

# Ancyrocephalidae (Monogenea) of Lake Tanganyika: II: description of the first *Cichlidogyrus* spp. parasites from Tropheini fish hosts (Teleostei, Cichlidae)

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**Abstract** Although Lake Tanganyika hosts the most diverse endemic cichlid fish assemblage, its monogenean parasite fauna has hardly been documented. The cichlid tribe Tropheini has generated great interest because of its systematic position within the Haplochromini s.l. and its diversity in trophic morphology, reproductive behaviour and population structure. It has the potential to host a diverse Monogenea fauna. Here, we describe the first *Cichlidogyrus* spp.: *Cichlidogyrus steenbergei* sp. n., *Cichlidogyrus irenae* sp. n. and *Cichlidogyrus gistelincki* sp. n. The three host species, *Limnotilapia dardennii*, *Ctenochromis horei* and *Gnatho-*

*chromis pfefferi*, are all infected by a single unique *Cichlidogyrus* sp. The genital and haptor structure of the new species suggests a close relationship, which might mirror the close affinities between the hosts within the Tropheini. Based on haptor configuration, the new species belong to a morphological group within the genus containing parasites both of West African cichlids and of Haplochromini, and hence, do not represent a new organisation of the attachment organ (as has recently been described of congeners infecting the ectodine cichlid *Ophthalmotilapia*).

**Keywords** Africa · Cichlid parasites · *Ctenochromis horei* · *Gnathochromis pfefferi* · *Limnotilapia dardennii* · Platyhelminthes

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## Introduction

Lake Tanganyika is the deepest and oldest among the African Great Lakes (Cohen et al. 1997). It is home to the morphologically, behaviourally and genetically most diverse cichlid fish fauna (Snoeks 2000). The diversity makes the Cichlidae in general, and the Lake Tanganyika cichlid radiation in particular, a well-established study system, especially for mechanisms underlying speciation (Kornfield and Smith 2000; Koblmüller et al. 2008 and references therein). This requires a good understanding of the phylogenetic relationships within Cichlidae. Parasites are well-established tools in speciation research and to understand the host's phylogeny (Page and Holmes 1998; Nieberding and Olivieri 2007). Furthermore, there is significant evidence that parasites may influence speciation in cichlids by influencing sexual selection (Blais et al. 2007; Maan et al. 2008). Hence, the study of parasite diversity and evolution seems a useful complementary approach in Tanganyika

cichlids. A particularly useful group of parasites in this respect is Monogenea, in view of their species diversity, relatively high host specificity and direct life cycle. Conversely, highly diverse assemblages of closely related and sympatric host species, such as Cichlidae, are fruitful study systems to disentangle factors behind monogenean species richness (Pariselle et al. 2003b).

Cichlid Monogenea belonging to the Ancyrocephalidae have mainly been studied as parasites of West African tilapiine hosts. The gill parasite *Cichlidogyrus* Paperna, 1960 is the most widespread and speciose genus with 75 recognised species (Pariselle and Euzet 2009; Vanhove et al. 2011b). While its representatives are not known to harm fish stocks in Africa and the Middle East (Paperna 1996), considerable pathogenicity was reported under anthropogenic conditions in Southeast Asia (Kabata 1985). A co-phylogenetic analysis on species from West African Tilapiini taught that species richness seems underestimated due to cryptic species and demonstrated ecological transfers and parallel speciation events (Pouyaud et al. 2006). However, Monogenea of Lake Tanganyika did not receive attention, until a remarkable genetic and phenotypic diversity was shown in *Gyrodactylus* von Nordmann, 1832 (Vanhove et al. 2011a) and morphologically atypical representatives of *Cichlidogyrus* were described (Vanhove et al. 2011b).

Lake Tanganyika cichlids were classified into tribes by Poll (1986). One of these tribes, the endemic and monophyletic Tropheini, is a rather species-rich assemblage, mostly of rock-dwelling algae scrapers and invertivores. They are maternal mouthbrooders and display a wide range of trophic morphological adaptations (Sturmbauer et al. 2003). They are a lineage belonging to the widespread Haplochromini s.l. and represent a sister clade to several riverine Cichlidae and the Malawi and Victoria species flocks (Salzburger et al. 2005). Their interesting phylogenetic position, as well as their diverse mating behaviour, variable extent of colour polymorphism and genetic population structuring and trophic diversity makes them very well studied (Koblmüller et al. 2010 and references therein). They potentially harbour a species-rich assemblage of Monogenea (*nobis*). Considering the advantages of using cichlid hosts in parasitological research (Pariselle et al. 2003b), the closely related and often sympatric Tropheini constitutes a promising subject for a “natural experiment”. This enables the assessment of which effects e.g. host ecology or host population structure have on parasite communities. In this paper, we describe the first *Cichlidogyrus* spp. recorded from Tropheini hosts. The host fishes under scrutiny are *Ctenochromis horei* (Günther, 1894), *Gnathochromis pfefferi* (Boulenger, 1898) and *Limnotilapia dardennii* (Boulenger, 1899), all Tanganyika endemics with a lake-wide distribution. As in most other Tropheini of rather sediment-rich habitats, their intraspecific phenotypic and genetic differentiation is limited (Koblmüller

et al. 2010). While *L. dardennii* and *C. horei* are omnivores, *G. pfefferi* is a predator, mainly of shrimps (Konings 1998; Yuma et al. 1998).

## Materials and methods

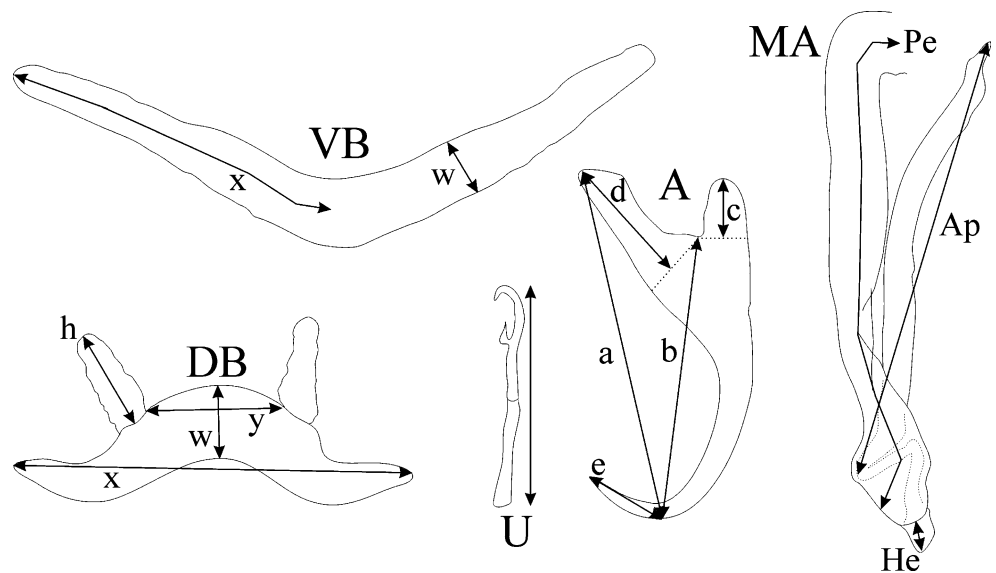
Host cichlid fish were collected in April 2008 (Zambia and Tanzania) and March and April 2010 (Democratic Republic of the Congo—DRC) using gill nets (*cf. infra* for location details). They were identified to species level on site by C. Sturmbauer (Karl-Franzens University of Graz, Austria) and D. Muzumani Risasi (Centre de Recherche en Hydrobiologie, Uvira, DRC), respectively. The fish were kept alive in aerated tanks until they were sacrificed and dissected. The right branchial arches were stored in 96% ethanol for further examination. In the laboratory, the gills were inspected for parasites under an Olympus SZX12 stereomicroscope. Monogenea were removed with a dissection needle. They were mounted on a slide in milli-Q water and fixed under a coverslip using ammonium picrate-glycerine (Malmberg 1957). On some individuals, partial digestion through proteinase K treatment was carried out following Harris and Cable (2000). Some worms collected in the DRC were mounted in the field directly.

Pictures and measurements of the hard parts of the haptor and the male copulatory organ (MCO) were taken based on Gussev (1962) using an Olympus BX50 microscope at a magnification of  $\times 100$  (oil immersion,  $\times 10$  ocular) with Olympus DP-Soft 3.2 software. The numbering of haptoral parts was adopted from ICOPA IV (Euzet and Prost 1981); the terminology follows Pariselle and Euzet (1995) (i.e. “uncinuli” for marginal hooks) and the metrics taken are those from Pariselle et al. (2003a) (Fig. 1). Measurements are in micrometers and presented in Table 1. Taxon and author names of fishes follow Eschmeyer and Fricke (2011).

## Results

Following Paperna (1960) and Pariselle et al. (2003a), the monogenean species described below belong to *Cichlidogyrus* Paperna, 1960. *Generic diagnosis*: Ancyrocephalidae. Three pairs of cephalic glands. Two posterior ocellae with crystalline lenses. Two small inconsistent anterior ocellae. Median muscular pharynx. Simple intestinal caeca joined posteriorly. Two pairs of anchors, one dorsal and one ventral. Two transverse bars, one dorsal with two auricles, one ventral curved and articulated. Fourteen uncinuli. Median posterior testis. Vas deferens at right side, not encircling intestinal caecum. Seminal vesicle present. One prostatic reservoir. Male copulatory complex with penis and

**Fig. 1** Measurements used to study the three new *Cichlidogyrus* spp. *DB* dorsal transverse bar: *h* length of dorsal bar auricle, *w* dorsal bar maximum width, *x* dorsal bar total length, *y* distance between auricles. *A* anchor: *a* anchor total length, *b* anchor blade length, *c* anchor shaft length, *d* anchor guard length, *e* anchor point length. *MA* male apparatus: *Ap* accessory piece length, *Pe* penis total length, *He* heel length. *U* uncinuli length. *VB* ventral transverse bar: *w* ventral bar maximum width, *x* length of one ventral bar branch



accessory piece (Vanhove et al. (2011b) mention that the latter is not always present); auxiliary plate sometimes present. Median pre-testicular ovary. Submedian vaginal opening. Sclerotised vagina. Seminal receptacle present. Gill parasites of African Cichlidae, Cyprinodontidae and Nandidae.

*Cichlidogyrus steenbergei* sp. n. (Fig. 2; Table 1)

Type host: *L. dardennii* (Boulenger, 1899)

Site of infection: gills

Type locality: Kalambo Lodge, Lake Tanganyika, Zambia (8°37' S, 31°12' E)

Additional locality: Mugayo, Lake Tanganyika, DRC (6°47' S, 29°34' E).

Material studied: 21 individuals

Type material: the holotype has been deposited at the Natural History Museum, London, UK (NHMUK 2011.6.21.1). Paratypes have been deposited at the Royal Museum for Central Africa, Tervuren, Belgium (MRAC 37683) and at the Iziko South African Museum, Cape Town, Republic of South Africa (SAMCTA 29509).

Etymology: named after mathematician and biologist Maarten Van Steenberge (Belgium), specialist of African freshwater fish diversity, and a good colleague and friend of the authors.

**Diagnosis:** adults 330 (211–409) long. Dorsal anchor with guard much longer than shaft and regularly curved blade. Large dorsal transverse bar thick and arched, tapering towards the extremities, with auricles relatively far apart. Ventral anchor with guard and shaft more equal in size, as ventral anchor guard is shorter than that of dorsal anchor. Thick ventral transverse bar widest at mid-length of branches; branches straight. First and third to

seventh uncinuli short (sensu Pariselle and Euzet 2009, i.e. when considered in proportion to the second uncinuli, which retain their larval size). Very large MCO with broad and thin-walled tubular penis, widening towards the end, and starting in clearly striated bulb with thin, not very prominent heel; accessory piece not reaching end of penis, sharply bent, tapering towards the extremities and slightly curved in the middle. No sclerotised vagina observed.

**Remarks:** The overall resemblance to *Cichlidogyrus halli* (Price and Kirk 1967), found on a variety of Tilapiini and Haplochromini, is quite high; however, the smaller diameter of the penis and less pronounced heel of the MCO of *C. steenbergei* sp. n. represent clear differences. This species also resembles *Cichlidogyrus arfii* Pariselle and Euzet 1995 (large penis and simple accessory piece) found on *Pelmatochromis buettikoferi* (Steindachner, 1894), but the latter has large uncinuli I.

*Cichlidogyrus irenae* sp. n. (Fig. 3; Table 1)

Type host: *G. pfefferi* (Boulenger, 1898).

Site of infection: gills.

Type locality: Kalambo Lodge, Lake Tanganyika, Zambia (8°37' S, 31°12' E)

Additional locality: Luhanga, Lake Tanganyika, DRC (3°31' S, 29°9' E)

Material studied: 23 individuals

Type material: the holotype has been deposited at the Natural History Museum, London, UK (NHMUK 2011.6.21.2). Paratypes have been deposited at the Royal Museum for Central Africa, Tervuren, Belgium (MRAC 37684) and at the Iziko South African Museum, Cape Town, Republic of South Africa (SAMCTA 29510).

**Table 1** Comparison of morphological body and haptor measurements (in micrometers, average  $\pm$  standard deviation with range in parentheses) of *C. steenbergei* sp. n., *C. irenae* sp. n. and *C. gistelincki* sp. n.

	<i>C. steenbergei</i> sp. n. ( <i>L. dardennii</i> ) (n=21)	<i>C. irenae</i> sp. n. ( <i>G. pfefferi</i> ) (n=23)	<i>C. gistelincki</i> sp. n. ( <i>C. horei</i> ) (n=24)
Total body length	330 $\pm$ 66 <sup>a</sup> (211–409)	364 $\pm$ 120 <sup>c</sup> (193–545)	287 $\pm$ 57 <sup>g</sup> (150–392)
Dorsal anchor total length (a DA)	37.4 $\pm$ 2.9 <sup>b</sup> (33.3–43.6)	35.0 $\pm$ 2.8 <sup>f</sup> (30.0–38.5)	30.9 $\pm$ 1.6 <sup>f</sup> (27.8–33.7)
Dorsal anchor blade length (b DA)	25.6 $\pm$ 1.6 <sup>b</sup> (22.6–28.6)	25.8 $\pm$ 1.6 <sup>f</sup> (22.4–28.8)	22.3 $\pm$ 0.8 <sup>f</sup> (20.4–23.7)
Dorsal anchor shaft length (c DA)	4.1 $\pm$ 0.9 <sup>b</sup> (2.8–5.9)	4.6 $\pm$ 0.7 <sup>f</sup> (3.6–5.9)	3.9 $\pm$ 0.6 <sup>f</sup> (3.0–5.1)
Dorsal anchor guard length (d DA)	13.7 $\pm$ 1.9 <sup>b</sup> (9.4–16.5)	12.3 $\pm$ 1.5 <sup>f</sup> (9.6–14.7)	11.2 $\pm$ 1.9 <sup>f</sup> (6.0–13.8)
Dorsal anchor point length (e DA)	10.4 $\pm$ 1.1 <sup>b</sup> (8.7–12.0)	9.1 $\pm$ 1.0 <sup>f</sup> (6.9–11.1)	7.6 $\pm$ 1.0 <sup>f</sup> (5.8–9.6)
Length of dorsal bar auricle (h DB)	13.7 $\pm$ 1.8 <sup>c</sup> (10.3–17.3)	14.2 $\pm$ 2.4 <sup>f</sup> (9.6–19.0)	11.2 $\pm$ 1.1 <sup>f</sup> (8.9–12.8)
Dorsal bar maximum width (w DB)	6.9 $\pm$ 1.2 <sup>c</sup> (4.6–9.4)	6.1 $\pm$ 1.1 <sup>f</sup> (4.2–8.2)	4.0 $\pm$ 0.4 <sup>f</sup> (3.1–4.5)
Dorsal bar total length (x DB)	43.0 $\pm$ 3.1 <sup>c</sup> (37.6–47.6)	32.7 $\pm$ 7.0 <sup>f</sup> (17.9–45.8)	28.9 $\pm$ 2.7 <sup>f</sup> (24.9–34.0)
Distance between dorsal bar auricles (y DB)	14.8 $\pm$ 1.4 <sup>c</sup> (12.7–18.7)	11.5 $\pm$ 1.8 <sup>f</sup> (8.3–15.2)	9.6 $\pm$ 1.2 <sup>f</sup> (8.0–12.1)
Ventral anchor total length (a VA)	31.4 $\pm$ 1.9 <sup>c</sup> (28.4–34.5)	31.4 $\pm$ 1.6 <sup>g</sup> (29.3–34.6)	27.4 $\pm$ 1.4 <sup>f</sup> (24.8–31.3)
Ventral anchor blade length (b VA)	27.7 $\pm$ 1.6 <sup>c</sup> (25.6–30.8)	28.5 $\pm$ 1.4 <sup>g</sup> (26.1–30.2)	24.6 $\pm$ 0.9 <sup>f</sup> (23.5–26.5)
Ventral anchor shaft length (c VA)	4.8 $\pm$ 1.1 <sup>c</sup> (2.3–6.5)	5.4 $\pm$ 1.2 <sup>g</sup> (3.2–7.8)	4.3 $\pm$ 0.7 <sup>f</sup> (2.7–5.7)
Ventral anchor guard length (d VA)	7.1 $\pm$ 1.1 <sup>c</sup> (4.2–8.7)	8.1 $\pm$ 1.3 <sup>g</sup> (5.9–10.1)	7.8 $\pm$ 1.5 <sup>f</sup> (5.9–11.9)
Ventral anchor point length (e VA)	11.3 $\pm$ 1.0 <sup>c</sup> (9.9–12.9)	10.0 $\pm$ 1.5 <sup>g</sup> (7.9–12.8)	8.8 $\pm$ 1.1 <sup>f</sup> (6.1–10.4)
Ventral bar maximum width (w VB)	6.0 $\pm$ 0.8 <sup>c</sup> (4.8–7.8)	4.8 $\pm$ 0.9 <sup>f</sup> (3.2–6.5)	4.3 $\pm$ 0.6 <sup>g</sup> (3.3–5.5)
Length of one ventral bar branch (x VB)	35.5 $\pm$ 2.6 <sup>c</sup> (32.1–40.6)	31.6 $\pm$ 4.6 <sup>f</sup> (24.8–39.5)	28.0 $\pm$ 1.9 <sup>g</sup> (24.8–30.9)
Length of first uncinuli (UI)	12.5 $\pm$ 0.5 <sup>c</sup> (11.7–13.7)	11.6 $\pm$ 0.4 <sup>f</sup> (10.8–12.1)	11.3 $\pm$ 0.5 <sup>f</sup> (10.4–12.0)
Length of second uncinuli (UII)	12.2 $\pm$ 1.6 <sup>c</sup> (10.0–16.1)	11.4 $\pm$ 0.9 <sup>f</sup> (9.2–12.6)	14.2 $\pm$ 3.3 <sup>f</sup> (9.8–19.4)
Average length of third to seventh uncinuli (UIII–UVII)	16.0 $\pm$ 1.2 <sup>c</sup> (13.2–17.9)	16.3 $\pm$ 2.1 <sup>f</sup> (11.9–19.3)	18.1 $\pm$ 2.3 <sup>f</sup> (13.5–21.7)
Accessory piece length (AP)	37.5 $\pm$ 2.2 <sup>d</sup> (34.1–41.6)	59.5 $\pm$ 5.8 <sup>d</sup> (37.8–64.8)	25.6 $\pm$ 2.0 <sup>h</sup> (22.7–28.4)
Penis total length (Pe)	62.8 $\pm$ 5.3 <sup>d</sup> (52.7–71.1)	69.5 $\pm$ 5.7 <sup>d</sup> (48.0–73.3)	34.9 $\pm$ 1.8 <sup>h</sup> (32.2–37.9)
Heel length (He)	5.4 $\pm$ 0.7 <sup>d</sup> (4.2–6.4)	4.1 $\pm$ 0.2 <sup>d</sup> (3.6–4.4)	3.2 $\pm$ 0.2 <sup>h</sup> (2.9–3.5)

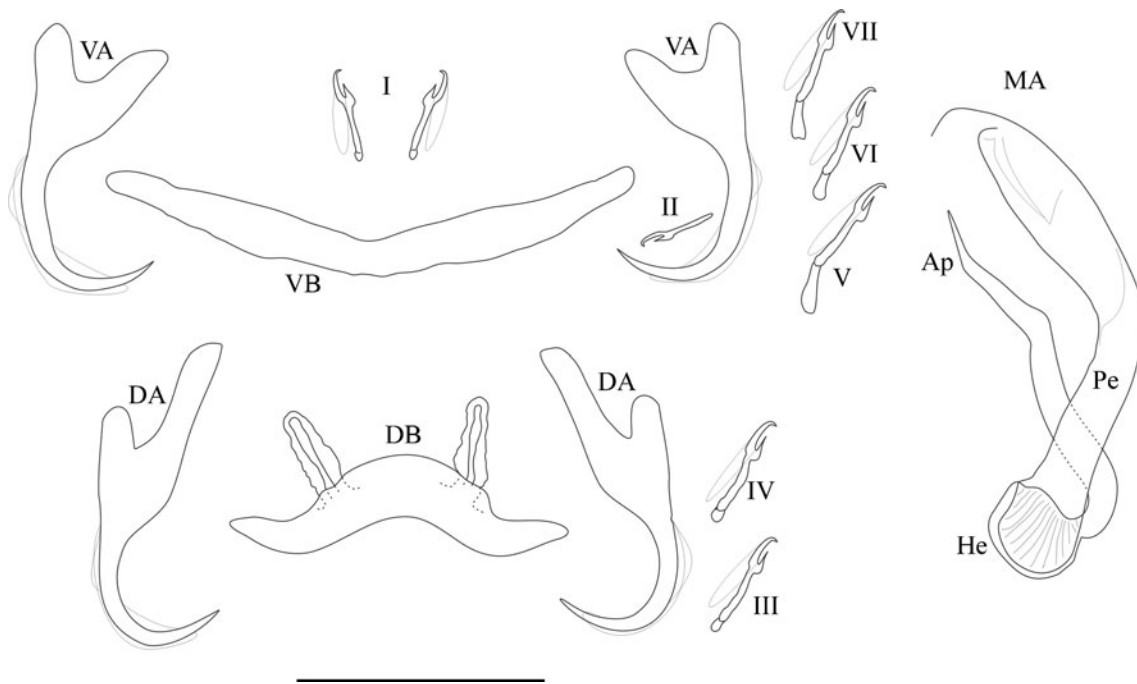
<sup>a</sup> n=13<sup>b</sup> n=16<sup>c</sup> n=17<sup>d</sup> n=20<sup>e</sup> n=11<sup>f</sup> n=15<sup>g</sup> n=14<sup>h</sup> n=18

Etymology: named for “Irene”, the vernacular name for the host species used by the fishermen/snorkelers at Kalambo Lodge who caught the majority of fish specimens.

**Diagnosis:** adults 364 (193–545) long. Dorsal anchor with guard relatively long as compared to shaft and of irregular shape; rather wide opening between shaft and guard; blade point only curves towards end of the slender blade. Dorsal transverse bar curved and thinner towards the extremities than in the middle; auricles relatively longer than in *C. steenbergei* sp. n. and planted at mid-width of bar. Ventral anchor also with slender blade curving towards the end, and guard of irregular shape; guard planted at almost right angle of shaft; length difference between both less pronounced than in dorsal anchor. Branches of ventral transverse bar straight; incision where both branches join.

First and third to seventh uncinuli short (*cf. supra*). Very large MCO. Penis tubular with swollen portion in the middle, starting in pear-shaped bulb with distinct and blunt heel; accessory piece of comparable length as penis, narrowing towards the end. No sclerotised vagina observed.

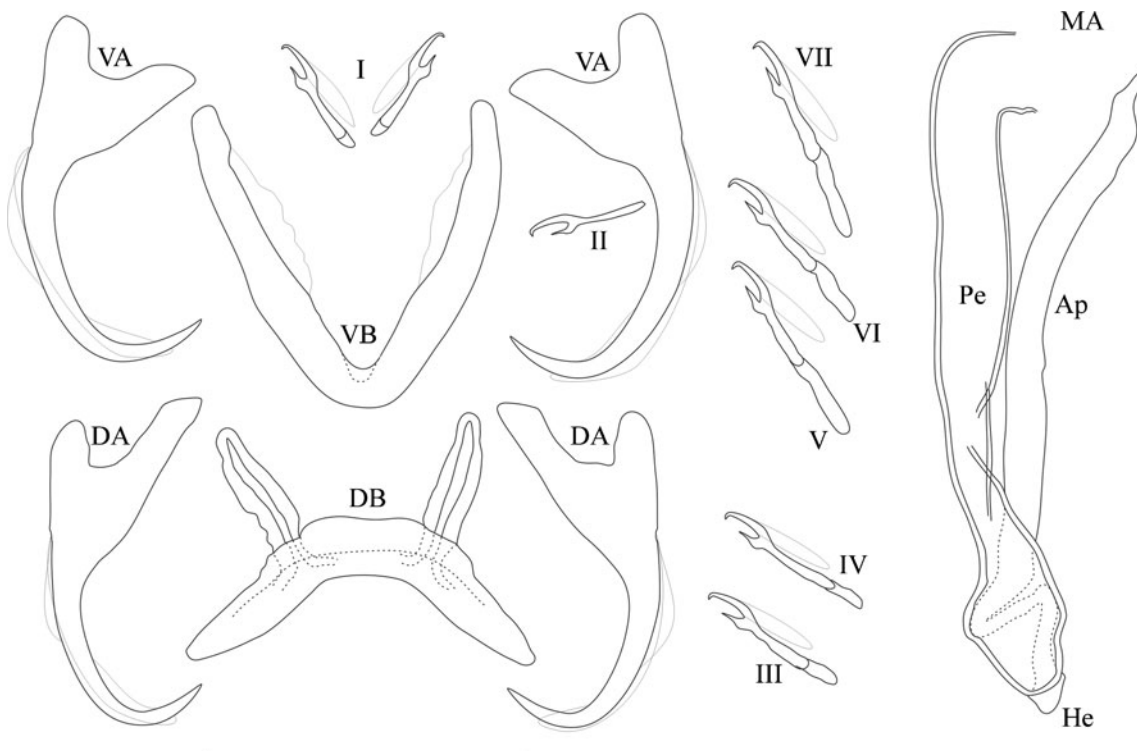
**Remarks:** because of the overall haptor morphology and the presence of a swollen portion in the penis, *C. irenae* sp. n. resembles *Cichlidogyrus karibae* Douëllou, 1993 and *Cichlidogyrus zambezensis* Douëllou, 1993 [described from *Sargochromis codringtonii* (Boulenger, 1908) and *Serranochromis macrocephalus* (Boulenger, 1899), respectively]. However, *C. karibae* has an S-shaped MCO accessory piece, more uneven in thickness than the rather straight accessory piece of *C. irenae* sp. n. The shape of the accessory piece of *C. zambezensis*, including a finger-like



**Fig. 2** Sclerotised parts of *C. steenbergei* sp. n. MA male apparatus: Ap accessory piece, He heel, Pe penis. DB dorsal transverse bar. DA dorsal anchor. VB ventral transverse bar. VA ventral anchor. I–VII uncinuli. Scale bar=30  $\mu$ m

extension ending in a hook, clearly distinguishes this species from *C. irenae* sp. n. as well, while both *C. karibae* and *C. zambezensis* are larger in size. The MCO of *C.*

*irenae* is reminiscent of *C. halli* and *C. arfii*, both in shape and size. However, the penis of these latter species lacks the diffuse swollen portion (sensu Pariselle and Euzet 2009)



**Fig. 3** Sclerotised parts of *C. irenae* sp. n. MA male apparatus: Ap accessory piece, He heel, Pe penis. DB dorsal transverse bar. DA dorsal anchor. VB ventral transverse bar. VA ventral anchor. I–VII uncinuli. Scale bar=30  $\mu$ m

present in the new species. The haptor elements of *C. halli* also generally exceed those of *C. irenae* sp. n. in size, while the haptor of *C. arfii* possesses large uncinuli I.

*Cichlidogyrus gistelincki* sp. n. (Fig. 4; Table 1)

Type host: *C. horei* (Günther, 1894)

Site of infection: gills

Type locality: Kalambo Lodge, Lake Tanganyika, Zambia (8°37' S, 31°12' E)

Additional localities: Mbita Island, Lake Tanganyika, Zambia (8°45' S, 31°05' E); Mtosi, Lake Tanganyika, Tanzania (7°35' S, 30°38' E); Kalemie, near Lukuga outflow, DRC (5°54' S, 29°12' E)

Material studied: 24 individuals

Type material: the holotype has been deposited at the Natural History Museum, London, UK (NHMUK 2011.6.21.3). Paratypes have been deposited at the Royal Museum for Central Africa, Tervuren, Belgium (MRAC 37685) and at the Iziko South African Museum, Cape Town, Republic of South Africa (SAMCTA 29511).

Etymology: named after biochemist and aquariologist Marc Gistelinck (Belgium), a special friend of first author C.G.

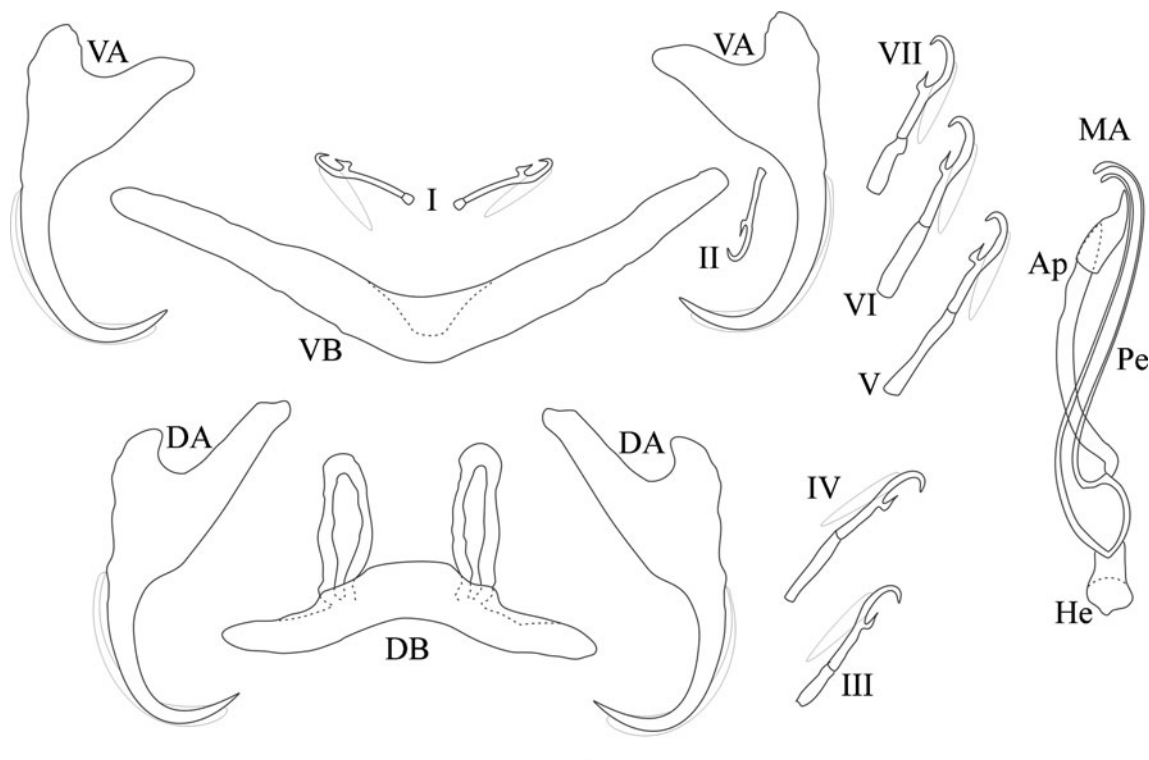
**Diagnosis:** adults 287 (150–392) long. Dorsal anchor with relatively short blade, the base of which is clearly separated from the guard; guard considerably longer than shaft. Dorsal transverse bar with similar width throughout, only tapering towards the extremities; auricles planted at mid-width.

Ventral anchor with stubby guard and shaft at right angle to each other; ventral anchor blade relatively longer than that of dorsal anchor. Ventral transverse bar with straight branches widest at mid-length and incised where branches meet. First and third to seventh uncinuli short (*cf. supra*). Rather small-sized MCO; tubular penis, beginning in a heart-shaped bulb with trapezoid heel, narrowing and bending backwards towards the opening; slender accessory piece twisted and with distal end covered by a pointed cap. No sclerotised vagina observed.

**Remarks:** The overall similarities to *C. halli* or *C. arfii* are quite high; however, the dimensions of body, haptor parts, penis and MCO accessory piece are considerably smaller in *C. gistelincki* sp. n. The more slender penis, more pronounced heel and capped accessory piece allow clear distinction between *C. gistelincki* sp. n. and *C. steenbergei* sp. n. on the basis of their MCO.

## Discussion

The first representatives of *Cichlidogyrus* (Monogenea, Ancyrocephalidae) living on Tropheini are described, namely on *L. dardennii*, *G. pfefferi* and *C. horei* hosts. Apart from *Gyrodactylus zimbae* Vanhove, Snoeks, Volckaert and Huyse, 2011, described from *Simochromis diagramma*



**Fig. 4** Sclerotised parts of *C. gistelincki* sp. n. MA male apparatus: Ap accessory piece, He heel, Pe penis. DB dorsal transverse bar. DA dorsal anchor. VB ventral transverse bar. VA ventral anchor. I–VII uncinuli. Scale bar=30  $\mu$ m

(Günther, 1894) and also recorded on *C. horei* (Vanhove et al. 2011a), no helminth parasites are known from these hosts, to the best of our knowledge. Throughout the Tropheini, *Cichlidogyrus* spp. seems to be more prevalent and host-specific compared to monogeneans belonging to *Gyrodactylus (nobis)*.

The current descriptions corroborate the assertion of Pouyaud et al. (2006) that similar species can be distinguished on the basis of their MCO. On a higher level, *Cichlidogyrus* can be divided in groups based on haptoral configuration (mainly considering relative lengths of the various pairs of uncinuli) (Pariselle and Euzet 2003; Vignon et al. 2011). Molecular information suggests that they reflect genuine evolutionary relationships (Pouyaud et al. 2006). The first pair of uncinuli, as well as pairs three to seven, of all three new species are short. In this sense, the new species do not represent a new haptoral configuration, and thus seem morphologically less unusual, than some of the species described from *Ophthalmotilapia* Pellegrin, 1904 (Ectodini) in Lake Tanganyika. Indeed, while *C. vandekerkhovei* Vanhove, Volckaert and Pariselle, 2011 and *C. makasai* Vanhove, Volckaert and Pariselle, 2011 possess extremely long dorsal bar auricles, *C. centesimus* Vanhove, Volckaert and Pariselle, 2011 displays several features previously unknown from *Cichlidogyrus*: a spirally coiled thickening at the end of the penis, the lack of an MCO accessory piece, and a unique haptoral organisation.

Haptor characteristics are useful to define morphological groups within *Cichlidogyrus* (cf. supra). The group of *Cichlidogyrus* spp. in which both the first pair and pairs three to seven of the uncinuli are short, includes, in addition to a variety of West African parasite species, several parasites of Haplochromini s.l., such as *C. haplochromii* Paperna, 1979, *C. karibae* and *C. zambezensis*. On the other hand, *C. philander* Douëllou, 1993 does not belong to this group (Vignon et al. 2011) and *C. bifurcatus* Paperna, 1960 seems to have longer UIII – UVII (Paperna 1979). Nevertheless, these species also infect representatives of the Haplochromini s.l., such as *Pseudocrenilabrus* Fowler, 1934 and *Haplochromis* Hilgendorf, 1888 (Paperna 1979; Douëllou 1993). In view of the interesting phylogenetic position of the Tropheini with regards to the Haplochromini (cf. supra), and of the role of Lake Tanganyika as the evolutionary reservoir to all Haplochromini in the region (Salzburger et al. 2005), molecular data and broader taxon sampling are needed to reconstruct the history of Central African *Cichlidogyrus*. Further molecular work should also elucidate relationships to the already mentioned *C. halli*, a species with a broad host range, occasionally even parasitizing Haplochromini s.l. (Douëllou 1993: *S. macrocephalus*), which probably represents a species complex (Pouyaud et al. 2006; Pariselle and Euzet 2009).

In any case, the haptor configuration (similar uncinuli length, hence belonging to the same morphological group within the genus, and similar dorsal bar), the same MCO type (simple accessory piece, broad penis) and the shared absence of a sclerotised vagina suggest a close relationship between the three new species. Interestingly, the three host species are relatively closely related to each other within the Tropheini (Koblmüller et al. 2010). Although it is too early for conclusions, the hypothesis that these species evolved from a shared ancestor on an ancestral Tropheini host should be retained. This is in stark contrast to the only other monogeneans known from Tropheini, namely the *Gyrodactylus* spp. described from *S. diagramma*. Indeed, in view of their genetic and morphological differences, ecological transfer needs to be invoked to explain their co-occurrence on one host species (Vanhove et al. 2011a).

Dispersal capacity, leading to gene flow across even unfavourable habitats, is frequently linked to a lack of genetic and morphological substructuring in Tanganyika cichlids (Meyer et al. 1996; Wagner and McCune 2009). For example, *L. dardennii*, a dweller on preferably vegetated shallow sediment-rich grounds, is known to be a good disperser, also over sandy stretches. It contrasts with other Tropheini cichlids such as *Tropheus* Boulenger, 1898, which are strongly bound to rocky substrates (Konings 1998). Indeed, the hosts under study hardly display genetic and phenotypic within-species diversity (Koblmüller et al. 2010). It has been suggested that the mobility of the host species positively influences parasite species richness (Gregory 1990; Mwita and Nkwengulila 2008). As the new species are the only *Cichlidogyrus* spp. retrieved from their respective hosts, with sampling sites several hundreds of kilometres apart, this hypothesis is not supported here. There is strong evidence from other Monogenea that genetic data may contribute to the detection of cryptic speciation and the recognition of underestimated host specificity (Ziętara and Lumme 2003; Huyse and Malmberg 2004; Pouyaud et al. 2006). Hence, the next phase includes the molecular characterization of the parasite fauna. Preliminary molecular data (nuclear rDNA) do not suggest cryptic speciation in parasites collected from the three hosts species (Vanhove et al. unpublished data).

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