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TAXONOMY AND NOMENCLATURE

Description of three new species of *Quadriacanthus* (Monogenea: Ancyrocephalidae) gill parasites of *Clarias submarginatus* (Siluriformes: Clariidae) from Lake Ossa (Littoral region, Cameroon)

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ABSTRACT. Clariidae is a group that includes many species that have great economic importance in both fisheries and fish culture. Monogenean parasites of fishes assigned to this family have been studied in Cameroon, but there have been no studies on *Clarias submarginatus* Peter, 1882, a fish that is traditionally consumed by the local people. The examination of 43 specimens identified as *C. submarginatus* from Lake Ossa (first record of this fish species in the Sanaga basin), revealed that some of them belong to *Quadriacanthus* and are new. Their identification was made based on the morphology and the size of sclerotized parts of the haptor and the male and female copulatory complexes. *Quadriacanthus macruncus* Bahanak, Nack & Pariselle **sp. nov.** and *Quadriacanthus submarginati* Bahanak, Nack & Pariselle **sp. nov.** are characterized by the morphology of their accessory piece, pointed, slightly curved and wider at medium level, equipped with two subterminal, symmetrical and similar spines for *Q. macruncus* **sp. nov.** and made up of one long tip flanked by a short spine and a bulb for *Q. submarginati* **sp. nov.**, while *Quadriacanthus ossaensis* Bahanak, Nack & Pariselle **sp. nov.** is distinguished by the unique morphology of the penis, ending in a fork. The new species of *Quadriacanthus* are herein described and their host specificity is discussed.

KEY WORDS. *Quadriacanthus macruncus* **sp. nov.**, *Quadriacanthus ossaensis* **sp. nov.**, *Quadriacanthus submarginati* **sp. nov.**

Clariid catfishes are characterized by the presence of a unique arborescent supra-branchial organ formed by the second and fourth gill arches, which enables them to breathe atmospheric oxygen (Teugels & Adriaens 2003). This family contains 15 genera and includes 89 species that occur in the freshwaters of Africa (13 genera, 74 species), Asia Minor (1 species, also present in Africa), and South East Asia (3 genera and 15 species) (Agnèse & Teugels 2005). In Cameroonian freshwaters, 4 genera: *Clarias* Scopoli, 1777, *Gymnallabes* Günther, 1867, *Heterobranchus* Geoffroy Saint-Hilaire, 1809, and *Clariallabes* Boulenger, 1900, represented by 13 species (Stiassny et al. 2007), have been reported. Species of *Clarias*, the most speciose clariid genus (39 species) (Agnèse & Teugels 2005), occur in two continents (Asia and Africa). *Clarias* spp. inhabit calm freshwaters such as lakes, streams, swamps and flood plains. Their accessory air breathing organs enable them to survive during the dry season (Bruton 1979). Moreover, their high growth rate, their resistance to handling and stress, their omnivorous diet, and their flesh, which is well appreciated in many African countries, give them a unique aquaculture value (Legendre et al. 1992).

Parasitism is a major threat to fish productivity, especially in aquaculture systems (Bilong Bilong et al. 1998). Several studies have been carried out on the monogenean fauna of clariid species in Cameroon (Birgi 1988, Nack et al. 2005, Bilong Bilong et al. 2007, Nack & Bilong Bilong 2007), but none has studied *Clarias submarginatus* Peter, 1882 a common food resource for local people. This study was conducted at lake Ossa (3°45'-3°51'N, 9°58'-0°03'E in Cameroon, Central Africa) situated 8 m above sea level and located 20 km to the west of the city of Edéa and 30 km from the Atlantic Ocean. According to Wirrmann (1992) and Wirrmann et al. (2001), the Lake Ossa system is composed of several subunits, with a total surface area of about 3,800 ha. The system consists of three main lakes: Mévia, located north; Ossa, at the middle; and Mwembé, in the South. Ossa and Mévia are the two largest within the system and communicate through a short channel, whereas Mwembé is isolated. In its southeastern part, Lake Ossa, communicates with the Sanaga River by a sinuous outlet (Nack et al. 2015) (Fig. 1).

MATERIAL AND METHODS

Specimens (n = 43) of *C. submarginatus* examined in this study were caught using gill nets, cast nets, fish-traps or hook lines by fishermen and were purchased on shore market (SM in Fig. 1) or at the Edéa fish market (EFM in Fig. 1). Fish were immediately placed in a cool box containing ice, and were transported to the laboratory, where they were frozen at -21°C. After thawing, gills arches were removed by dorsal and ventral sections, and placed in a Petri-dish containing tap water. The parasites were dislodged from the gill filaments with the aid of a dissection needle. The monogeneans were fixed between slides and cover slips into a drop of glycerin ammonium-picrate mixture (GAP) Malmberg (1957). After 24 hours the preparations were sealed using nail varnish. Specimen's identification, based on the morphology and the size of sclerotized pieces of the haptor and the copulatory complex, followed Kritsky & Kulo (1988), N'Douba et al. (1999) and N'Douba & Lambert (2001). The measurements and drawings of the sclerotized pieces of the haptor and copulatory complex were made with the aid of microscope Leica DM 2500, LAS software (3.8) and Corel Draw X4® software, version 14.0.0.701. These measurements and the numbering of haptoral pieces were carried out based on N'Douba et al. (1999) (Fig. 2). Measurements were given in micrometers as follows: average (minimum – maximum); the standard deviation is given when n ≥ 30. Types where deposited in the Musée Royal de l'Afrique Central (MRAC, Tervuren, Belgium).

TAXONOMY

Class Monogenea Van Beneden, 1858
Dactylogyridea Bychowsky, 1937
Ancyrocephalidae Bychowsky, 1937

The anatomy of the new species described herein corresponds to the diagnosis of *Quadriacanthus* Paperna, 1961 given by Paperna (1961), amended by Kritsky & Kulo (1988) and used by Nack et al. (2015).

Quadriacanthus macruncus Bahanak, Nack & Pariselle, **sp. nov.**

Fig. 3

urn:lsid:zoobank.org:act:2FE39BE9-F936-4BE4-A907-F8BDB8FEA566

Description (based on 9 specimens, all mounted in GAP): adults measure 428.3 (209.7-737.6) long, 83.4 (47.8-101.5) wide at level of ovary. Pharynx circular is 26. 9 (25.8-27.9) wide. Straight tubular penis widened at basal extremity and tapering at distal one, Pe = 28.7 (25.1-31.5) long. Accessory piece pointed, slightly curved and wider at median level, equipped with two subterminal, symmetrical and similar spines, Ap = 21.6 (18.1-23.3). Vagina not observed. Hooklets pair I = 12.9 (12.2-13.7), II = 12.9 (11.8-13.8), III = 13.6 (12.9-13.9), IV = 25.6 (24.9-26.7), V = 13.4 (12.4-14.3), VI = 14 (13.1-15.9), VII = 13.5 (12.9-14.1). Dorsal bar composed of developed rectangular centre, Ct = 24.7 (24.1-25.7), w = 9.1 5 (6.5-14.2) wide, with one median triangular

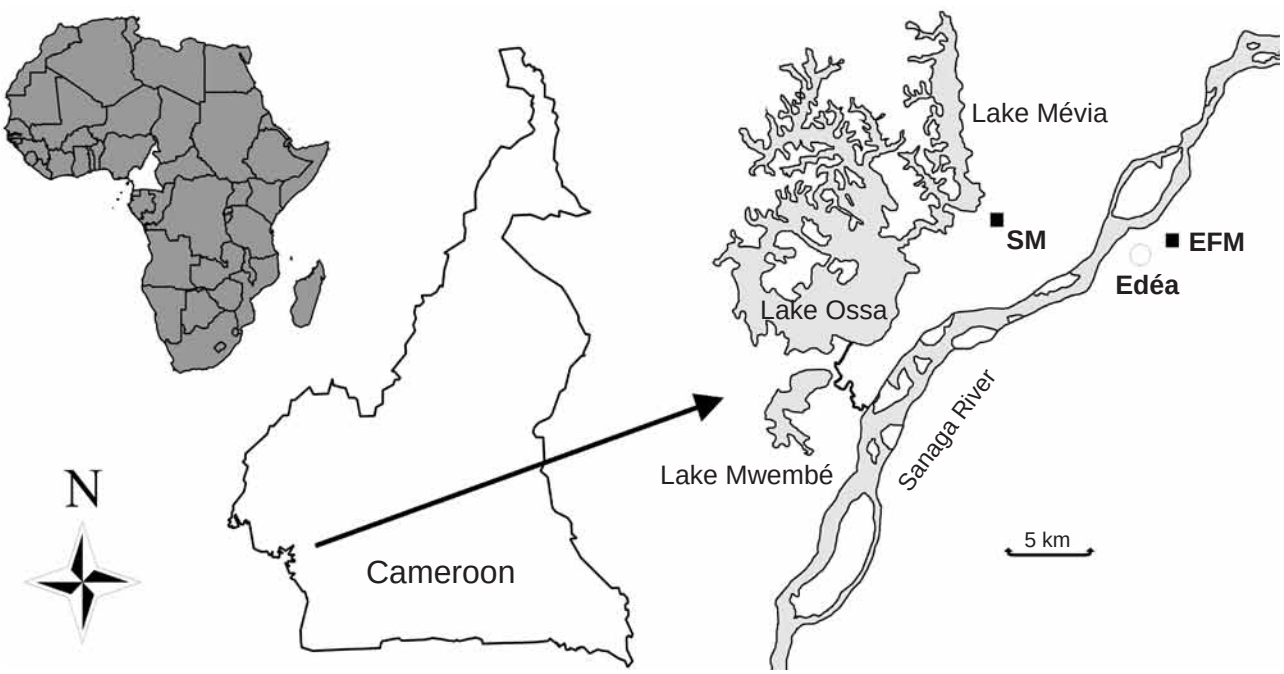

Figure 1. Map of Lake Ossa: (SM) Shore market, (EFM) Edéa fish market (modified from Nack et al. 2015).

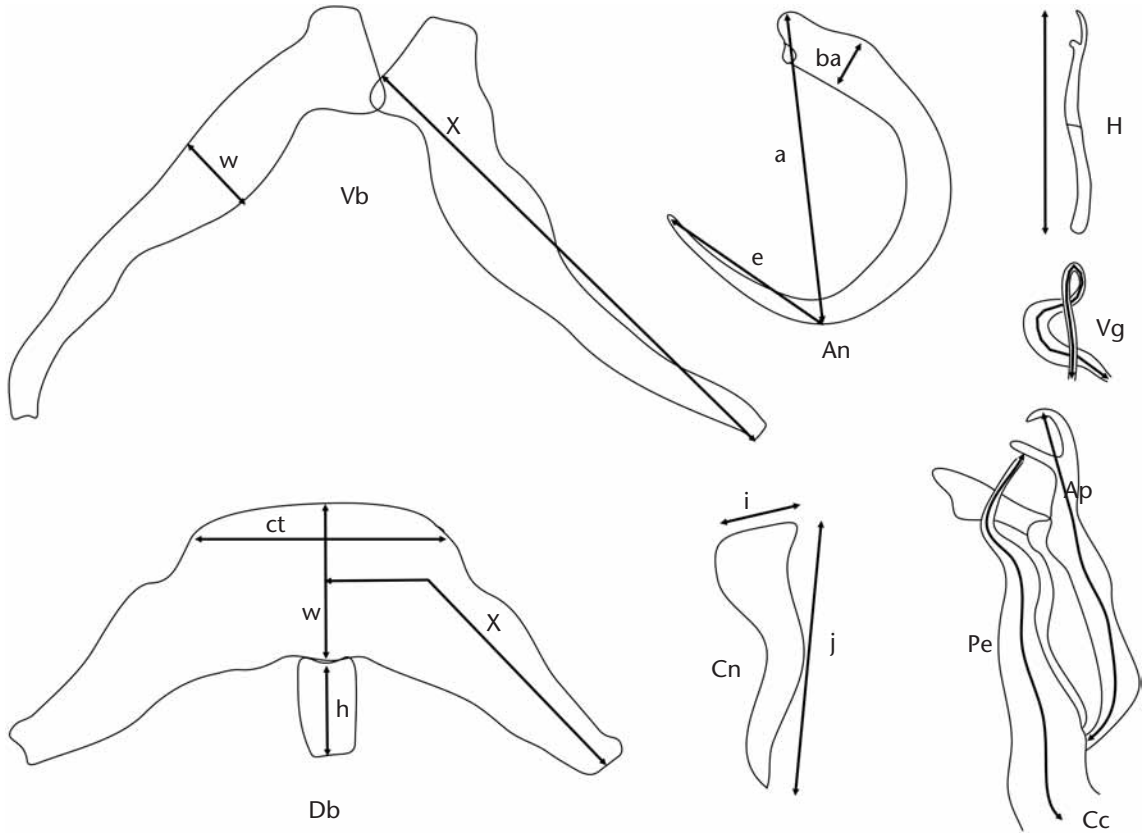

Figure 2. Morphometrics of *Quadriacanthus* spp. used in this study are based on Gussev (1962) and modified by N'Douba et al. (1999). (An) Anchor: (a) length, (ba) base width, (e) point length; (Cc) copulatory complex: (Ap) accessory piece length, (Pe) penis length; (Cn) cuneus: (j) length, (i) width; (Db) dorsal bar: (ct) centre length, (h) median process length, (w) width, (x) length, (H) hooklet length; (Vb) ventral bar: (w) width, (x) length, (Vg) vagina.

process posteriorly directed, h = 10.2 (8.6-11.6), and two lateral expansions, x = 35.6 (33.6-37.1). Dorsal anchor with curved blade, reduced guard and short point, a = 38.3 (36.8-41.6), ba = 10.6 (9.3-11.7), e = 2.5 (1.9-3.1). Dorsal triangular cuneus (or patch), i = 3.6 (2.1-4.6), j = 9 (6.1-12.5). Ventral bar V-shaped, made up of two branches medially articulated, x = 46.3 (41.9-49.5) long, w = 6.5 (5.5-8) wide. Ventral anchor quite similar to dorsal one, a = 39.7 (37.3-41.5), ba = 9.2 (8.8-9.9), short point e = 3.9 (3.2-4.3). Slightly curved ventral cuneus with bilobed proximal extremity, i = 2.9 (2.2-3.9), j = 6.1 (4-7.5).

Type host. *Clarias submarginatus* Peter, 1882.

Site. Gills.

Type locality. Lake Ossa, Cameroon (3°45'-3°51'N, 9°58'-10°03'E).

Type specimens. Holotype deposited at the Royal Museum for Central Africa (Tervuren): #37935. Paratype deposited at the Royal Museum for Central Africa (Tervuren): #37936.

Parasitic indices. Prevalence = 18.2%, mean abundance = 0.2 ± 0.4.

Etymology. The specific name, *macruncus*, refers to the large size of the anchors of this species.

Remarks. The morphology of the male copulatory complex of *Q. macruncus* resembles *Q. levequei* Birgi, 1988 and *Q. euzeti* Nack, Pariselle & Bilong Bilong, 2015; *Q. macruncus*) can be distinguished by its smaller size: (Pe = 25.1-31.5 vs 45-50, 36-40; Ap = 18.1-23.3 vs 30-35, 25-28), and by the morphology of the median process, directed posteriorly to the dorsal bar, triangular. This structure is in the shape of a stick in *Q. levequei* and a funnel in *Q. euzeti*.

Quadriacanthus ossaensis
Bahanak, Nack & Pariselle, **sp. nov.**

Fig. 4

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Description (based on 33 specimens, all mounted in GAP): adults measure: 368 ± 86.8 (188.9-597.7) long, 65. 5 ± 16. 1 (33.7-98.9) wide at level of ovary). Pharynx circular is 21 (18-24) wide. Winding tubular penis, widened at basal extremity, regularly

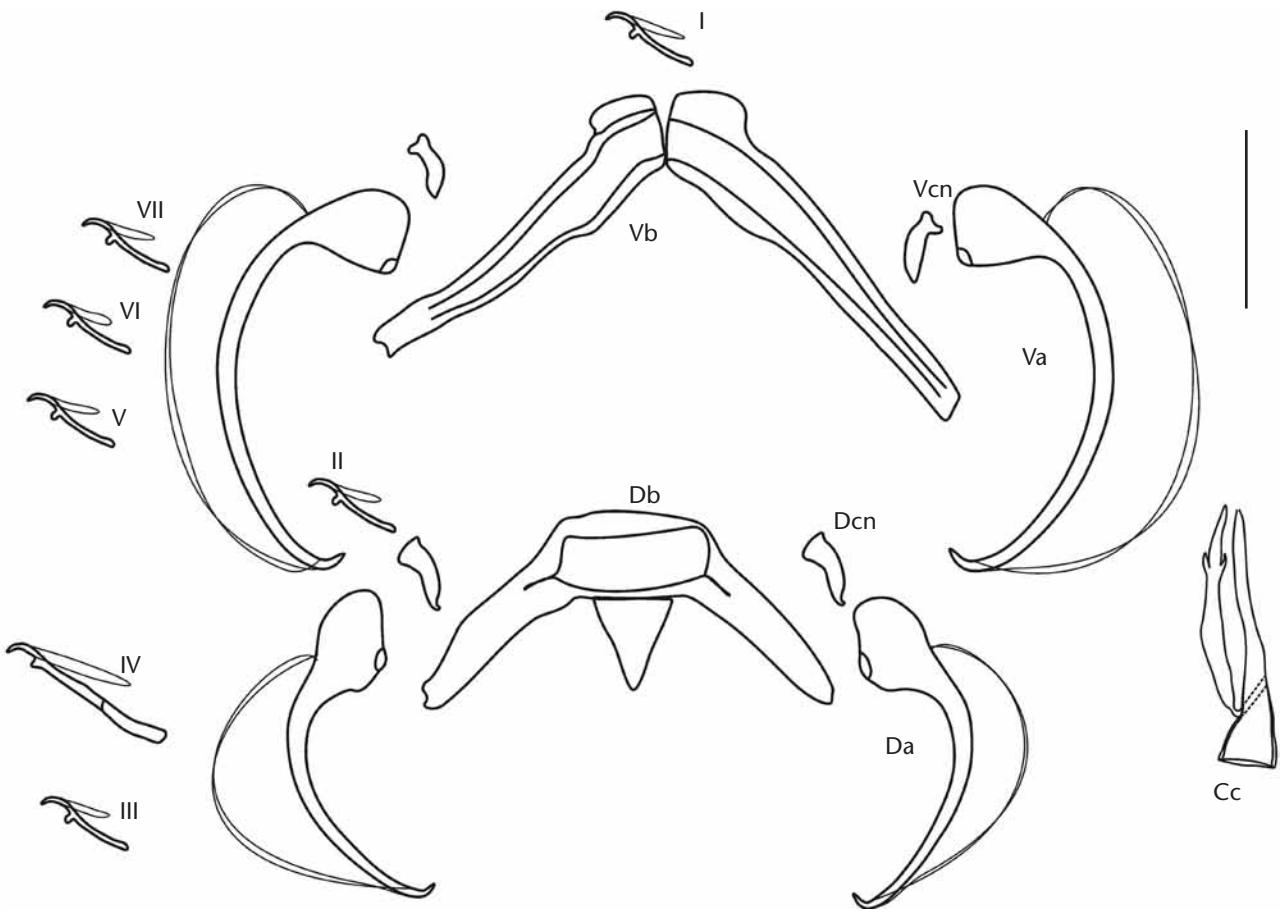

Figure 3. Sclerotized parts of *Quadriacanthus macruncus* **sp. nov.**: (Cc) copulatory complex, (Da) dorsal anchor, (Db) dorsal bar, (Dcn) dorsal cuneus, (H) hooklets, (Va) ventral anchor, (Vb) ventral bar, (Vcn) ventral cuneus, (Vg) vagina. Scale bar: 20 µm.

tapering to the distal one Pe = 28.2 ± 3.1 (23.9-32.4). Accessory piece, tubular, slightly arched and ending with two expansions: one fork shaped, the other one chevron shaped, Ap = 26.5 ± 2.9 (22-30.1). Tubular vagina, Vg = 24.9 ± 5 (20.9-30.6). Hooklets pair I = 13.5 ± 0.9 (11.7-15.4), II = 13.3 ± 0.8 (12-15.6), III = 14.3 ± 0.6 (12.1-15.7), IV = 24.8 ± 0.5 (23.8-25.7), V = 12.9 ± 0.7 (11.7-14.3), VI = 13.2 ± 0.8 (11.9-15), VII = 12.7 ± 0.8 (11-14.2). Dorsal bar composed of a developed trapezoidal centre, Ct = 17.4 ± 2.7 (14.5-21.9), w = 9.7 ± 0.8 (8.2-10.7) wide, with one posteriorly directed rectangular process, h = 8.6 ± 1.4 (7.1-9.9), and two lateral expansions, x = 20.4 ± 1.2 (18.9-22). Dorsal anchor without shaft, but with curved blade and short point, a = 28.3 ± 1.2 (26.9-30.8), ba = 9.1 ± 0.6 (8.1-9.8), e = 6.2 ± 1.2 (5.2-8.6), triangular dorsal cuneus (or patch) slightly curved, i = 5.2 ± 0.5 (4.8-5.8), j = 15.7 ± 0.6 (15-16.8). Ventral bar V-shaped, made up of two branches medially articulated, x = 32.6 ± 1.3 (30.4-36.2), w = 4.3 ± 0.5 (3.3-5.3), ventral anchor quite similar to dorsal one, a = 19.9 ± 1 (18.6-21.4), ba = 4.8 ± 0.3 (4.1-7.7), e = 9.8 ± 1.2 (7.7-12.1), triangular ventral cuneus, i = 2.4 ± 0.4 (1.6-3.3), j = 4.1 ± 0.7 (3.5-5.8).

Type host. *Clarias submarginatus* Peter, 1882.

Site. Gills.

Type locality. Lake Ossa, Cameroon (3°45'-3°51'N, 9°58'-10°03'E).

Type specimens. Holotype deposited at the Royal Museum for Central Africa (Tervuren): #37933. Paratype deposited at the Royal Museum for Central Africa (Tervuren): #37934.

Materials studied. 43 host individuals and 33 monogeneans.

Parasitic indices. Prevalence = 81.8%, mean abundance = 4.4 ± 5.8.

Etymology. The specific name, *ossaensis*, refers to the type locality of this species.

Remarks. The morphologies of the penis and of the accessory piece of *Q. ossaensis* **sp. nov.** are similar to *Quadriacanthus ayameensis* N'Douba, Lambert & Euzet, 1999, a gill parasite of *Heterobranchus longifilis* (Valenciennes, 1840) and *Heterobranchus isopterus* Bleeker, 1863 in the rivers Bia, Agnéby and in Lake Ayamé (Ivory Coast). *Quadriacanthus ossaensis* can be distin-

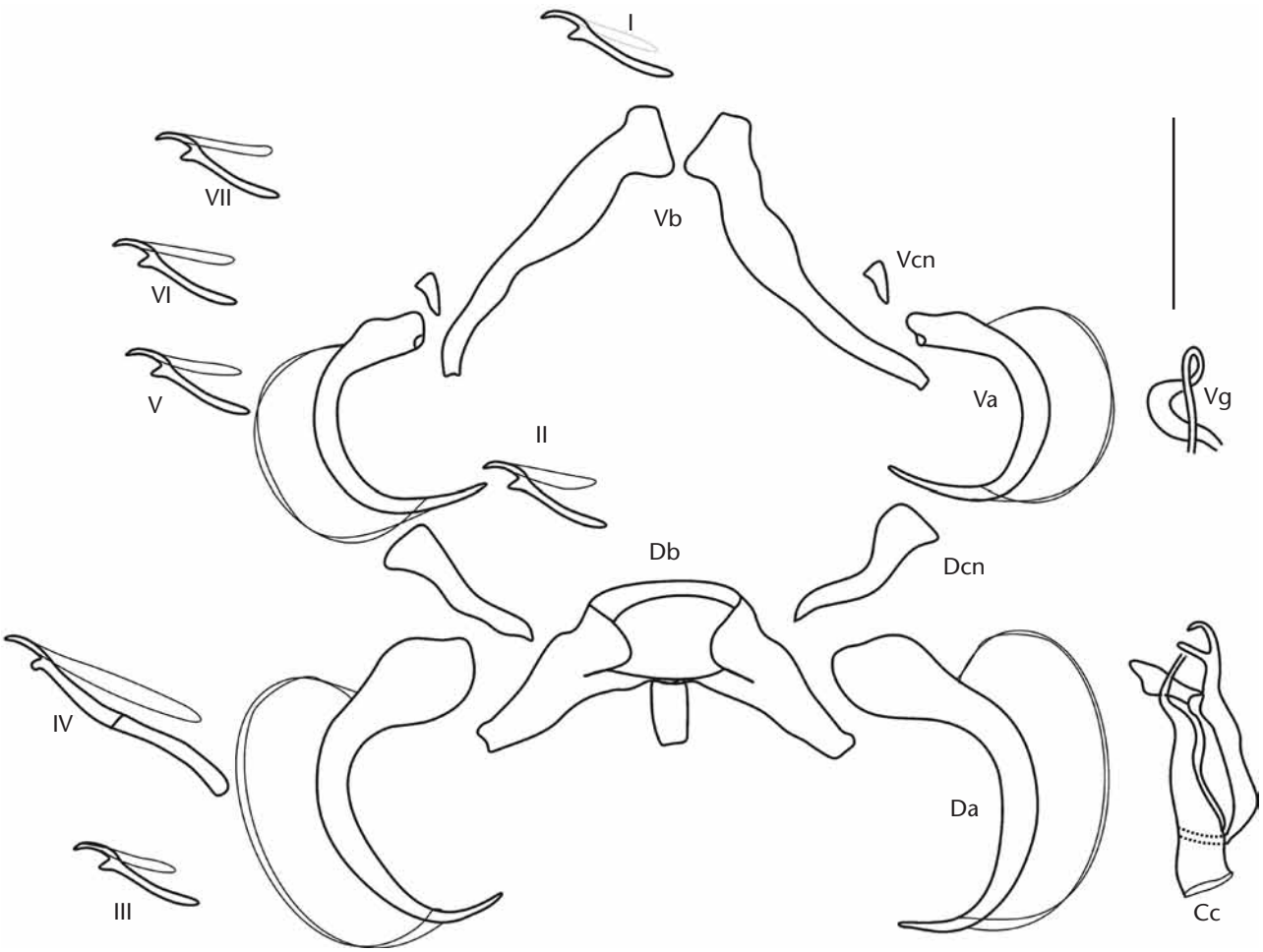

Figure 4. Sclerotized parts of *Quadriacanthus ossaensis* **sp. nov.**: (Cc) copulatory complex, (Da) dorsal anchor, (Db) dorsal bar, (Dcn) dorsal cuneus, (H) hooklets, (Va) ventral anchor, (Vb) ventral bar, (Vcn) ventral cuneus, (Vg) vagina. Scale bar: 20 µm.

guished from *Q. ayameensis* species by having one tip of the distal end of the accessory piece shaped as a fork, by the size of the dorsal cuneus (patch) (i = 2.5-7 vs 7-10, j = 13.8-18 vs 8-11), the trapezoid shape of the central sclerite of the dorsal bar, and the shape (thin and twisted) of the branches of the ventral bars.

Quadriacanthus submarginati Bahanak, Nack & Pariselle **sp. nov.**

Fig. 5

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Description (based on 22 specimens, all mounted in GAP): adults measure 399.6 (250.6-572.3) length, 63.8 (11.6-113.6) wide at level of ovary. Pharynx circular is 21.7 (20.2-21.6) wide. Penis wide-opened at basal extremity, tapering, bent and forked at the distal extremity, Pe = 29.7 (25.8-31.6). Accessory piece tubular, slightly curved, with a complex structure made up of one long tip flanked by a short tip and by a bulb, Ap = 21.8 (19.2-25.8). Tubular curved vagina, slim and slightly sclerotized at basal zone, and connected to a large seminal receptacle which opens near vaginal pore, Vg = 26.9 (25.3-32.1). Hooklets pair I = 13.7 (12.7-14.7), II = 14 (12.9-14.7), III = 14.3 (12.5-15.7), IV = 21.1 (19.7-24.3), V = 13.6 (12.3-14.8), VI = 14.1(12.5-15.1), VII = 14.1 (11.7-15.7). Dorsal bar with a rectangular centre, Ct = 19.1 (16.7-23.3), w = 8.5 (6-11.5) wide, a median posteriorly directed triangular process, h = 5.3 (4-6.5), and two lateral expansions, x = 29.2 (26.4-32.9), dorsal anchor lacking shaft, but with reduced guard, curved blade at distal region and mean point, a = 32.7 (30-34.7), ba = 9.1 (7.7-10), e = 8.4 (6.1-9.7), triangular and slightly curved dorsal cuneus (or patch), i = 3.5 (2.1-3.1), j = 6.3 (5.1-7.1), ventral bar made up of two branches medially articulated, x = 43 (37.9-47.7), w = 5.5 (3.5-7.6), ventral anchor without shaft, but with reduced guard, curved blade, and with long point, a = 24.7 (22.8-26.9), ba = 5.8 (5.1-6.3), e = 10.8

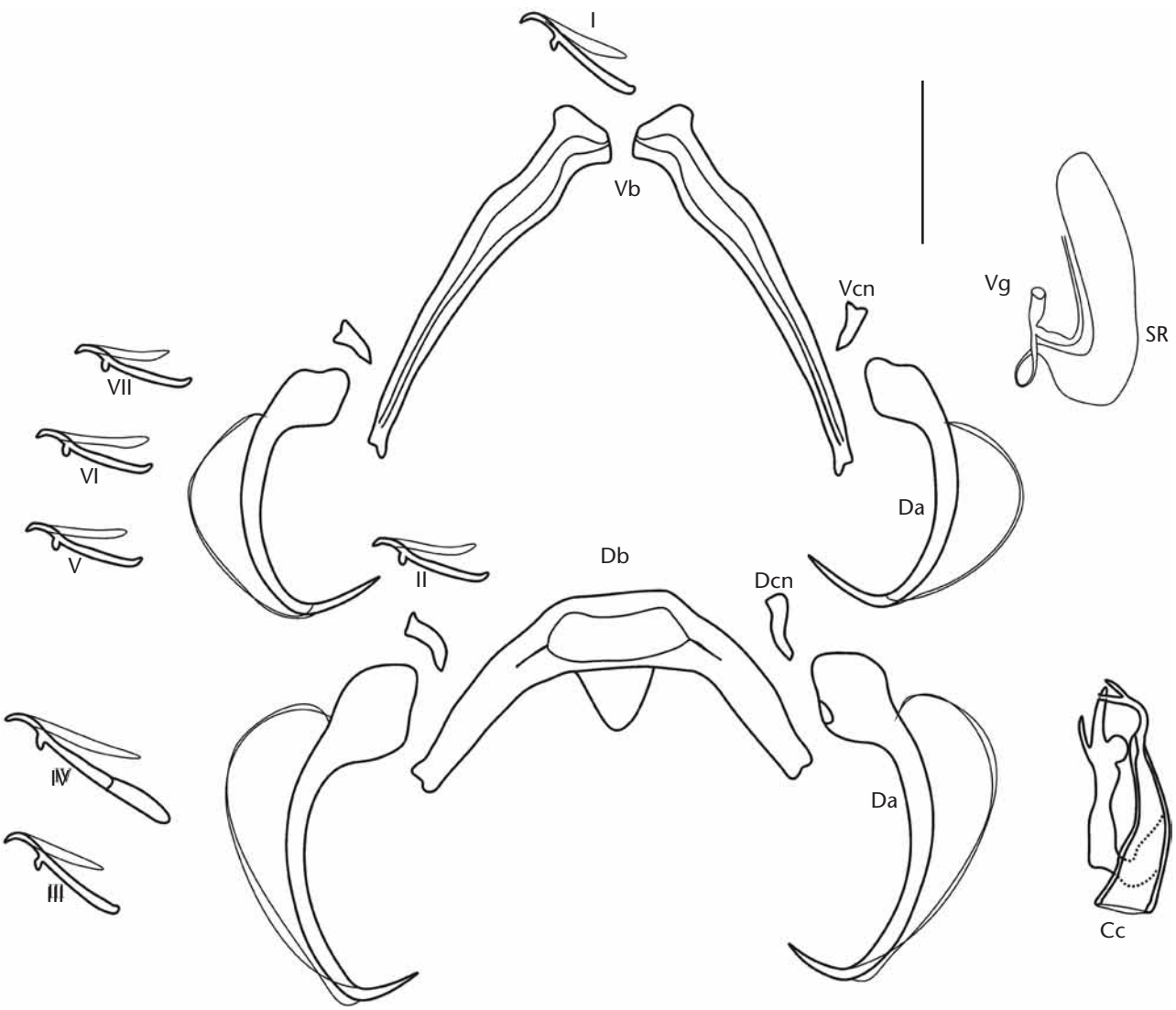

Figure 5. Sclerotized parts of *Quadriacanthus submarginati* **sp. nov.**: (Cc) copulatory complex, (Da) dorsal anchor, (Db) dorsal bar, (Dcn) dorsal cuneus, (H) hooklets, (Va) ventral anchor, (Vb) ventral bar, (Vcn) ventral cuneus, (Vg) vagina, (SR) seminal receptacle. Scale bar: 20 µm.

(8-11.7), ventral cuneus (or patch) smaller than dorsal one, i = 1.7(1.2-2), j = 3.8 (4.6-4.9).

Type host. *Clarias submarginatus* Peter, 1882.

Site. Gills.

Type locality. Lake Ossa, Cameroon (3°45'-3°51'N, 9°58'-10°03'E).

Type specimens. Holotype deposited at the Royal Museum for Central Africa (Tervuren): #37937. Paratype deposited at the Royal Museum for Central Africa (Tervuren): #37938.

Materials studied. 43 host individuals and 22 monogeneans.

Parasitic indices. Prevalence = 45.5%, mean abundance = 2.8 ± 3.8.

Etymology. The specific name, *submarginati* refers to specific name of the host.

Remarks. This species is close to *Q. macruncus* **sp. nov.** in the morphology of the dorsal and ventral bars, dorsal and ventral anchors; it differs from it in the morphology of the copulatory complex and the size of the point of its dorsal (e = 6.1-9.7 vs 1.9-3.1) and ventral (e = 8-11.7 vs 3.2-4.3) anchors.

DISCUSSION

This is the first record of *C. submarginatus* in the Sanaga basin, precisely at Lake Ossa. Up to now, this fish species was recorded in the rivers Kienké (at Kribi), Lobé (misspelled Lobi)

and Ntem (in Cameroon), Komo and Ogôoué (in Gabon) (Stiassny et al. 2007).

In Cameroon, only two studies by Birgi (1988) and Nack et al. (2015) have been conducted on *Quadriacanthus* species. They resulted in the description of five species: *Quadriacanthus levequei* from *Clarias pachynema* Boulenger, 1903; *Quadriacanthus dageti* Birgi, 1988 from *C. jaensis* Boulenger, 1909, and *Quadriacanthus nyongensis* Birgi, 1988 and *Quadriacanthus teugelsi* Birgi, 1988 from *C. pachynema* and *C. jaensis* (Nyong basin); and *Q. euzeti* from *Papyrocranus afer* Günther, 1868 (Notopteridae) in Lake Ossa (Sanaga basin). Monogenean parasites are known for their narrow host specificity (Euzet & Combes 1980, Noble et al. 1989); even so lateral transfers have happened numerous times in lakes, most likely promoted by ecological and ethological changes (Combes 1990, Norton & Carpenter 1998). For example in Lake Ossa where *Quadriacanthus euzeti* was recently described on a host belonging to Osteoglossiformes (see above), when *Quadriacanthus* spp. are specific of *Clarias*, *Heterobranchus* and *Bagrus* fishes (Nack et al. 2015); the same is true for *Scutogyrus vanhovei* Pariselle, Bitja Nyom & Bilong Bilong, 2013 described on *Tilapia mariae* in the same lake, while *Scutogyrus* spp. were only known from *Sarotherodon* and *Oreochromis* hosts species (Pariselle et al. 2013).

In this context of variable specificity according to ecological conditions, it would be interesting to determine the range of the host spectrum of *Quadriacanthus* species from *Clarias pachynema*, *C. jaensis*, *P. afer* and the newly studied *C. submarginatus* in the Lake Ossa system, where these fish are sympatric (Stiassny et al. 2007).

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