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# Description of Afrogyrodactylus ardae sp. n. (Monogenea: Gyrodactylidae) from Rhabdalestes septentrionalis (Characiformes: Alestidae) in the Niokolo-Koba National Park, Senegal

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Article info	Summary
Received May 2, 2017 Accepted August 8, 2017	The monogenean, <i>Afrogyrodactylus ardae</i> sp. n., is described from the African tetra, <i>Rhadbalestes septentrionalis</i> (Characiformes: Alestidae), collected from the Niokolo Koba and Gambie Rivers in the Niokolo-Koba National Park, Senegal during 2008. The newly described species can be differentiated from three known species of the genus based on the dimensions of its opisthaptoral hard parts, having the smallest ones, and based on the shape of the marginal hooks sickle. The present finding represents a new host record for the genus <i>Afrogyrodactylus</i> . <b>Keywords:</b> new species; <i>Afrogyrodactylus</i> ; Gyrodactylidae; morphology; Senegal

## Introduction

Currently, 32 valid genera belong to Gyrodactylidae Cobbold, 1864 of which 25 are viviparous and the remaining seven oviparous (Přikrylová et al., 2017). To date, species belonging to six genera have been described solely from African hosts. The first African genus of Gyrodactylidae was Macrogyrodactylus Malmberg, 1957 which was identified on gray bichir, Polypterus senegalus Cuvier imported to Europe from the Gambia (Malmberg, 1957). Shortly thereafter, a member of the genus Gyrdicotylus Vercammen-Grandjean, 1960 was reported from a non-fish host, the African clawed toad Xenopus laevis Daudin (Vercammen-Grandjean, 1960); and in the late sixties, a species of the genus Afrogyrodactylus Paperna, 1968 was identified from the alestid fish Micralestes sp. (Paperna, 1968). Thirty-five years later, Mormyrogyrodactylus Luus-Powell, Mashego et Khalil, 2003 was described from Marcusenius macrolepidotus (Peters) (Luus-Powell et al., 2003). Most recently species of the genus Diplogyrodactylus Přikrylová, Matějusová, Musilová, Gelnar et Harris, 2009 were described from P. senegalus and Citharodactylus Přikrylová, Shinn et Paladini, 2017 from *Citharinus citharus* (Geoffroy Saint-Hilaire) (Přikrylová *et al.*, 2009, 2017). The most speciose genus of Gyrodactylidae parasitising African fishes is the cosmopolitan *Gyrodactylus* von Nordmann, 1832, currently with 36 species described from this continent (Zahradníčková *et al.*, 2016, Přikrylová *et al.*, 2017).

The first species of the genus *Afrogyrodactylus*, *Afrogyrodactylus characinis* Paperna, 1968, was described from Lake Volta (Paperna, 1968), however a decade later, this genus was synonymised with *Gyrodactylus* (see Paperna, 1979). Recently, the genus *Afrogyrodactylus* was revised and brought out of synonymy (Přikrylová & Luus-Powell, 2014), confirming the suggestions of Bakke *et al.* (2007) that the genus is valid based on its distinctive morphological features. Moreover, the first molecular data on *Afrogyrodactylus* irrefutably confirmed the validity of the genus (Přikrylová *et al.*, 2013). Currently, there are three valid species of *Afrogyrodactylus*, but potentially there might be more undescribed species as was shown by Přikrylová & Luus-Powell (2014).

The present study describes a new species of the genus *Afrogyrodactylus* from *Rhabdalestes septentrionalis* (Boulenger) collected in Senegal based on a detailed morphometric study.

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#### **Material and Methods**

During March 2008, 20 specimens of the African tetra, Rhabdalestes septentrionalis, with a mean total length of 53.3  $\pm$  3.75 (47 - 62 mm) were collected from three localities within Niokolo-Koba National Park, Segenal, using a seine net and fishing rods. Localities were as follows: Niokolo Koba River, Passage Koba (13°03.928' N, 13°10.144' W; n = 2), Niokolo Koba River, Pont Suspendu (13°01.522' N, 13°13.220' W; n = 9), Gambie River, Simenti (13°01.395' N, 13°17.350' W; n = 9). Parasites were collected from the fins of host fishes using dissection needles. Specimens were fixed in ammonium picrate glycerine (APG) (Malmberg, 1970) and mounted on slides for subsequent morphological analysis. Morphological analysis of the collected parasite specimens was performed using a phase-contrast microscope (Olympus BX51) at the Laboratory of Parasitology, Department of Botany and Zoology, Faculty of Science, Masarvk University, Brno, Czech Republic, Metrical characteristics were obtained using a digital image analysis system (Motion Stream version 1.9, Olympus, Tokyo, Japan). Measurements of hamuli were taken for each specimen according to Přikrylová & Luus-Powell (2014). Parameters such as measurements of bars, size of the body, and marginal hooks, were taken following Christison et al. (2005). All measurements are in micrometres (µm) and are presented as a range with the mean and number of specimens studied in parentheses. Hard parts were drawn with the aid of a drawing attachment. The drawings were digitised and arranged using Adobe Illustrator CS6 version 13.0. Prior to depositing the specimens into

museums, the specimens in APG were transferred into Canada balsam following the procedure proposed by Ergens (1969).

#### Results

## Afrogyrodactylus ardae sp. n. (Fig. 1, Table 1)

Description (based on five coverslip-flattened specimens): Total body length 569 - 725 (652, n = 5); maximum body width at level of uterus 65 – 109 (91, n = 5). Pharyngeal bulb 32 – 52 (45, n = 5) long, 36 - 41 (38, n = 5) wide across anterior bulb. Excretory bladders present. MCO not observed. Ventral bar simple, membrane and lateral processes absent. Dorsal bar simple, connecting hamuli at base of outer roots. Measurements of opisthaptoral hard parts are given in Table 1. Hamuli of slender appearance marked by constriction between shaft and point; prominent outer and inner roots. Narrow outer roots maximum half of length of inner roots (Figs. 1A, 2E). Sickle proper with flat underside: upperside flat in proximal one third and afterward declines downward into roundish toe. Slightly forward projecting stout shaft region with very short sickle point that projects forward and terminates above point where upperside starts to decline. Foot with rounded heel, mildly heading downward. Heel merges smoothly with sickle shaft.

Type host: *Rhabdalestes septentrionalis* (Characiformes: Alestidae) Site of infection: Fins.

Type locality: Pont Suspendu, Niokolo Koba River Senegal, March 2008.



Fig. 1. Opisthaptoral hard parts of Afrogyrodactylus ardae sp. n.; A - hamuli and bars, B - marginal hooks.

IVIEASULETTIETTIS	A. aruae sp. n.	A. Criaracinis	A. yıryırae	A. KIIIGI	Airogyrouaciyius sp.
	(n = 5)	(n = 7)	(n = 16)	(n = 13)	(n = 2)
	Present study	Paperna (1968)	Přikrylová and	Přikrylová and	Přikrylová and
			Luus-Powell (2014)	Luus-Powell (2014)	Luus-Powell (2014)
Hamulus total length	23.6 – 26.6 (25.6)	55 – 70	33.3 – 36.2 (34.8)	27.2 – 31.3 (29.1)	28.1 – 31.6
Hamulus point length	9.4 – 10.1 (9.8)	I	13.1 – 15.1 (14.1)	9.9 – 12.4 (11.2)	13.2 – 13.6
Hamulus shaft length	20.7 – 22.4 (21.2)	I	26.8 – 31.3 (28.7)	23.0 – 26.9 (24.0)	25.9 – 26.1
Hamulus outer root length	3.6 – 4.6 (4.2)	5 – 10	4.3 – 6.6 (5.4)	5.5 – 5.9 (5.0)	4.2 – 4.4
Hamulus inner root length	8.0 – 9.1 (8.4)	8 – 11	10.2 – 13.6 (12.3)	7.4 – 10.4 (8.8)	9.5 – 10.2
Ventral bar width	8.7 – 10.5 (9.5)	10 – 12	10.2 – 15.0 (12.8)	10.0 – 11.5 (10.8)	11.9
Ventral bar length	3.4 – 5.0 (4.2)	I	4.5 – 6.0 (5.3)	4.3 – 6.2 (5.3)	4.2
Dorsal bar width	7.0 – 7.6 (7.2)	10 – 12	10.4 – 10.8 (10.6)	8.4 – 9.9 (9.1)	I
Dorsal bar length	1.0 – 1.4 (1.2)	I	1.0 – 1.2 (1.1)	1.0 – 1.2 (1.1)	I
Marginal hook total length	17.4 – 17.7 (17.5)	20 – 30	19.0 – 21.9 (20.9)	18.4 – 20.0 (19.1)	18.7
Marginal hook sickle length	3.0 – 3.2 (3.1)	5 – 7	3.2 – 3.7 (3.5)	3.2 – 3.6 (3.4)	3.1
Marginal hook handle length	14.2 – 14.8 (14.6)	I	15.4 – 18.3 (17.4)	15.1 – 16.4 (15.4)	15.7
Marginal hook proximal width	2.8 – 3.0 (2.9)	I	2.8 – 3.7 (3.3)	2.9 – 3.4 (3.1)	3.3
Marginal hook distal width	1.9 – 2.4 (2.2)	I	2.4 – 2.9 (2.6)	2.2 – 2.9(2.5)	2.3
Marginal hook aperture distance	2.4 – 2.9 (2.6)	I	2.7 – 3.2 (2.9)	2.6 – 3.0 (2.8)	2.6



Fig. 2. Comparison of the opisthaptoral hard parts of *Afrogyrodactylus* spp. A-D – marginal hook sickles, E-H – hamuli. *Afrogyrodactylus ardae* sp. n. (A, E), A. girgifae (B, F), A. kingi (C, G), *Afrogyrodactylus* sp. (D, H). Drawings B-D and F-H modified from Přikrylová & Luus-Powell, 2014.

Type specimens: Holotype and one paratype slide with two specimens deposited in the Institute of Parasitology, Biology Centre of the Academy of Sciences of the Czech Republic in České Budějovice, Czech Republic (IPCAS; Coll. No. M-665), one slide with two paratype specimens, the Natural History Museum London, UK (NHMUK 2017.7.21.10-11)

Prevalence of infection: Niokolo Koba River, Passage Koba 0/2 hosts; Niokolo Koba River, Pont Suspendu 2/9 (22%); Gambie River, Simenti 0/9.

Etymology: The specific name honours Arda, a close friend of the last author.

Sequenced data: No molecular data obtained.

**Remarks.** The presence of one pair of hamuli with well developed outer and inner roots together with the 16 marginal hooks of the same type which are distributed symetrically along the edge of the opisthaptor define the newly found parasites as members of the genus *Afrogyrodactylus*. Based on the dimension of the opisthaptoral hard parts, *A. ardae* sp. n. is the species with the smallest structures on the opisthaptor of all known *Afrogyrodactylus* spp. (see Table 1). In the shape of the hamuli, *A. ardae* sp. n. resem-

bles Afrogyrodactylus kingi Přikrylová et Luus-Powell, 2014, by its slender character (Figs. 2E,G), but the hamuli of A. ardae sp. n. do not broaden at the junction of the inner and outer roots as they do in A. kingi. Moreover, these two species can be distinguished based on the shape of the marginal hook sickles. Afrogyrodactylus kingi has a stouter shaft proper with a longer point projecting downward and ending above the edge of the toe, but the shaft proper of A. ardae sp. n. has a short point which projects forward and ends only above rear half length of the toe. The new species can be differentiated from Afrogyrodactylus girgifae Přikrylová et Luus-Powell, 2014 based on the smaller dimension of the hamuli (hamulus total length 23.6 - 26.6 vs 33.3 - 36.2 and hamulus point length 9.4 - 10.1 vs 13.1 - 15.1). Compared to the Afrogyrodactylus sp. (undescribed species found in the same geographical area), A. ardae sp. n. differs in the overall appearance of the hamuli and their dimensions (see Figs. 2E, H, Table 1). Hamuli of Afrogyrodactylus sp. are more robust in the shaft and roots parts while those of A. ardae sp. n. are slender and smaller than those of Afrogyrodactylus sp. (hamulus shaft length 20.7 - 22.4 vs 25.9 - 26.1, hamulus point length 9.4 - 10.1 vs 13.2 - 13.6). Moreover, A. ardae sp. n. differs from Afrogyrodactylus sp. by the shape of the marginal hooks (Figs. 2A, D). The base of the marginal hook sickle of *Afrogyrodactylus* sp. has a bigger body with a sturdy sickle proper which curves immediately after rising from the base and the point projects distinctively downwards. The sickle proper of *A. ardae* sp. n. rises from the base, slightly forward, and turns only in its end part into a short point that heads forward.

## Discussion

The description of *A. ardae* sp. n. brings the total number of known species of *Afrogyrodactylus* to four and this parasite genus is now recorded from alestid hosts of three genera. According to Přikrylová & Luus-Powell (2014), there is evidence that species richness of this genus might be much higher then presently known. This can be seen by the undescribed species from *Brycinus imberi* (Peters) collected in the same sampling area as the present study. Moreover, the Alestidae contains a diverse group of fishes exclusive to Africa, consisting of 18 genera and 119 species (Neslon, 2006) that represent many potential hosts for these parasites. It is possible that due to the small size of some alestid species together with the low prevalence of *Afrogyrodactylus* spp. (Přikrylová & Luus-Powell, 2014, present study) that these small parasites might be overlooked during parasitological surveys, in comparison to some of the larger more prevalent gyrodactylid genera.

Traditionally the taxomony of gyrodactlid parasites has been based on the morphometry of the hard parts of the opisthaptor (Malmberg, 1970; Ergens, 1973). With the implementation of molecular methods in the differentiation of Gyrodactylus species (Cunningham et al., 1995), the application of molecular methods became an important part of taxonomic studies (García-Vásquez et al., 2011; Vanhove et al., 2011; Přikrylová et al., 2012; Zahradníčková et al., 2016). These methods have also been applied to various genera of Gyrodactylidae, inlcuding Afrogyrodactylus (Přikrylová et al., 2013). However, even with the best intentions of obtaining molecular data, sequencing of monogenean DNA remains challenging and can be unsuccessful (García-Vásquez et al., 2011) and, therefore, proper, detailed morphometric descriptions alone are still acceptable for the designation of new species (Vanhove et al., 2014). The comparative features of the three known species of Afrogyrodactylus (Figs. 1,2, Table 1) support designating A. ardae sp. n. as a distinct species. We hope to obtain molecular data in the future.

There is currently a paucity of data on parasites from the African fish families closely related to Alestidae. For example, the Distichontidae which includes 101 species in 17 genera, have no published record of infection by monogeneans. The Hepsedidae, with five species in one genus, have been found to host only three monogenean species (Ndouba *et al.*, 1997) and fish of Citharinidae, currently consisting of eight species in three genera, are known to be parasitized by three monogenean species (Musilová *et al.*, 2011; Přikrylová *et al.*, 2017). This clearly shows that the lack of the knowledge on parasite fauna on certain host groups can be very high. The description of *A. ardae* sp. n. from *R. septentrionalis* increases the host range for the representatives of genus *Afrogyrodactylus* to three genera, as the currently known *Afrogyrodactylus* spp. have only been found on the genera *Micralestes* Boulenger and *Brycinus* Valenciennes (Paperna, 1968; Přikrylová & Luus-Powell, 2014). Therefore, based on the present knowledge of described *Afrogyrodactylus* species, it might be possible to conclude that these viviparous gyrodactylid parasites seem to parasitise only the African tetras (Alestidae). However more extensive surveys of the ectoparasite fauna of alestids and other closely related fishes of Africa are needed to confirm host specificity of the genus *Afrogyrodactylus*.

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