C.<sup>1</sup> MT35.928) has convinced us that *C. erectus* Dossou, 1982, a gill parasite of the cichlid *Sarotherodon melanotheron*, is a synonym of this species. Six species are considered new: *Cichlidogyrus amphoratus* n. sp., *C. levequei* n. sp., *C. microscutus* n. sp., *C. ornatus* n. sp., *C. ouedraogoi* n. sp. and *C. yanni* n. sp. All new species belong to *Cichlidogyrus* as redefined by Dossou and

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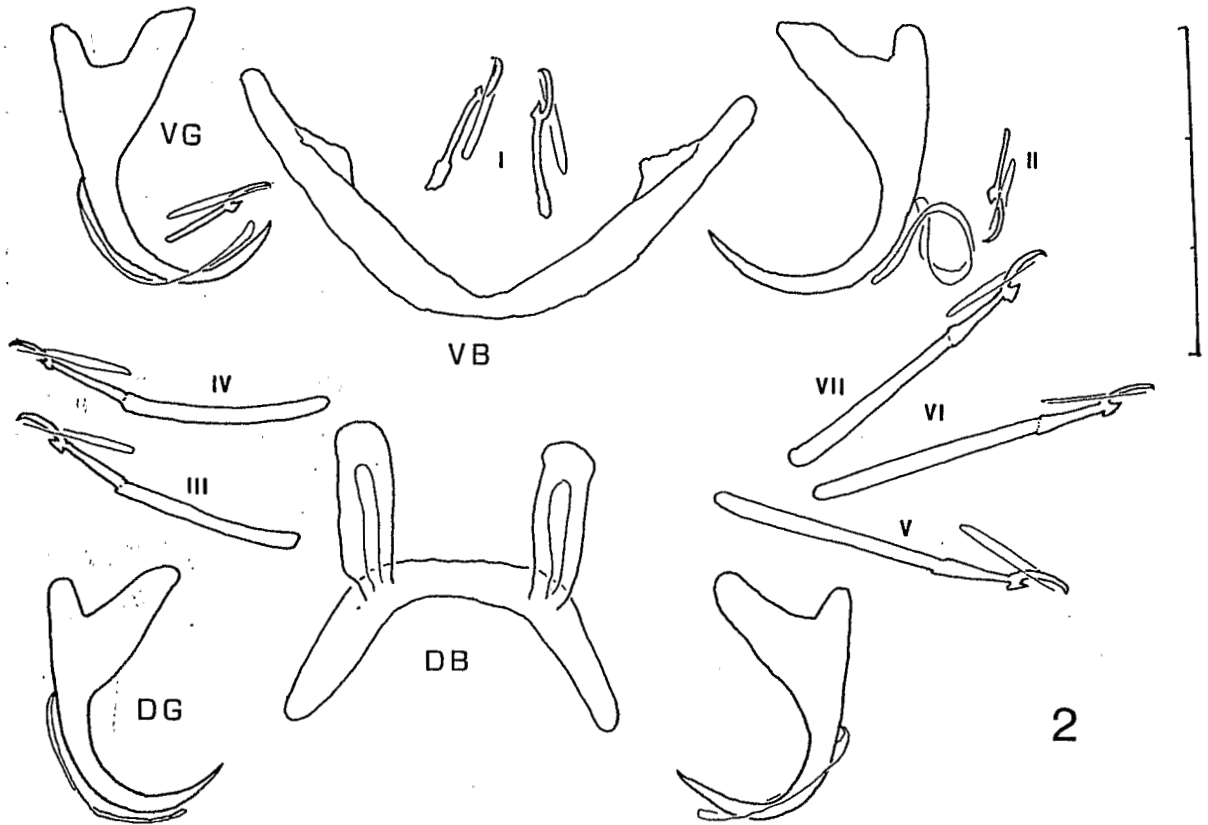


Figure 2. *Cichlidogyrus aegypticus* Ergens, 1981, Haptor. Abbreviations: DG, dorsal gripus; DB, dorsal bar; VG, ventral gripus; VB, ventral bar; I-VII, marginal uncinuli. Scale-bar: 30 $\mu$ m.

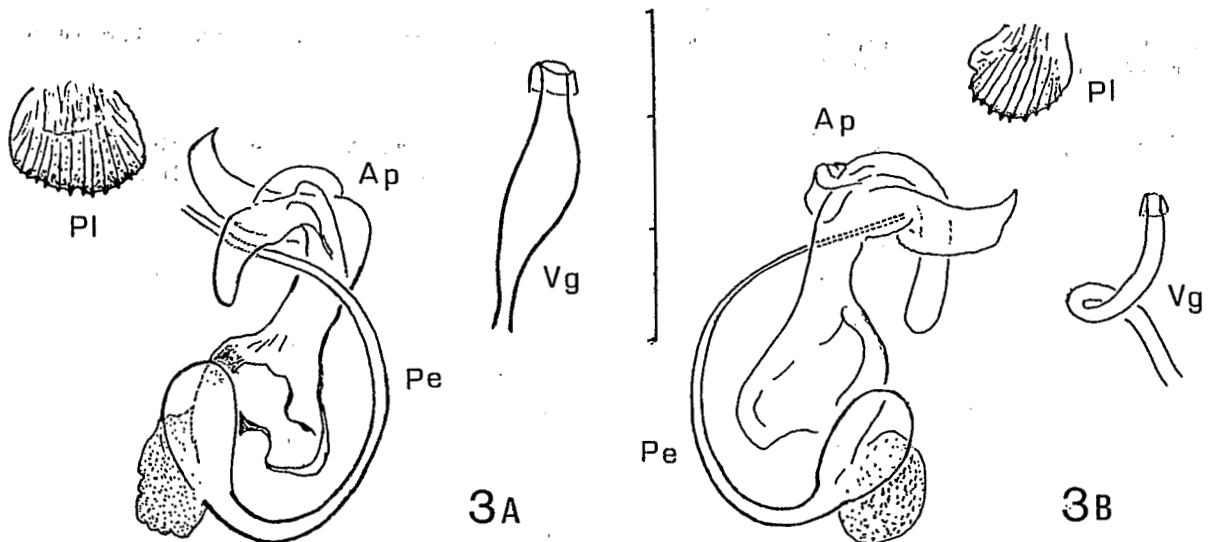


Figure 3. *Cichlidogyrus aegypticus* Ergens, 1981. Male copulatory complex and vagina; A. from *Tilapia zillii* and *T. dageti*; B. from *T. louka* and *T. walteri* in Guinea. Abbreviations: Ap, accessory piece; Pe, penis; Pl, auxiliary plate; V, vagina. Scale-bar: 30  $\mu$ m.

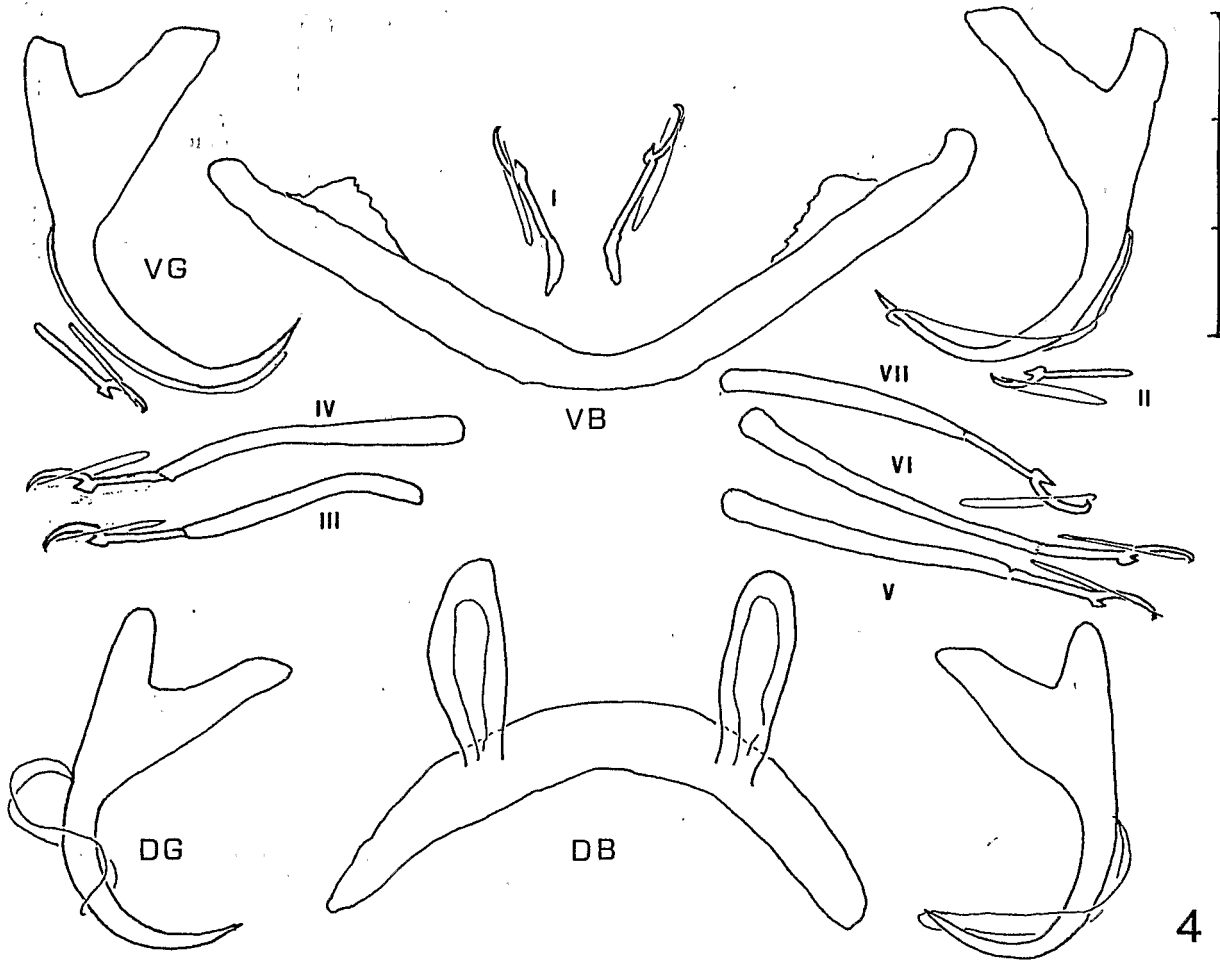


Figure 4. *Cichlidogyrus microscutus* n. sp. Haptor. Abbreviations: DG, dorsal gripus; DB, dorsal bar; VG, ventral gripus; VB, ventral bar; V, vagina; I-VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

Birgi (1984) with specific differences coming from the morphology and size of the sclerotized pieces of the haptor, the male copulatory complex and the vagina.

*Cichlidogyrus* Paperna, 1960.

Ancyrocephalidae. Three pairs of cephalic glands. Two posterior ocelles with crystalline lenses. Two small inconstant anterior ocelles. Simple intestinal branches joined posteriorly. Two pairs of gripi, one dorsal, one ventral. Two transverse bars, dorsal with two auricles, ventral V-shaped. Fourteen uncinuli. Median posterior testis. Vas deferens on the right side, not encircling the intestinal branch. Seminal vesicle present. One prostatic reservoir. Male copulatory complex with penis and accessory piece. Auxiliary plate sometimes present. Median pretesticular ovary. Ventral submedian vaginal opening. Sclerified vagina. Semi-

nal receptacle present. Parasites of African Cichlidae (rarely on Cyprinodontidae or Nandidae). Type species *Cichlidogyrus arthracanthus* Paperna, 1960.

#### *Cichlidogyrus aegypticus* Ergens, 1981

*Type-host*: *Tilapia zillii* (Gervais).

*Site*: Gills.

*Type-locality*: River Nile at Cairo (Egypt).

*Other records*; This species was also found (present material) on the same host in the Baoulé and Bagoué Rivers and in Kossou Lake (Ivory Coast) and also in the Volta Noire River (Burkina Fasso), and on *Tilapia dageti* in the Comoé River (Ivory Coast).

*Material studied*: 30 individuals stained and mounted in Malmberg's solution.

*Voucher specimens:* Deposited at the Muséum National d'Histoire Naturelle (Paris): 484HF-Tg 96 and Tg 97.

*Description* (Figures 2,3A)

Thirty specimens of this species were measured (vs. 3 in original description) from several *T. zillii* from different locations. Adult individuals:  $522 \pm 78.5$  (385–782) long,  $113 \pm 18.7$  (68–153) wide at level of vagina; pharynx  $37 \pm 4$  (25–44) at widest point. Dorsal gripus with guard twice length of shaft; blade regularly arched:  $a = 24 \pm 0.8$  (23–27),  $b = 20 \pm 0.7$  (18–21),  $c = 5 \pm 0.7$  (2–6),  $d = 10 \pm 1$  (8–12),  $e = 9 \pm 0.7$  (7–11). Dorsal transverse bar:  $x = 32 \pm 3.8$  (26–40),  $w = 4 \pm 0.5$  (3–5),  $h = 15 \pm 1.3$  (13–19),  $y = 13 \pm 1.4$  (11–17). Ventral gripus similar to dorsal but slightly larger:  $a = 29 \pm 1.2$  (26–31),  $b = 25 \pm 1$  (23–28),  $c = 5 \pm 0.9$  (2–7),  $d = 11 \pm 1.1$  (8–14),  $e = 10 \pm 0.7$  (9–12). V-shaped ventral transverse bar:  $x = 34 \pm 1.6$  (31–37),  $w = 5 \pm 0.4$  (4–6). Uncinulus I =  $15 \pm 0.7$  (14–17) long; uncinulus II =  $12 \pm 0.4$  (11–13); marginal uncinulus III =  $31 \pm 2$  (28–37), IV =  $34 \pm 1.6$  (30–38), V =  $35 \pm 1.6$  (31–39), VI =  $34 \pm 1.8$  (29–37), VII =  $31 \pm 1.2$  (29–34). Male copulatory organ with arched tubular penis and large basal bulb:  $Pe = 65 \pm 3$  (60–70) long. Accessory piece (linked to heel), bent at right angle (with digitation at its vertex), ended in large hook:  $Ap = 36 \pm 3.2$  (32–42),  $He = 5 \pm 0.8$  (3–7). Auxiliary plate present:  $L = 12 \pm 1.1$  (10–14),  $l = 14 \pm 1.1$  (11–16). Vagina bent in middle, with bulge in distal half, thin walled:  $V = 28 \pm 2.2$  (25–33),  $v = 7 \pm 0.9$  (5–9).

*Comments*

Ergens (1981, p. 211) gave a very good description of this species in his original paper. All of the subsequently described species possessing an auxiliary plate are easily distinguishable from *C. aegypticus* by the shapes of the accessory piece of the male copulatory complex, the auxiliary plate and the vagina.

The parasite named *C. aegypticus* by Dossou (1982) from *Tilapia zillii* (Ouémé River, Benin) was synonymised with *C. gallus* by Pariselle & Euzet (1995).

N.B. Another monogenean has been found on *Tilapia louka* and *T. walteri* in Guinea which is very closely related to *C. aegypticus*, although measurements of the accessory piece are sometimes slightly smaller and the shape of the vagina (especially the absence of a bulging

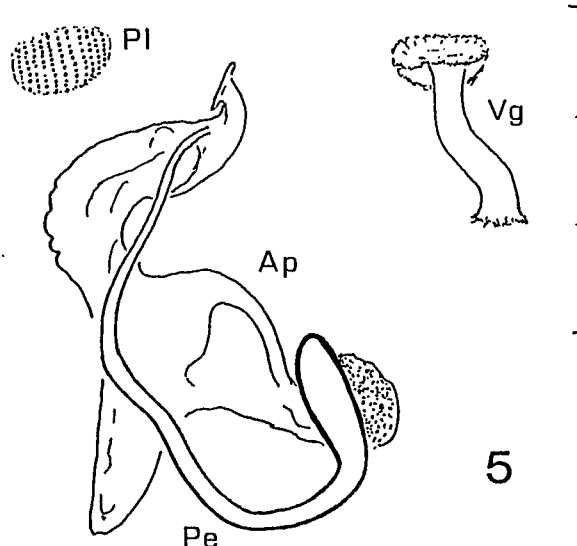


Figure 5. *Cichlidogyrus microscutus* n. sp. Male copulatory complex and vagina. Abbreviations: Ap, accessory piece; Pe, penis; Pl, auxiliary plate; V, vagina. Scale-bar: 30  $\mu$ m.

portion and a loop in the middle) is always different (Figure 3B). These minor morphological differences are probably not sufficient to consider this parasite as a new species.

*Cichlidogyrus microscutus* n. sp.

*Type-host:* *Tilapia guineensis* (Bleeker).

*Site:* Gills.

*Type-locality:* Loufoualéba Lake, near Pointe Noire (Congo).

*Other records:* This species has also been found on *T. dageti* in the Gambia River (at Niokolo-Koba National Park, Senegal).

*Material studied:* 30 individuals stained and mounted in Malmberg's solution.

*Type-material:* Holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 488HF-Tg.103. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 488HF-Tg.104; The Natural History Museum (London): Reg. no. 1996 1.5.10–11; the Musée Royal d'Afrique Centrale (Tervuren): M.R.A.C. no. M.T. 37.385.

*Description* (Figures 4,5)

Adult individuals  $586 \pm 72.2$  (464–738) long,  $127 \pm 18$  (85–162) wide at level of vagina; pharynx  $37 \pm$

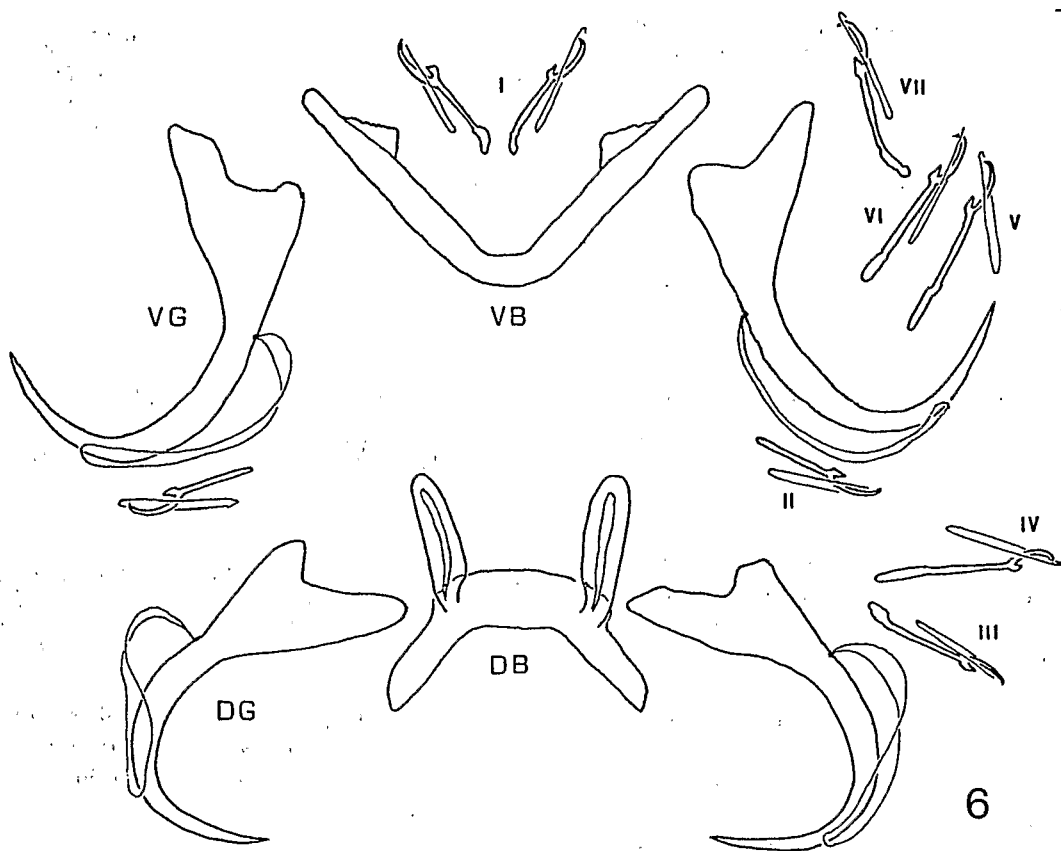


Figure 6. *Cichlidogyrus amphoratus* n. sp. Haptor. Abbreviations: DG, dorsal gripus; DB, dorsal bar; VG, ventral gripus; VB, ventral bar; I-VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

4.9 (24-46) at widest point. Dorsal gripus with guard slightly longer than shaft; blade arched, bent in distal half:  $a = 28 \pm 1.1$  (24-30),  $b = 21 \pm 0.8$  (19-23),  $c = 7 \pm 0.8$  (5-8),  $d = 11 \pm 0.9$  (9-13),  $e = 10 \pm 0.6$  (8-11). Dorsal transverse bar, arched, with 2 auricles on its convex face:  $x = 43 \pm 4$  (36-57),  $w = 6 \pm 0.8$  (5-8),  $h = 15 \pm 1.2$  (13-18),  $y = 18 \pm 1.8$  (12-21). Ventral gripus, similar to dorsal, slightly larger:  $a = 32 \pm 1.3$  (29-36),  $b = 27 \pm 0.8$  (25-29),  $c = 7 \pm 0.8$  (5-9),  $d = 12 \pm 1.1$  (10-14),  $e = 11 \pm 0.6$  (10-13). V-shaped ventral transverse bar:  $x = 38 \pm 1.9$  (33-42),  $w = 5 \pm 0.5$  (4-6). Uncinulus I =  $16 \pm 0.8$  (15-19) long; uncinulus II, associated with ventral gripus, has larval size =  $13 \pm 0.5$  (11-13); marginal uncinulus, with developed shaft: III =  $36 \pm 1.9$  (32-41), IV =  $38 \pm 1.5$  (34-41), V =  $39 \pm 1.5$  (32-42), VI =  $39 \pm 2.2$  (33-43), VII =  $34 \pm 2.2$  (22-38). Male copulatory complex distinguished by presence of very thin auxiliary plate. Penis regularly arched; accessory piece, which resembles that of *C. gallus*, ends in distal hook: Pe =  $62 \pm 1.7$  (60-68), He

=  $5 \pm 0.6$  (4-6), Ap =  $34 \pm 2.5$  (27-37); auxiliary plate: L =  $11 \pm 1$  (9-13), l =  $7 \pm 0.9$  (5-9). Short vagina, slightly S-shaped, with sclerotised plate at aperture: V =  $19 \pm 1.9$  (13-22), v =  $4 \pm 0.4$  (3-5).

#### Comments

This species belongs to the group of *Cichlidogyrus* with a small uncinulus I, large uncinuli III to VII and an auxiliary plate: *C. aegypticus* Ergens, 1981; *C. agnesi* Pariselle & Euzet, 1995; *C. bilongi* Pariselle & Euzet, 1995 and *C. gallus* Pariselle & Euzet, 1995. It is readily distinguished from all these species by the size of the auxiliary plate (smaller) and the absence of semi-circular expansion at the bend of the accessory piece. The name *C. microscutus* n. sp. is proposed, reflecting the dimensions of the auxiliary plate.

***Cichlidogyrus amphoratus* n. sp.**

*Type-host:* *Tilapia louka* Thys van den Audenaerde.

*Site:* Gills.

*Type-locality:* Laramie, Bourouma River (Guinea).

*Material studied:* 29 individuals stained and mounted in Malmberg's solution.

*Type-material:* Holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 486HF-Tg.100. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 486HF-Tg.99; The Natural History Museum (London): Reg. no. 1996.1.5.16; the Musée Royal d'Afrique Centrale (Tervuren): M.R.A.C. no. M.T. 37.384.

**Description (Figures 6,7)**

Adult individuals  $493 \pm 62.9$  (393–686) long,  $81 \pm 9.8$  (58–96) wide at level of vagina; pharynx  $23 \pm 2.3$  (18–28) at widest point. Dorsal gripus with very short shaft; guard slightly longer; blade arched, bent in distal half:  $a = 29 \pm 1.5$  (26–32),  $b = 25 \pm 1.9$  (20–28),  $c = 2.8 \pm 1$  (1–5),  $d = 9 \pm 1.1$  (7–12),  $e = 10 \pm 0.7$  (8–12). Dorsal transverse bar arched, with 2 auricles on its convex face:  $x = 27 \pm 2.5$  (24–34),  $h = 12 \pm 1.3$  (9–15),  $w = 6 \pm 0.7$  (4–7),  $y = 11 \pm 1$  (9–13). Ventral gripus similar to dorsal but slightly larger:  $a = 32 \pm 1.3$  (29–34),  $b = 28 \pm 1.5$  (25–31),  $c = 3 \pm 0.8$  (1–5),  $d = 9 \pm 1$  (7–11),  $e = 12 \pm 0.8$  (10–13). V-shaped ventral transverse bar, thinner in middle:  $x = 27 \pm 1.5$  (24–30),  $w = 4 \pm 0.5$  (2–5). Uncinulus I =  $12 \pm 0.6$  (11–14); uncinulus II, associated with ventral gripus =  $11 \pm 0.9$  (8–13); marginal uncinulus III =  $15 \pm 0.9$  (13–18), IV =  $17 \pm 0.8$  (16–19), V =  $17 \pm 1$  (12–18), VI =  $15 \pm 0.8$  (12–17), VII =  $14 \pm 0.6$  (13–16). Male copulatory complex composed of arched tubular penis, characterised by swollen portion close to sub-spherical basal bulb and large sub-circular heel:  $Pe = 46 \pm 1.3$  (43–48),  $He = 7 \pm 0.7$  (5–8). Large accessory piece, attached to heel by short, thin ligament, folded at right angle and ending in terminal hook:  $Ap = 27 \pm 1.7$  (23–32). Thin vagina, S-shaped:  $L = 23 \pm 1.2$  (20–25),  $l = 2 \pm 0.2$  (1–2).

**Comments**

Only a few *Cichlidogyrus* spp. present a penis with a swollen portion: *C. papernastrema* (Price et al., 1969); *C. karibae* Douëllou, 1993; and *C. zambezensis* Douëllou, 1993. This new species differs from *C. papernastrema* mainly by having a small uncinulus I

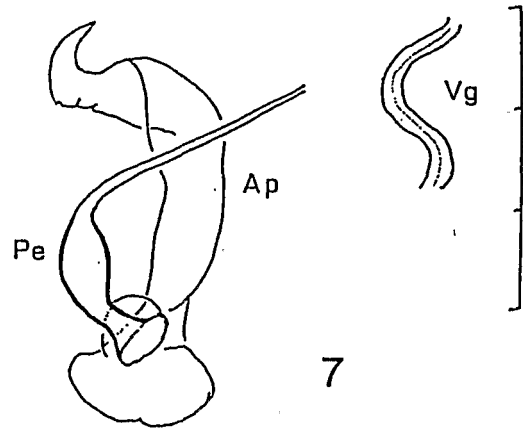


Figure 7. *Cichlidogyrus amphoratus* n. sp. Male copulatory complex and vagina. Abbreviations: Ap, accessory piece; Pe, penis; V, vagina. Scale-bar: 30  $\mu$ m.

(vs. large); from *C. karibae* and *C. zambezensis* by a shorter penis (46 vs. 62 for both Lake Kariba species), a large heel (vs. absence) and a well marked swollen portion of the penis. The name *C. amphoratus* n. sp. is proposed to reflect the shape of the swollen portion of the penis, which resembles an amphora.

***Cichlidogyrus ornatus* n. sp.**

*Type-host:* *Tilapia zillii* (Gervais).

*Site:* Gills.

*Type-locality:* Baoulé River (Ivory Coast).

*Other records:* This species has also been found on the same host in the Bagoué River and on *T. dageti* in the Comoé River (Ivory Coast).

*Material studied:* 16 individuals stained and mounted in Malmberg's solution.

*Type-material:* Holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 487HF-Tg.102. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 487HF-Tg.101; The Natural History Museum (London): Reg. no. 1996.1.5.1–2; the Musée Royal d'Afrique Centrale (Tervuren): M.R.A.C. no. M.T. 37.383.

**Description (Figures 8,9)**

Adult individuals  $484 \pm 91.7$  (377–702) long,  $84 \pm 10.8$  (61–103) wide at level of vagina; pharynx  $25 \pm 3.3$  (19–30) at widest point. Dorsal gripus with very short shaft; guard slightly longer; blade arched and bent in distal half:  $a = 37 \pm 1.4$  (33–39),  $b = 31 \pm 1.4$

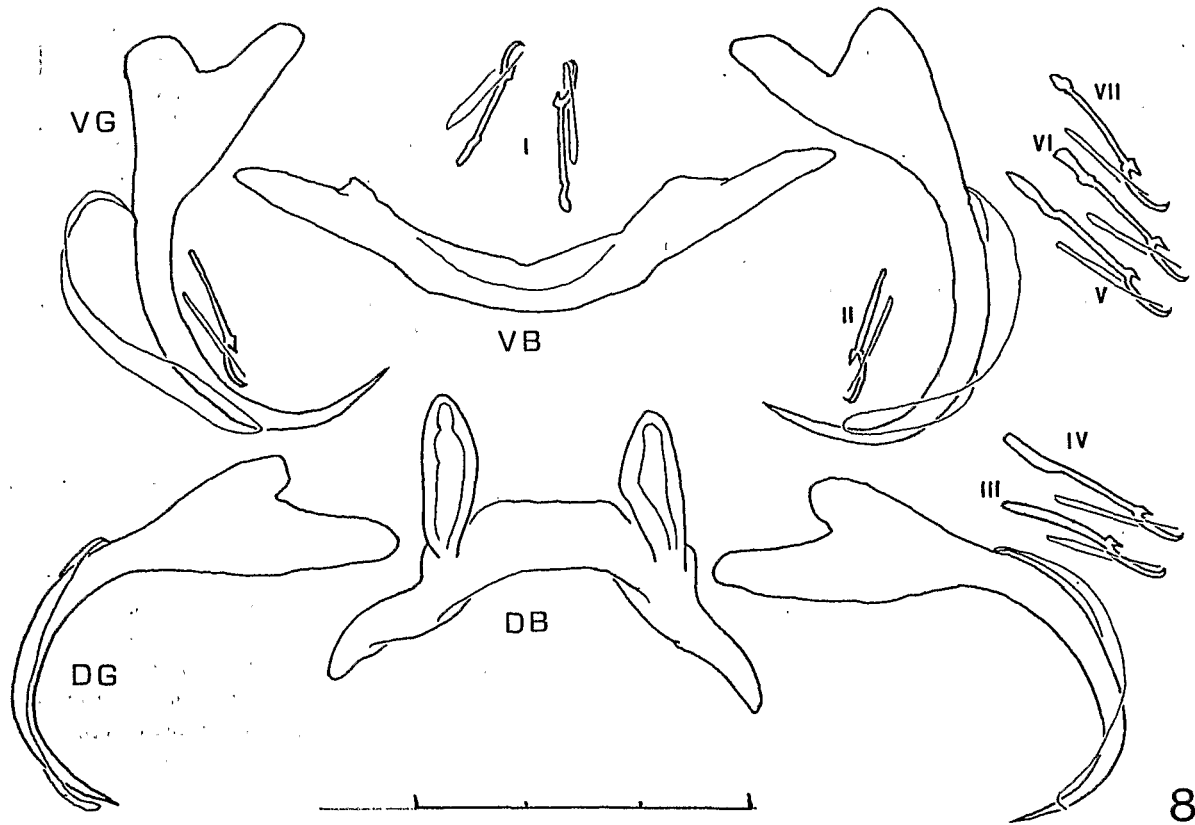


Figure 8. *Cichlidogyrus ornatus* n. sp. Haptor. Abbreviations: DG, dorsal gripus; DB, dorsal bar; VG, ventral gripus; VB, ventral bar; I–VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

(27–34),  $c = 3 \pm 0.8$  (2–5),  $d = 11 \pm 1.3$  (9–14),  $e = 10 \pm 0.8$  (8–12). Dorsal transverse bar with auricles:  $x = 32 \pm 1.8$  (29–35),  $w = 7 \pm 1.3$  (5–9),  $h = 13 \pm 0.9$  (11–15),  $y = 13 \pm 1.2$  (12–16). Ventral gripus with same shape as dorsal, slightly larger:  $a = 37 \pm 1.4$  (34–39),  $b = 33 \pm 1.4$  (30–36),  $c = 4 \pm 0.9$  (2–6),  $d = 10 \pm 1.4$  (8–14),  $e = 12 \pm 0.9$  (10–14). V-shaped ventral transverse bar:  $x = 29 \pm 1.2$  (26–31),  $w = 5 \pm 0.7$  (4–6). Uncinulus I =  $13 \pm 0.6$  (11–14), uncinulus II, associated with ventral gripus =  $12 \pm 0.7$  (11–14), marginal uncinulus III =  $15 \pm 0.6$  (14–16), IV =  $18 \pm 0.8$  (16–19), V =  $18 \pm 0.6$  (16–19), VI =  $16 \pm 0.8$  (14–18), VII =  $15 \pm 0.5$  (14–16). Male copulatory complex resembles that of *C. amphoratus*, especially regarding presence of swollen portion of penis near basal bulb (it differs in diameter of swollen portion of penis and shape of accessory piece, i.e. curved, lined on its convex side by tubercles, ending in semicircular extremity):  $Pe = 53 \pm 2$  (49–56),  $He = 5 \pm 0.5$  (4–6),  $Ap = 22 \pm 2.2$  (18–27). Thin, sinuous vagina, notable for its large, hemispherical auricle:  $V = 33 \pm 2.9$  (29–37),  $v = 2 \pm 0.3$  (2–3).

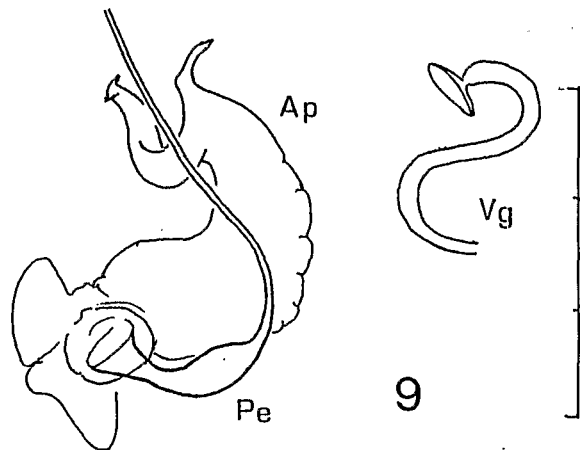


Figure 9. *Cichlidogyrus ornatus* n. sp. Male copulatory complex and vagina. Abbreviations: Ap, accessory piece, Pe, penis, V, vagina. Scale-bar: 30  $\mu$ m.

#### Comments

Within the group of *Cichlidogyrus* spp. that possess a swollen portion of the penis, namely *C. papernastrema*



(Price et al., 1969), *C. karibae* Douëllou, 1993, *C. zambezensis* Douëllou, 1993 and *C. amphoratus* n. sp., this species is distinguished by the shape of the accessory piece and the shape (and length) of the vagina. *C. ornatus* n. sp. is proposed to reflect the ornamentation on the convex side of the accessory piece.

### *Cichlidogyrus digitatus* Dossou, 1982

Syn. *C. halinus* Paperna, 1969 in part (see Remarks below).

*Type-host*: *Tilapia zillii* (Gervais).

*Site*: Gills.

*Type-locality*: Ouémé (Benin).

*Other records*: This species was also found (present record) on the same host in the Kossou Lake and Bagoué River (Ivory Coast) and Kogon River (Guinea), on *Tilapia dageti* in the Gambia River (at Niokolo-Koba National Park, Senegal) and in the Niger River (Bamako, Mali), on *T. guineensis* in the Bandama River (Ivory Coast) and the mouth of Gambia River (Gambia), and on *T. louka* in the Bourouma River (Guinea).

*Material studied*: 30 individuals stained and mounted in Malmberg's solution.

### *Description* (Figure 10)

Adult individuals  $534 \pm 84.3$  (394–692) long,  $100 \pm 18.9$  (68–146) wide at level of penis (no visible vagina); pharynx  $30 \pm 3$  (25–38) at widest point. Dorsal gripus with guard much longer than shaft; thin blade bent in distal third:  $a = 41 \pm 1.7$  (38–45),  $b = 30 \pm 1.5$  (27–34),  $c = 4 \pm 0.9$  (2–7),  $d = 15 \pm 1.2$  (12–18),  $e = 12 \pm 0.9$  (10–14). Thick dorsal transverse bar with large auricles:  $x = 33 \pm 2.2$  (29–37),  $w = 8 \pm 1.1$  (6–10),  $h = 14 \pm 1.3$  (12–17),  $y = 10 \pm 1.1$  (8–11). Large ventral gripus with short guard and shaft:  $a = 36 \pm 1.4$  (32–38),  $b = 34 \pm 1.5$  (31–38),  $c = 3 \pm 0.7$  (2–5),  $d = 8 \pm 1.3$  (6–11),  $e = 15 \pm 1$  (13–17). Ventral transverse bar V-shaped:  $x = 37 \pm 2.2$  (32–44),  $w = 6 \pm 0.7$  (4–7). Large uncinulus I =  $24 \pm 0.9$  (22–27); uncinulus II =  $12 \pm 0.5$  (10–13); short marginal uncinulus III =  $19 \pm 1$  (16–22), IV =  $21 \pm 0.8$  (20–24), V =  $22 \pm 1.2$  (19–25), VI =  $21 \pm 1.3$  (15–23), VII =  $19 \pm 0.8$  (17–21). Penis as described by Dossou (1982): short and lightly sinuous, with fine, straight heel:  $Pe = 35 \pm 1.9$  (32–37). Accessory piece, linked to base of penis, ending in 2 fine, opposed digitations:  $Ap = 31 \pm 3.1$  (24–36). No auxiliary plate and no vagina observed.

### *Comments*

The presence of the large uncinulus I places this species of *Cichlidogyrus* in the group, which includes *C. arthracanthus* Paperna, 1960, *C. brevicirrus* Paperna, 1969, *C. bychowskii* (Markevitch, 1934) Paperna, 1960, *C. dageti* Dossou & Birgi, 1984, *C. dionchus* Paperna, 1968, *C. euzeti* Dossou & Birgi, 1984, *C. falcifer* Dossou & Birgi, 1984, *C. halinus* Paperna, 1969 (syn. *C. erectus* Dossou, 1982, see remarks below), *C. haplochromii* Paperna & Thurston, 1969, *C. kothiasii* Pariselle & Euzet, 1994, *C. longicirrus* Paperna, 1965, *C. papernastrema* Price et al., 1969, *C. philander* Douëllou, 1993 and *C. quaestio* Douëllou, 1993. It is distinguished from all of these species by the shapes and dimensions of the sclerotised pieces of the haptor and copulatory organs (see Dossou, 1982, p. 305; Dossou & Birgi, 1984, p. 106; Bilong Bilong, 1986; Douëllou, 1993, p. 181).

### *Remarks*

In the original description of *C. halinus*, based on only two worms from *Tilapia heudeloti* (= *Sarotherodon melanotheron*) (type-host) and *T. guineensis* (probably one worm from each host species), Paperna (1969) presented two drawings of the copulatory organs (fig. 71, p. 861), but did not specify which was from *T. guineensis* and which was from *T. heudeloti*. Therefore, we consider that, because of the presence of a typically large uncinulus I in both cases, Paperna may have confused *C. halinus* from *T. heudeloti* (type-host, as the first cited in the host list) with *C. digitatus* from *T. guineensis* (type-host, see Dossou, 1982). In fact, comparison of the two drawings of the copulatory organs indicates differences in the shape of the heel, the dimension of the penis (the measurement given by Paperna (60  $\mu$ m) is probably erroneous; this is indicated by the length of the scale-bar) and the shape of the end of the accessory piece (see comments below about *C. yanni* n. sp.). Following the examination of the holotype of *C. halinus* (M.T. 35.928 from M.R.A.C., Tervuren) from *T. heudeloti* (= *S. melanotheron*), which exhibits in particular a very long dorsal gripus shaft, we consider that *C. erectus* Dossou, 1982, also from *S. melanotheron*, should be synonymised with *C. halinus*. *C. digitatus* from *T. guineensis* (with a shorter shaft of the dorsal gripus) is considered a valid species. The specimen of *C. halinus* found by Paperna on *T. guineensis* is probably *C. digitatus* (because of

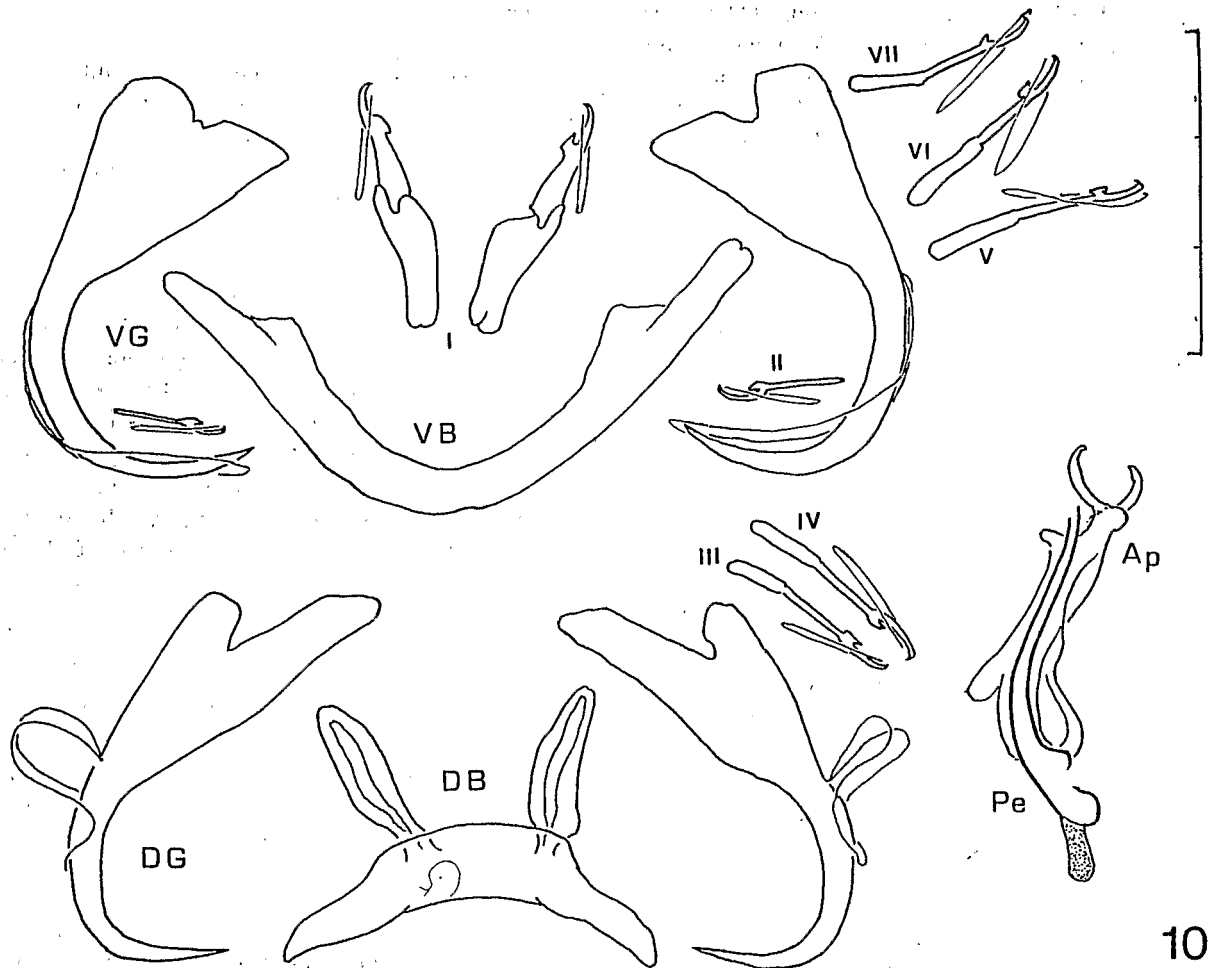


Figure 10. *Cichlidogyrus digitatus* Dossou, 1982. Haptor and male copulatory complex. Abbreviations: Ap, accessory piece; DG, dorsal gripus; DB, dorsal bar; Pe, penis; VG, ventral gripus; VB, ventral bar; I-VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

the shape of the heel; see left drawing of fig. 71 in Paperna, 1969, p. 861).

***Cichlidogyrus yanni* n. sp.**

*Type-host:* *Tilapia zillii* (Gervais).

*Site:* Gills.

*Type-locality:* Kogon River (Guinea).

*Other records:* This species was also found on the same host in the Volta Noire River (Burkina Fasso), on *Tilapia dageti* in the Gambia River (at Niokoloko-Koba National Park, Senegal) and in the Niger River (Bamako, Mali), on *T. guineensis* at Layo Research Station, Ebrié Lagoon (Ivory Coast) and in the Sénégal River (Senegal), on *T. louka* in the Bourouma River

(Guinea) and on *T. walteri* in the Cavally and Nipoué Rivers (Ivory Coast).

*Material studied:* 30 individuals stained and mounted in Malmberg's solution.

*Type-material:* Holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 481HF-Tg.90. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 481HF-Tg.91; The Natural History Museum (London): Reg. no. 1996.1.5.22-25; the Musée Royal d'Afrique Centrale (Tervuren): M.R.A.C. no. M.T. 37.386.

*Description* (Figure 11)

Adult individuals  $550 \pm 70.1$  (454-764) long,  $87 \pm 13.6$  (64-113) wide at level of penis (no visible vagi-

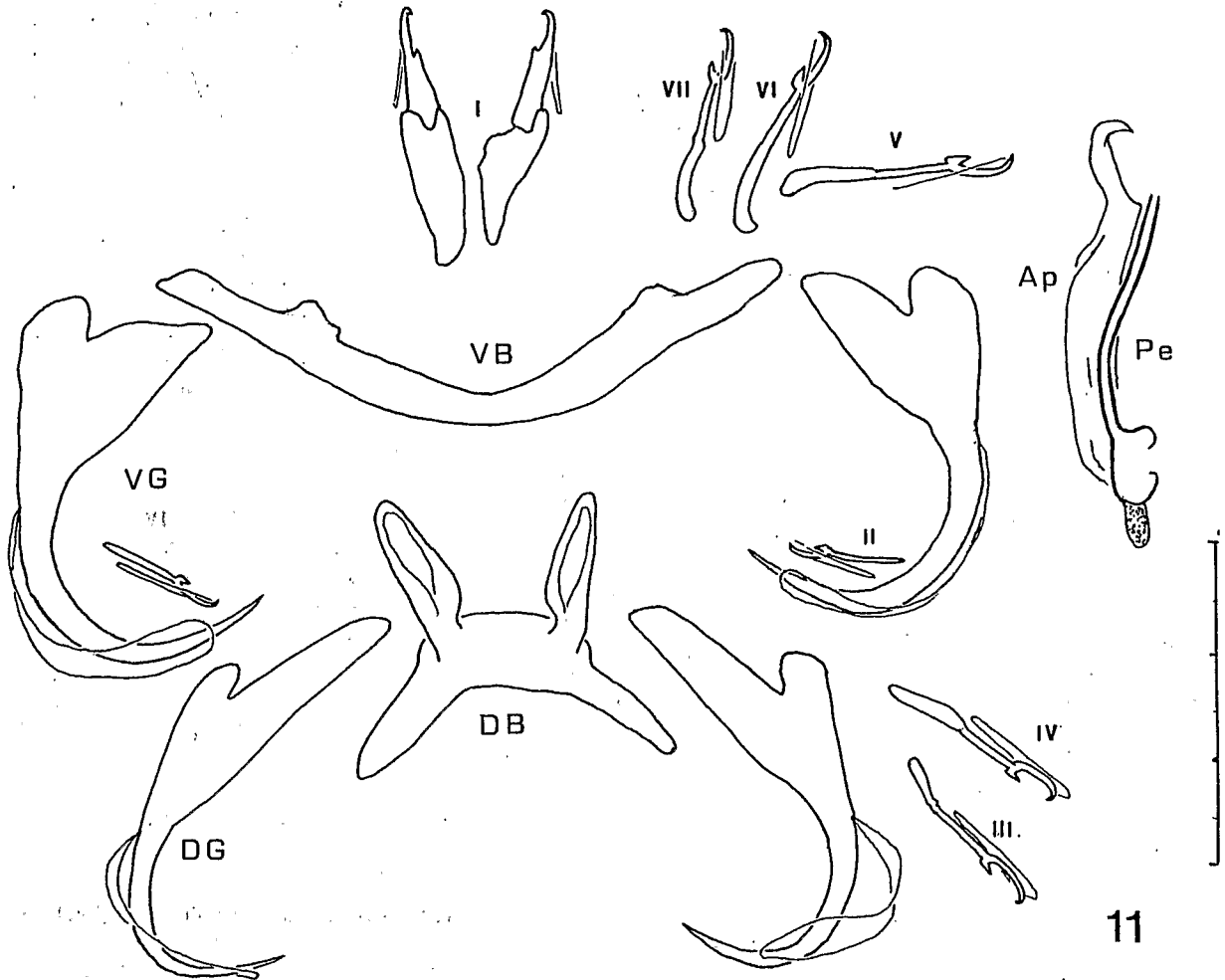


Figure 11. *Cichlidogyrus yanni* n. sp. Haptor and male copulatory complex. Abbreviations: Ap, accessory piece; DG, dorsal gripus; DB, dorsal bar; Pe, penis; VG, ventral gripus; VB, ventral bar; I–VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

na). Pharynx  $26 \pm 3.5$  (21–32) at widest point. Dorsal gripus with guard much longer than shaft; thin blade bent in distal third:  $a = 39 \pm 2.5$  (33–43),  $b = 28 \pm 2.2$  (23–32),  $c = 4 \pm 0.8$  (2–6),  $d = 14 \pm 1.4$  (11–17),  $e = 11 \pm 1.1$  (9–14). Thick dorsal transverse bar with large auricles:  $x = 31 \pm 2.3$  (26–36),  $w = 7 \pm 1.4$  (6–11),  $h = 14 \pm 2$  (9–20),  $y = 11 \pm 2$  (8–15). Large ventral gripus with short guard and shaft:  $a = 34 \pm 2.6$  (29–39),  $b = 33 \pm 2.3$  (27–36),  $c = 3 \pm 0.9$  (2–5),  $d = 9 \pm 1.6$  (6–13),  $e = 14 \pm 1.4$  (12–18). V-shaped ventral transverse bar:  $x = 36 \pm 3.3$  (31–45),  $w = 5 \pm 0.6$  (4–7). Large uncinulus I =  $24 \pm 1.8$  (20–28); uncinulus II =  $12 \pm 0.6$  (10–13); short marginal uncinulus III =  $18 \pm 1.3$  (15–21), IV =  $21 \pm 1.8$  (17–25), V =  $22 \pm 1.8$  (18–26), VI =  $21 \pm 1.8$  (18–25), VII =  $19 \pm 1.7$  (15–24). Penis similar to

*C. digitatus*: Pe =  $31 \pm 1.7$  (29–37). Accessory piece, linked to base of penis, ending in single short, rounded hook: Ap =  $28 \pm 2.4$  (23–33). No auxiliary plate. No vagina observed.

#### Comments

This new species is close to *C. halinus* Paperna, 1969 (= *C. erectus* Dossou, 1982, see above), but differs in the shape of the heel (thin and long vs. wide and short) and the measurements of sclerotised pieces, especially the dorsal gripus ( $a = 33–43$  vs. 51–53,  $d = 11–17$  vs. 20–23). This new species is also closely related to *C. digitatus*, except in relation to its measurements which are generally slightly shorter, and above all by

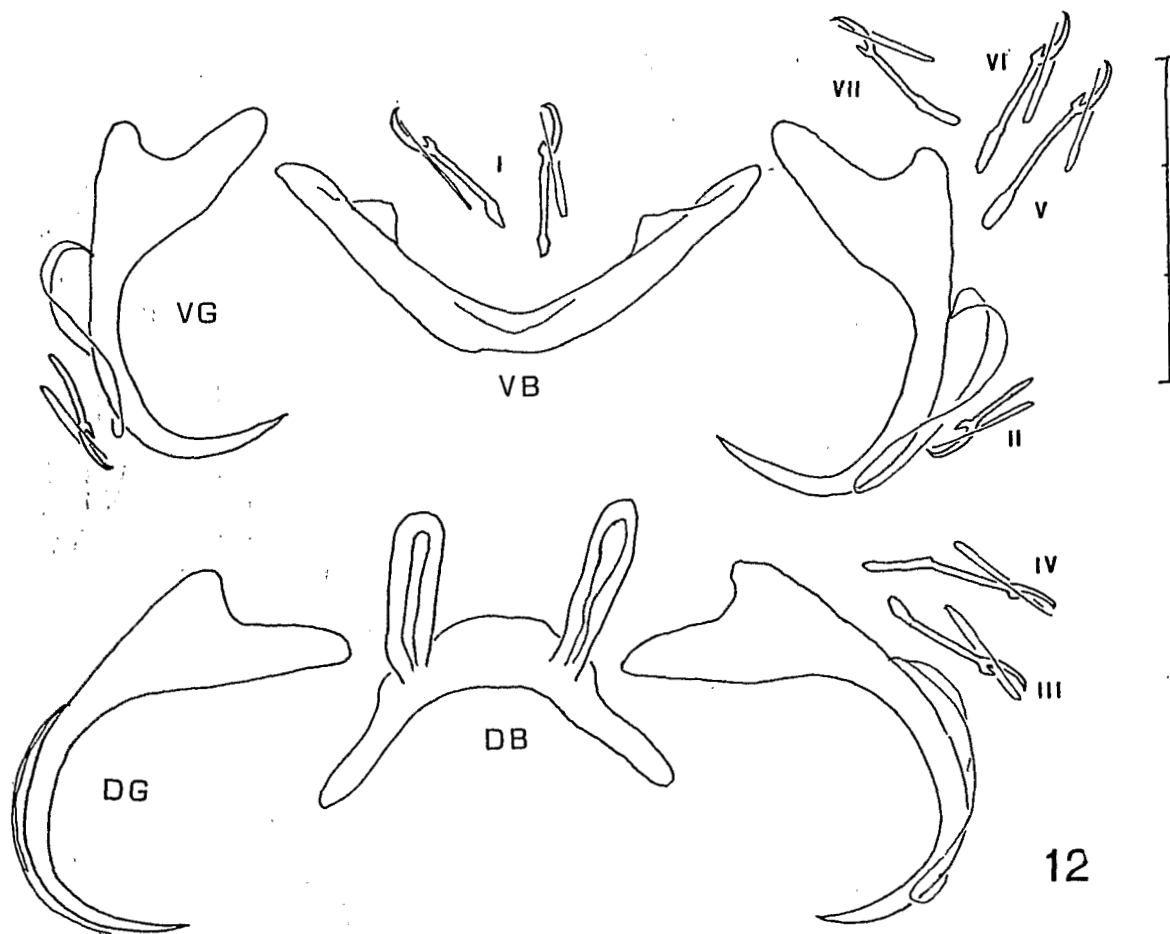


Figure 12. *Cichlidogyrus levequei* n. sp. Haptor. Abbreviations: DG, dorsal gripus; DB, dorsal bar; VG, ventral gripus; VB, ventral bar; I-VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

the shape of the end of the accessory piece (one short, large hook vs. two thin digitations). This latter difference readily permits the distinction of the two species, even when they share the same gill. This parasite is considered a new species and the name *C. yanni* n. sp. is proposed for our colleague, Yann Moreau.

#### *Cichlidogyrus levequei* n. sp.

*Type-host:* *Tilapia coffea* Thys van den Audenaerde.

*Site:* Gills.

*Type-locality:* Oulé River at Niambala (Guinea).

*Other records:* This species was also found on the same host at Koulé (Guinea).

*Material studied:* 30 individuals stained and mounted in Malmberg's solution.

*Type-material:* Holotype deposited at the Muséum

National d'Histoire Naturelle (Paris): 482HF-Tg.92. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 482HF-Tg.93; The Natural History Museum (London): Reg. no. 1996.1.5.15; the Musée Royal d'Afrique Centrale (Tervuren): M.R.A.C. no M.T. 37.388.

#### *Description* (Figures 12,13)

Adult individuals  $426 \pm 46.9$  (344–506) long,  $88 \pm 15.7$  (57–118) wide at level of vagina. Pharynx  $27 \pm 3.8$  (22–36) at its widest point. Dorsal gripus with guard twice as long as shaft; thin, regularly arched blade:  $a = 29 \pm 1.3$  (27–31),  $b = 25 \pm 0.8$  (23–26),  $c = 3 \pm 0.6$  (1–4),  $d = 9 \pm 1.1$  (7–11),  $e = 10 \pm 0.6$  (9–11). Dorsal transverse bar:  $x = 28 \pm 1.7$  (25–31),  $w = 4 \pm 0.5$  (4–5),  $h = 11 \pm 1$  (9–13),  $y = 11 \pm 0.9$  (8–12). Large ventral gripus similar to dorsal:  $a = 32 \pm$

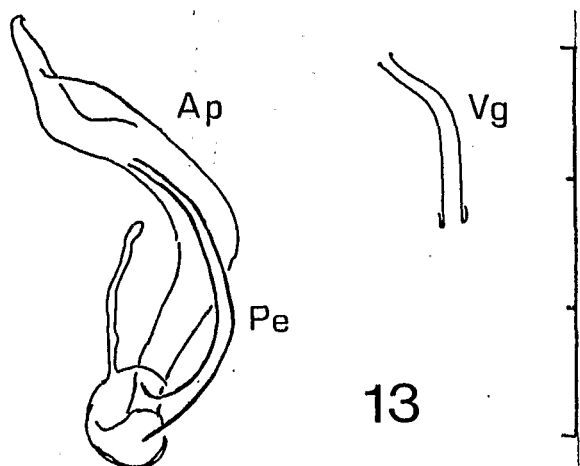


Figure 13. *Cichlidogyrus levequei* n. sp. Male copulatory complex and vagina. Abbreviations: Ap, accessory piece; Pe, penis; Pl, auxiliary plate; V, vagina. Scale-bar: 30  $\mu$ m.

1.2 (30–34), b = 28  $\pm$  1 (26–30), c = 2  $\pm$  0.5 (1–3), d = 9  $\pm$  1.1 (7–11), e = 11  $\pm$  0.8 (9–13). V-shaped ventral transverse bar: x = 24  $\pm$  1.4 (21–27), w = 4  $\pm$  0.5 (2–5). Small uncinulus I = 13  $\pm$  0.5 (12–15); uncinulus II = 12  $\pm$  0.6 (10–13); short marginal uncinuli III = 15  $\pm$  1.2 (13–17), IV = 17  $\pm$  0.9 (15–19), V = 17  $\pm$  0.8 (15–18), VI = 15  $\pm$  0.9 (14–18), VII = 14  $\pm$  0.7 (13–15). Thin, arched penis: Pe = 36  $\pm$  1.9 (31–39), with short heel: He = 1  $\pm$  0.3 (1–2). Accessory piece, with thin digitation at junction of basal bulb and penis, ending in single hook: Ap = 27  $\pm$  1.2 (25–30). No auxiliary plate. Short, thin vagina: V = 15  $\pm$  1.4 (12–18), v = 2  $\pm$  0.3 (1–2).

#### Comments

The presence of short uncinuli I to VII, a short penis (< 30  $\mu$ m) without a swollen portion and the presence of a visible vagina places this species of *Cichlidogyrus* in the group including only *C. acerbus* Dossou, 1982 and *C. gibbus* Dossou, 1982. This species is easily distinguished by the presence of a basal digitation on, and the simple shape of, the accessory piece. The name *C. levequei* n. sp. is proposed for Dr Christian Lévêque from ORSTOM.

#### *Cichlidogyrus ouedraogoi* n. sp.

*Type-host*: *Tilapia coffea* Thys van den Audenaerde.

*Site*: Gills.

*Type-locality*: Oulé River at Niambala (Guinea)

*Other records*: This species was also found on the same host at Koulé (Guinea)

*Material studied*: 23 individuals stained and mounted in Malmberg's solution.

*Type-material*: Holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 483HF-Tg.94. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 483HF-Tg.95; The Natural History Museum (London): Reg. no. 1996.1.5.21; the Musée Royal d'Afrique Centrale (Tervuren): M.R.A.C. no. M.T. 37.387.

#### Description (Figures 14,15)

Adult individuals 567  $\pm$  90 (421–776) long, 112  $\pm$  18 (59–144) wide at level of vagina. Pharynx 37  $\pm$  3.3 (29–43) at its widest point. Dorsal gripus with guard twice as long as shaft, with thin regularly arched blade: a = 24  $\pm$  0.8 (22–25), b = 20  $\pm$  0.6 (18–21), c = 5  $\pm$  0.6 (4–6), d = 10  $\pm$  0.8 (8–12), e = 9  $\pm$  0.8 (7–11). Dorsal transverse bar: x = 30  $\pm$  4 (24–39), w = 4  $\pm$  0.4 (3–4), h = 14  $\pm$  1.5 (12–19), y = 13  $\pm$  1.3 (11–16). Large ventral gripus similar to dorsal: a = 28  $\pm$  0.7 (26–30), b = 25  $\pm$  0.7 (23–26), c = 5  $\pm$  0.6 (3–6), d = 11  $\pm$  0.9 (9–12), e = 10  $\pm$  0.7 (9–12). V-shaped ventral transverse bar: x = 32  $\pm$  1.9 (27–36), w = 4  $\pm$  0.4 (4–5). Small uncinulus I = 15  $\pm$  0.5 (14–16); uncinulus II = 13  $\pm$  0.3 (13–14); long marginal uncinuli III = 31  $\pm$  1.2 (28–33), IV = 33  $\pm$  1.5 (30–37), V = 36  $\pm$  1.2 (33–38), VI = 34  $\pm$  1.3 (31–36), VII = 32  $\pm$  1.4 (29–36). Thin and arched penis: Pe = 55  $\pm$  2 (50–60); heel: He = 5  $\pm$  0.5 (4–5). Accessory piece bent at right-angle (L-shaped), ending in large hook: Ap = 30  $\pm$  1.6 (27–33). No auxiliary plate. Vagina bent at right-angle (L-shaped): V = 21  $\pm$  2.5 (17–25), v = 4  $\pm$  0.3 (3–4).

#### Comments

This species belongs to the group of *Cichlidogyrus* with a small uncinulus I, long uncinuli II to VII and no auxiliary plate: *C. anthemocolpos* Dossou, 1982, *C. dossoui* Douëllou, 1993, *C. ergensi* Dossou, 1982, *C. flexicolpos* Pariselle & Euzet, 1995, *C. halli* Paperna & Thurston, 1969, *C. testificatus* Dossou, 1982, *C. tiberianus* Paperna, 1960 and *C. vexus* Pariselle &

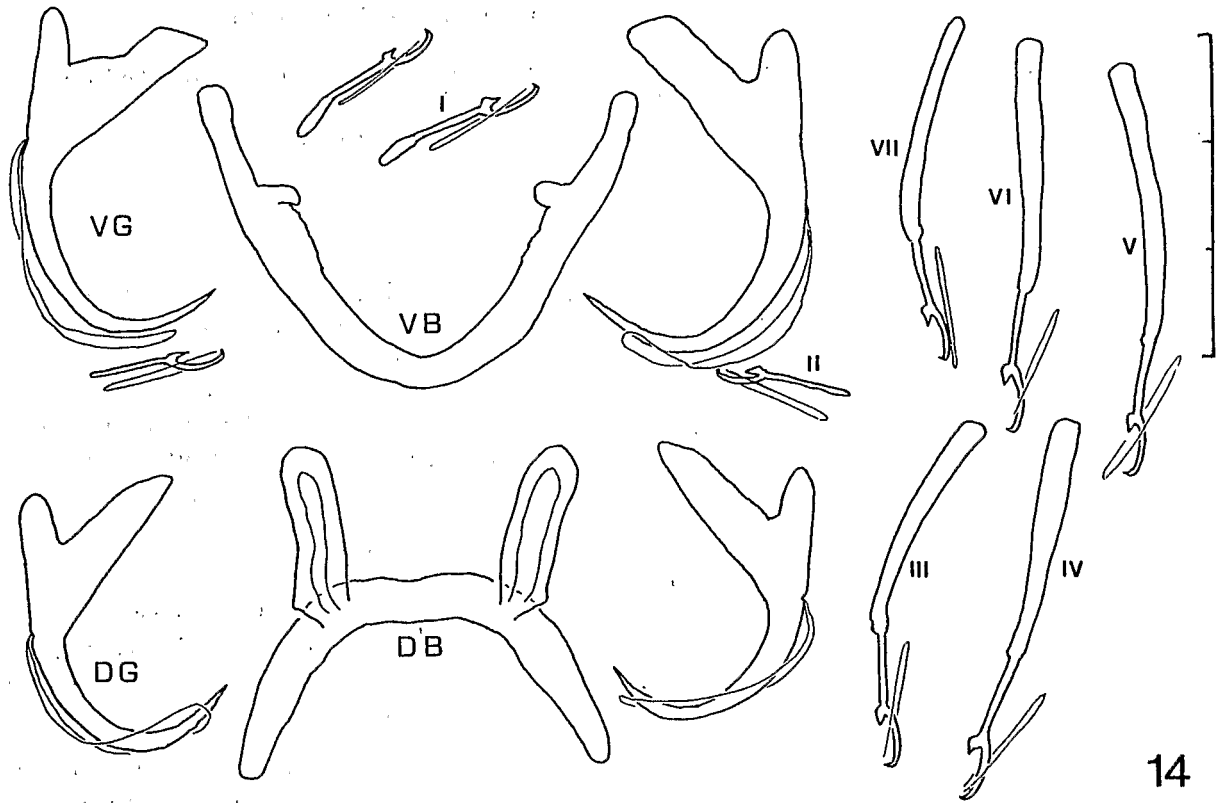


Figure 14. *Cichlidogyrus ouedraogoi* n. sp. Haptor. Abbreviations: DG, dorsal gripus; DB, dorsal bar; VG, ventral gripus; VB, ventral bar; I–VII, marginal uncinuli. Scale-bar: 30  $\mu$ m.

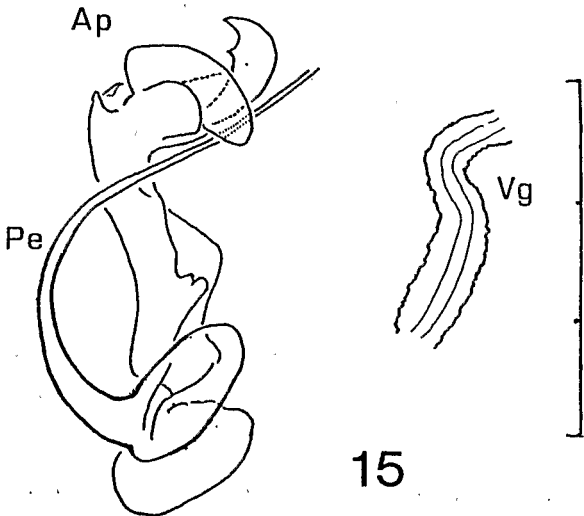


Figure 15. *Cichlidogyrus ouedraogoi* n. sp. Male copulatory complex and vagina. Abbreviations: Ap, accessory piece; Pe, penis; Pl, auxiliary plate; V, vagina. Scale-bar: 30  $\mu$ m.

species (except *C. dossoui* and *C. ergensi*) by the shape of the vagina and the shape of the accessory piece of the male copulatory complex. The new species is similar to *C. dossoui* in the shape of the accessory piece of the male copulatory complex but differs in the length of the vagina (shorter). It is similar to *C. ergensi* in the shape of the vagina, but differs in the shape of the end of the accessory piece. The name *C. ouedraogoi* n. sp. is proposed for Adama Ouedraogo, who helped collect the material.

**Conclusions**

The specificity of these parasites in relation to their host fish appears to be very variable (Table I): of the 19 *Cichlidogyrus* spp. observed, six were host specific (three on *Tilapia guineensis*); six were found on only two host species (five of these on a pair of hosts from the group: *T. dageti*, *T. guineensis* and *T. zillii*); and two were found on all *Coptodon* sampled, etc. We believe that the reason for this variability may be resolved by

Euzet, 1995. It is readily distinguished from all these

Table 1. Distribution of parasite species of the genus *Cichlidogyrus* on host species of the genus *Tilapia* (subgenus *Coptodon*)

Parasite species	Host species					
	<i>coffea</i>	<i>dageti</i>	<i>guineensis</i>	<i>louka</i>	<i>walteri</i>	<i>zillii</i>
<i>aegypticus</i>		+ <sup>1</sup>		+ <sup>2</sup>	+ <sup>2</sup>	+ <sup>1</sup>
<i>agnesi</i>			+			
<i>amphoratus</i>				+		
<i>anthemocolpos</i>			+			+
<i>arthracanthus</i>	+	+	+		+	+
<i>bilongi</i>			+			
<i>cubitus</i>		+	+	+	+	+
<i>digitatus</i>	+	+	+	+	+	+
<i>ergensi</i>	+	+	+	+	+	+
<i>flexicolpos</i>		+	+			
<i>gallus</i>			+		+	
<i>levequei</i>	+					
<i>loupaysani</i>			+			
<i>microscutus</i>		+	+			
<i>ornatus</i>		+				+
<i>ouedraogoi</i>	+					
<i>tiberianus</i>	+	+	+		+	+
<i>vexus</i>			+			+
<i>yanni</i>		+	+	+	+	+

<sup>1</sup>*C. aegypticus*, as described by Ergens (1981).

<sup>2</sup>*C. aegypticus* with particular shape of vagina (see Comments [N.B.] on *C. aegypticus*).

enquiries into the genetic relationships between the host species (see Pouyaud & Agnès, 1995), especially the fact that five species of parasites were found on only one group of host species, i.e. *Tilapia dageti*, *T. guineensis* and *T. zilli*, which are genetically very closely related, since wild hybrids may be found (Pouyaud, 1994).

### Acknowledgements

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