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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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Summary

The monogenean, *Afrogyrodactylus ardae* sp. n., is described from the African tetra, *Rhadbalestes septentrionalis* (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 *Afrogyrodactylus.*
Keywords: new species; *Afrogyrodactylus*; 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 ± 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, Masaryk 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.

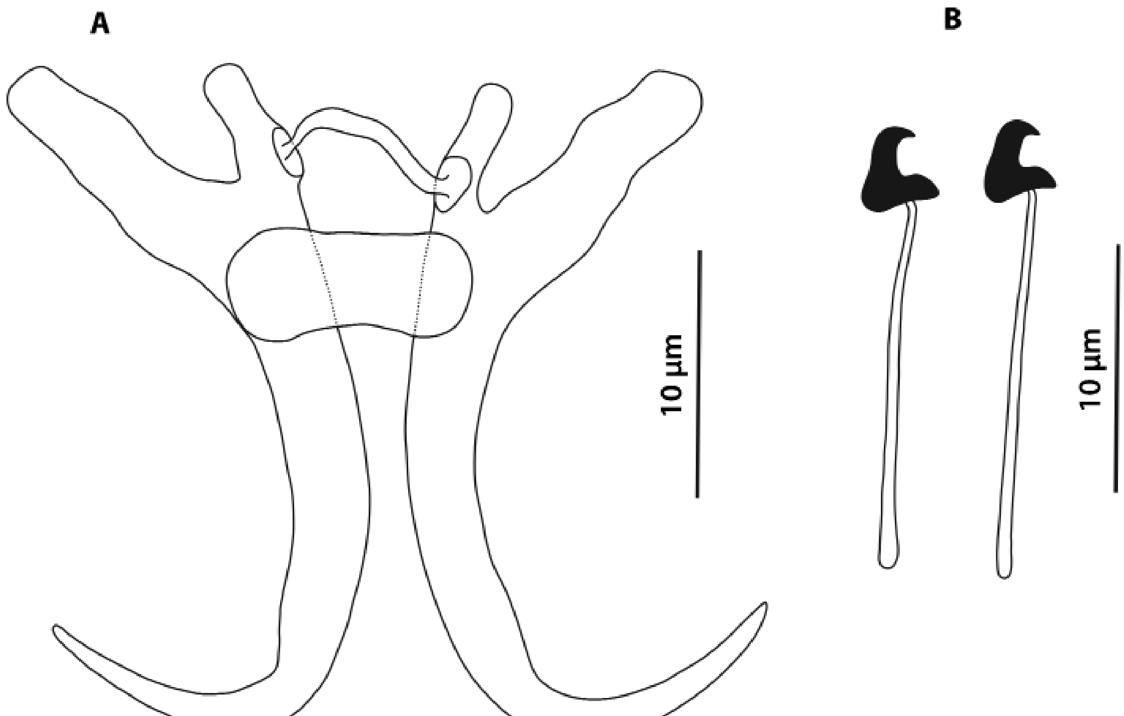

Fig. 1. Opisthaptoral hard parts of *Afrogyrodactylus ardae* sp. n.; A – hamuli and bars, B – marginal hooks.

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Table 1. Comparative metrical data for opisthaptoral hard parts of all Afrogyrodactylus species.

Measurements	*A. ardae* sp. n. (n = 5) Present study	*A. characinis* (n = 7) Paperna (1968)	*A. girgifae* (n = 16) Přikrylová and Luus-Powell (2014)	*A. kingi* (n = 13) Přikrylová and Luus-Powell (2014)	*Afrogyrodactylus* sp. (n = 2) Přikrylová and 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)	–	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)	–	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)	–	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)	–
Dorsal bar length	1.0 – 1.4 (1.2)	–	1.0 – 1.2 (1.1)	1.0 – 1.2 (1.1)	–
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)	–	15.4 – 18.3 (17.4)	15.1 – 16.4 (15.4)	15.7
Marginal hook proximal width	2.8 – 3.0 (2.9)	–	2.8 – 3.7 (3.3)	2.9 – 3.4 (3.1)	3.3
Marginal hook distal width	1.9 – 2.4 (2.2)	–	2.4 – 2.9 (2.6)	2.2 – 2.9(2.5)	2.3
Marginal hook aperture distance	2.4 – 2.9 (2.6)	–	2.7 – 3.2 (2.9)	2.6 – 3.0 (2.8)	2.6

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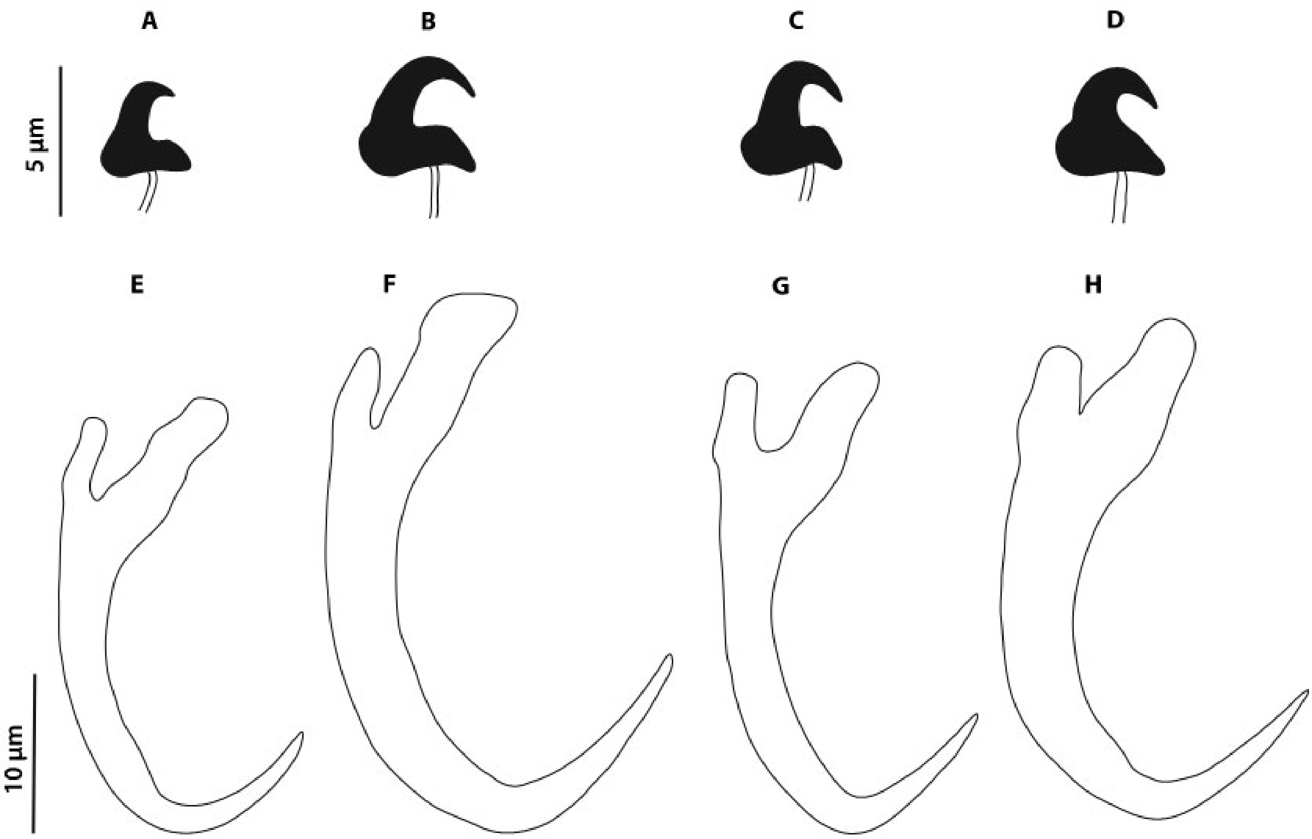

Fig. 2. Comparison of the opisthaptoral hard parts of *Afrogyrodactylus* spp. A-D – marginal hook sickles, E-H – hamuli. *Afrogyrodactylus ardae* sp. n. (A, E), *A. girgifae* (B, F), *A. kingi* (C, G), *Afrogyrodactylus* sp. (D, H). Drawings B-D and F-H modified from Přikrylová & Luus-Powell, 2014.

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. resembles *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

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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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References

Bakke, T.A., Cable, J., Harris, P.D. (2007): The biology of gyrodactylid monogeneans: the "Russian-doll killers." *Adv. Parasit*., 64: 161 – 276. DOI: 10.1016/S0065-308X(06)64003-7

Christinson K.W., Shinn, A.P., Van As, J.G. (2005): *Gyrodactylus thlapi* sp. n. (Monogenea) from *Pseudocrenilabrus philander philander* (Weber) (Cichlidae) in the Okawango Delta, Botswana. *Syst. Parasitol*., 60: 165 – 173

Cunningham, C.O., Mcgillivray, D.M., Mackenzie, K. (1995): Identification of *Gyrodactylus* (Monogenea) species parasitising salmonid fish using DNA probes. *J. Fish. Dis.,* 18: 539 – 554

Ergens, R. (1969): The suitability of ammonium picrate-glycerine in preparing slides of lower Monogenoidea. *Folia Parasitol.,* 16: 320

Ergens, R. (1973): Two new species of *Gyrodactylus* from *Clarias lazera*. *Rev. Zool. Bot. Afr.*, 87: 77 – 80

García-Vásquez, A., Hansen, H., Christison, K.W., Bron, J.E., Shinn, A.P. (2011):Description of three new species of *Gyrodactylus* von Nordmann, 1832 (Monogenea) parasitising *Oreochromis niloticus niloticus* (L.) and *O. mossambicus* (Peters) (Cichlidae). *Acta Parasitol*., 52: 20 – 33. DOI: 10.2478/s11686-011-0005-2

Luus-Powell, W.J., Mashego, S.N., Khalil, L.F. (2003): *Mormyrogyrodactylus gemini* gen. et sp. n. (Monogenea: Gyrodactylidae), a new gyrodactylid from *Marcusenius macrolepidotus* (Mormyridae) from South Africa. *Folia Parasitol*., 50: 49 – 55

Malmberg, G. (1957): [On the occurrence of *Gyrodactylus* on Swedish fishes.] *Skrifterutgivna av Sodra Sveriges Fiskeriforening*, (1956): 19 – 76 pp. (In *Swedish, with description of species and a summary in English*)

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Malmberg, G. (1970): The excretory systems and marginal hooks as basis for the systematics of *Gyrodactylus* (Trematoda, Monogenea). *Ark. Zool*. 2: 1 – 235

Musilová, N., Řehulková, E., Gelnar, M. (2011): *Nanotrema niokolenisis* sp. nov. and a redescription of *N. citharini* Paperna, 1969 (Monogenea, Dactylogyridae) from the gills of *Citharinus citharus citharus* (Characiformes, Cihterinidae) from Senegal. *Acta Parasitol*., 56 (1): 14 – 19. DOI: 10.2478/s11686-011-0013-2

Ndouba, V., Pariselle, A., Euzet, L. (1997): New species of the genus *Anulotrema* Paperna and Thurston, 1969 (Monogenea, Ancyrocephalidae) parasitic on *Hepsetus odoe* (Bloch, 1794) (Teleosstei, Hepsedidae) in Ivory Coast. *Parasite*, 4 (1): 55 – 61

Nelson, J.S. (2006): Fishes of the World. 4th Edition. John Wiley and Sons, Inc., New York, 601 pp.

Paperna, I. (1968): Monogenetic trematodes collected from fresh-water fish in Ghana. *Bamidgeh*, 20: 88 – 99

Paperna, I. (1979): Monogenea of inland water fish in Africa. *Ann. Mus. Roy. Afr. Centr., Sci. Zool.*, Ser. 8, 226, 131 pp.

Přikrylová, I., Matějusová, I., Musilová, N., Gelnar, M., Harris, P.D. (2009): A new gyrodactylid (Monogenea) genus on gray bichir, *Polypterus senegalus* (Polypteridae) from Senegal (West Africa). *J. Parasitol*., 95: 555 – 560

Přikrylová, I., Blažek, R., Vanhove, M.P.M. (2012): An overview of the *Gyrodactylus* (Monogenea: Gyrodactylidae) species parasitizing African catfishes, and their morphological and molecular diversity. *Parasitol. Res.*, 110 (3): 1185 – 1200. DOI: 10.1007/s00436-011-2612-0

Přikrylová, I., Vanhove, M.P.M., Janssens, S.B., Billeter, P.A., Huyse, T. (2013): Tiny worms from a mighty continent: high diversity and new phylogenetic lineages. *Mol. Phylogenet. Evol*., 67: 43 – 52. DOI: 10.1016/j.ympev.2012.12.017

Přikrylová, I., Luus-Powell, W.J. (2014): Revision of the genus *Afrogyrodactylus* Paperna, 1968 (monogenea: Gyrodactylidae) with description of two new species from geographically distant localities. *Folia Parasitol*., 61 (6): 529 – 536. DOI: 10.14411/fp.2014.066

Přikrylová, I., Shinn, A.P., Paladini, G. (2017): Description of *Citharodactylus gagei* n. gen. et n. sp. (Monogenea: Gyrodactylidae) from the moon fish, *Citharinus citharus* (Geoffroy Saint-Hilaire), from Lake Turkana. *Parasitol. Res*., 116: 281 – 292. DOI 10.1007/s00436-016-5289-6

Vanhove, M.P.M., Snoeks, J., Volckaert, F.A.M., Huyse, T. (2011): First description of monogenean parasites in Lake Tanganyika: the cichlid *Simochromis diagramma* (Teleostei, Cichlidae) harbours a high diversity of *Gyrodactylus* species (Platyhelminthes, Monogenea). *Parasitology*, 138: 364 – 380. DOI:10.1017/S0031182010001356

Vanhove, M.P.M., Economou, A.N., Zogaris, S., Giakoumi, S., Zanell, D., Volckaert, P.A.M., Huyse, T. (2014): The *Gyrodactylus* (Monogenea, Gyrodactylidae) parasite fauna of freshwater sand gobies (Teleostei, Gobioidei) in their centre of endemism, with description of seven new species. *Parasitol. Res*., 113 (2): 653 – 668. DOI: 10.1007/s00436-013-3693-8

Vercammen Grandjean, P.H. (1960): Les trematodes du lac Kivu Sud (Vermes). *Ann. Mus. Roy. Afr. Centr. Scien. Zool*. 5: 1 – 171

Zahradníčková, P., Barson, M., Luus-Powell W.J., Přikrylová, I. (2016): Species of *Gyrodactylus* von Nordamnn, 1832 (Platyhelminthes: Monogenea) from cichlids from Zambezi and Limpopo River basins in Zimbabwe and South Africa: evidence for unexplored species richness. *Syst. Parasitol.*, 93 (7): 679 – 700. DOI 10.1007/s11230-016-9652-x

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