Cestode infections of two clariid and two claroteid catfish species in River Galma, Zaria, Nigeria

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Abstract
Four catfish (Siluriformes) species comprising two clariids, *Heterobranchus bidorsalis* (65) and *Heterobranchus longifilis* (15) and two claroteids, *Auchenoglanis occidentalis* (31) and *Chrysichthys auratus* (19) from River Galma Zaria, Nigeria were examined for gastrointestinal cestodes between May 2016 and February 2017. Helminths recovered were stained, dehydrated, cleared and mounted in Canada balsam for microscopic examination. A total of seven cestode species were recovered from the clariids and claroteids. The cestodes were distributed among the fish examined as follows: in *C. auratus*: *Wenyonia longicauda* (26.32%), *W. virilis* (10.53%), and *W. minuta* (5.26%); in *H. bidorsalis*: *W. acuminata* (3.08%), *W. virilis* (18.46%), *Monobothrioides woodlandi* (6.15%), *Proteocephalus* sp. (1.54%) and *Tetracampos ciliotheca* (4.62%); in *H. longifilis*: *M. woodlandi* (6.67%), *W. longicauda* (6.67%) and *W. acuminata* (6.67%). Prevalence of cestode infection in *C. auratus* was higher in the wet than in the dry season; however, prevalence of infection in *H. longifilis* and *H. bidorsalis* was higher in the dry than in the wet season. The prevalence was found to be higher in male than in female *H. longifilis* while it was higher in female than in male *C. auratus* and *H. bidorsalis*. Prevalence decreased with increase in standard length of *C. auratus*, *H. longifilis* and *H. bidorsalis*. A seemingly posteriorly deformed *W. minuta* was recovered from *C. auratus*. None of the 31 *A. occidentalis* examined in this study was infected by cestodes. All the fish used in this study were collected mostly on the basis of availability. It is therefore recommended that larger sample of assorted sizes be obtained, especially of *H. longifilis* (15) and *C. auratus* (19), of which very few specimens were examined during the period of this study to obtain a clearer picture of infection by the cestodes from River Galma, Zaria, Nigeria.

Keywords: Cestodes; catfish; clariid claroteid; siluriformes; infection; prevalence; intensity.

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Introduction

Cestodes are mostly strobilate parasitic flatworms found in a wide variety of animals including fish, where they infect the alimentary tract, muscles or other internal organs. The cestodes comprise many orders that are restricted to fish (Williams and Jones, 1994). The plerocercoid larval stage of cestodes is one of the most damaging parasites of freshwater fish. Plerocercoids decrease carcass value if present in the muscle, and impair reproduction when they infect gonadal tissue (Klinger and Floyd, 2002).

Cestodes have been recovered from siluroids in African freshwater, some of which include *Wenyonia* species (Akinsanya *et al* 2010; Morenikeji *et al* 2013), *Tetracampos ciliotheca* and *Proteocephalus* species (Madanire-Moyo and Avenant-Oldewage, 2013). There is no published information, known to the authors, on the cestodes that infect *Heterobranchus bidorsalis* Geoffroy Saint-Hilaire, 1809, *Heterobranchus longifilis* Valenciennes, 1840, *Auchenoglanis occidentalis* Valenciennes, 1840 and *Chrysichthys auratus* Geoffroy Saint-Hilaire, 1809 in River Galma. This study was carried out to provide information on the cestodes of the four fish species in River Galma, Zaria, Nigeria.

Materials and methods

Live clariids *(H. bidorsalis* and *H. longifilis)*, and claroteids *(A. occidentalis* and *C. auratus)* were purchased weekly between May 2016 and February 2017 from fishermen at fish landing points along River Galma (Longitude 7°42′30″E to 7°47′30″E and Latitude 11°03′20″N to 11°09′10″N), and identified using the descriptions provided by Froese and Pauly (2017). The specimens were euthanized by cervical dislocation and dissected. Cestodes were collected live from the gastrointestinal tract of fish into cavity blocks containing 0.09% physiological saline, fixed in hot water and preserved in 5% formalin. Whole-mounts were prepared by staining worms in dilute Ehrlich's acid haematoxylin overnight, then dehydrating in a graded series (30%, 50%, 70%, 90% and 100%) of ethanol for 40 minutes each, clearing in methyl salicylate then mounting in thinned Canada balsam. Measurements (µm) of the cestodes were taken using a calibrated ocular micrometre. Photomicrographs were taken using a Panasonic digital camera (DMC-FX77). Cestodes were identified by

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consulting Mackiewicz and Beverley-Burton (1967), Ukoli (1972), Scholz *et al* (2009, 2011) and Kuchta *et al* (2012). The prevalence of cestodes was calculated and expressed as a percentage (%) using the formula:

$$\frac{\text{Number of fish infected}}{\text{Number of fish examined}} \times 100$$

The mean intensity was calculated by using the formula:

$$\frac{\text{Number of cestodes}}{\text{Number of fish infected}}$$

Correlation analysis was used to determine the relationship between fish standard length and cestode prevalence.

Results

Six species of cestodes: *W.acuminata* Woodland, 1923 (Plate I), *W. longicauda* Woodland, 1937 (Plate II), *W. virilis* Woodland, 1923 (Plate III), *Proteocephalus* sp. Weinland, 1858 (Plate IV), *T. ciliotheca* Wehdl, 1861 (Plate V), and *M. woodlandi* Mackiewicz and Beverley-Burton, 1967 (Plate Vl) were recovered from clariids and three species: *W. longicauda* Woodland, 1937, *W. virilis* Woodland, 1923, and *W. minuta* Woodland 1923 (Plate VII) were recovered from the claroteids examined. An apparently posteriorly deformed specimen (Plate VIII) of Y. *minuta* with neither a postovarian region nor longitudinal excretory canal was recovered from *C. auratus*.

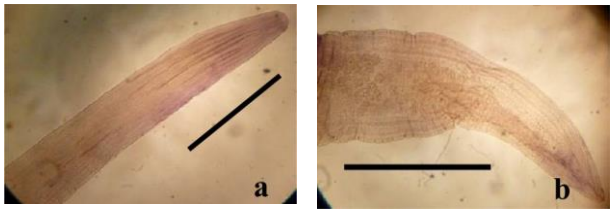


Plate I. *Wenyonia acuminata:* **a**. anterior portion; **b**. posterior portion. Scale bars: 1,500 µm; 250 µm.

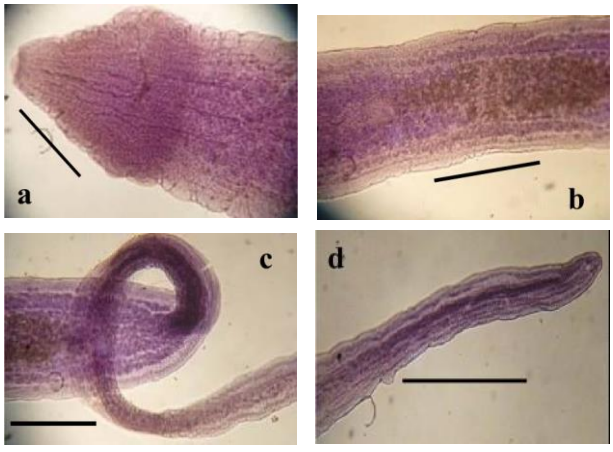


Plate II. *Wenyonia longicauda:* **a.** anterior portion; **b.** mid-portion; **c.** posterior portion; **d.** caudal portion. Scale bars: 150 µm; 150 µm; 100 µm; 50 µm.

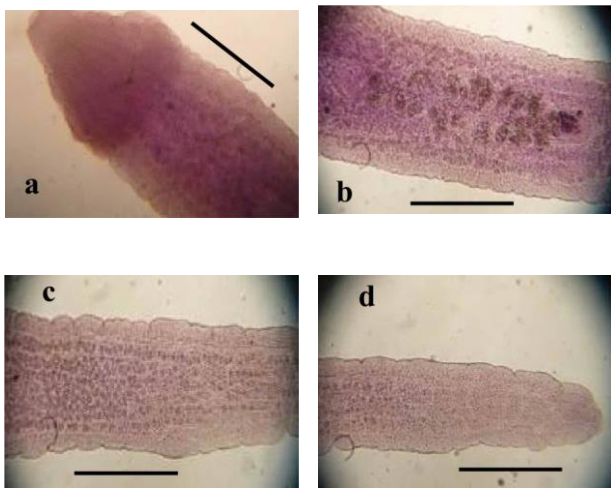


Plate III. *Wenyonia virilis:* **a**. anterior portion; **b**. mid-portion; **c**. posterior portion; **d**. extension of posterior portion. Scale bars: 100 µm;150 µm; 800 µm; 100 µm.

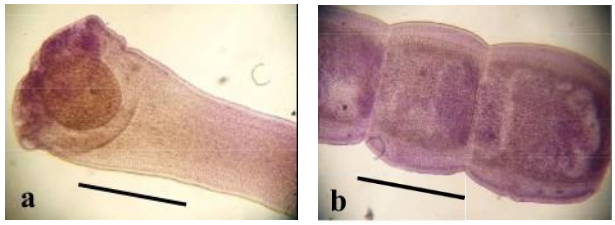


Plate IV. *Proteocephalus* sp.: **a**. anterior portion; **b**. gravid proglottids. Scale bars: 100 µm; 150 µm.

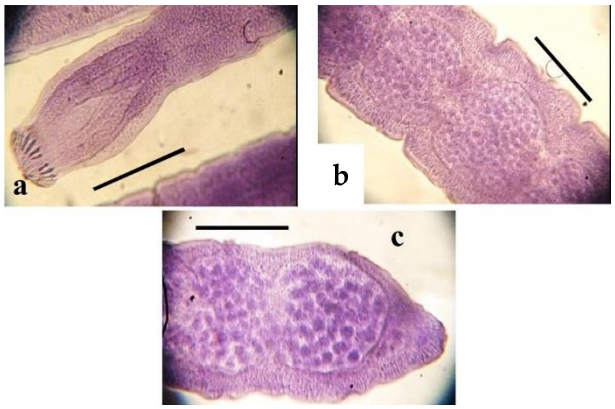


Plate V. *Tetracampos ciliotheca:* **a**. anterior portion; **b-c**. gravid proglottids. Scale bars: 150 µm; 250 µm.

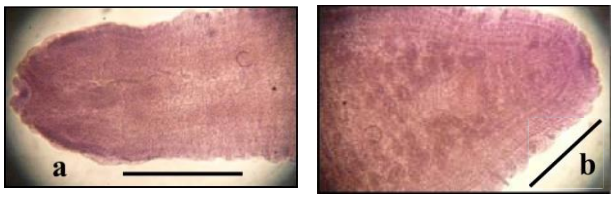


Plate VI. *Monobothrioides woodlandi:* **a**. anterior portion; **b**. posterior portion. Scale bars: 100 µm; 50 µm.

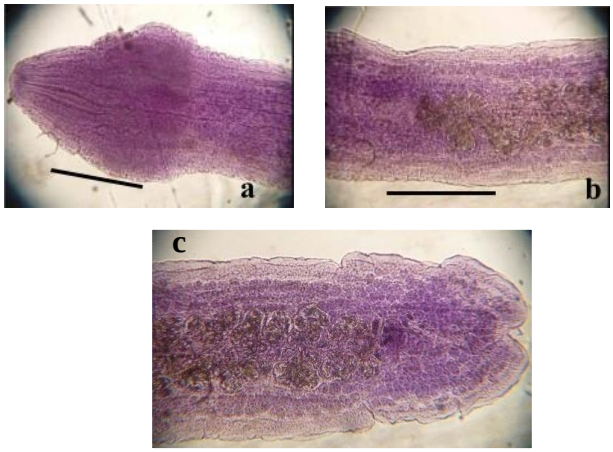


Plate VII. *Wenyonia minuta:* **a**. anterior portion; **b**. mid-portion; **c.** posterior portion. Scale bar: 150 µm.

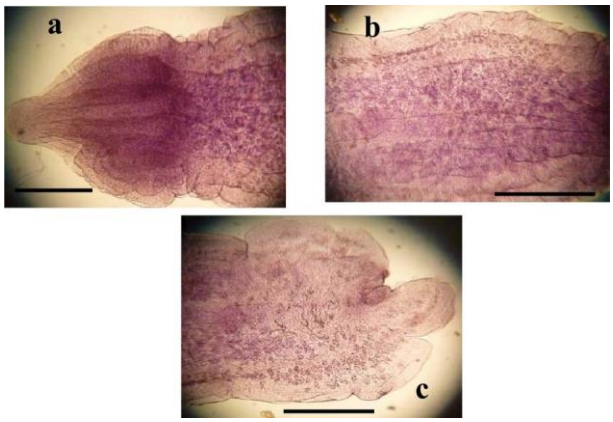


Plate VIII. Deformed *Wenyonia minuta* from *Chrysichthys auratus:* **a**. anterior portion; **b.** middle portion; **c.** posterior showing deformed portion. Scale bar: 250 µm.

Gastrointestinal cestode infection in relation to fish species

The summary of cestode infections of the examined fish species is presented in Table 1. *H. bidorsalis* had a greater assortment (5) of cestodes than all the catfishes examined. Among the clariids, *H. bidorsalis* had the highest prevalence of infection by *W. virilis*, and the lowest by *Proteocephalus* sp. The mean intensity was highest with *Proteocephalus* sp. and lowest in *W. acuminata*, both recovered from *H. bidorsalis.*

Among the claroteids, *C. auratus* had the highest prevalence of *W. longicauda* and the lowest of *W. minuta*, with the highest and lowest mean intensities of infection with both cestodes respectively. *Auchenoglanis occidentalis* had no cestode infection.

The highest overall prevalence of cestode infection among all four fish species was shown with *W. longicauda* in *C. auratus* while *H. bidorsalis* had the lowest overall prevalence of cestode infection with *Proteocephalus* sp. The difference in the prevalence of cestodes among the fish species was statistically significant ($p<0.05$) (Table 1).

Cestode prevalence in fish species in relation to the wet and dry seasons

Heterobranchus longifilis had a higher prevalence of *W. acuminata* infection in the dry than in the wet season, and *H. bidorsalis* showed the lowest prevalence of infection with *W. acuminata* and *Proteocephalus* sp. in the dry season. The prevalence of infection with *W. virilis* was highest and lowest in *H. bidorsalis* in the dry and wet seasons respectively. A higher prevalence of *W. longicauda* was recorded in *C. auratus* in the wet season while a lower prevalence of infection with the same cestode was observed in *H. longifilis* during the dry season. The highest prevalence of *M. woodlandi* infection was recorded in *H. bidorsalis* while the lowest prevalence was in *H. longifilis*, both in the dry season. Infection with *Proteocephalus* sp. and *T. ciliotheca* only occurred in *H. bidorsalis* and only in the dry season; no infection was recorded in the wet season (Table 2).

Gastrointestinal cestode infection in relation to sex of fish

Males of *H. bidorsalis* had similar prevalences of infection with all the cestodes recovered, while the females had high prevalence of *W. virilis* and low prevalence of *W. acuminata* and *Proteocephalus* sp.

Table 1: Cestode prevalence and intensity in fish species examined from River Galma, Zaria, Nigeria.

Fish species	Cestode species	Number of fish examined	Number of fish infected (%)	Number of cestodes recovered	Mean Intensity Standard Error
Heterobranchus bidorsalis	*W. acuminata*	65	2 (3.08)	5	2.5±0.24
	W. virilis	65	12 (18.46)	60	5±0.27
	M. woodlandi	65	4 (6.15)	24	6±0.63
	Proteocephalus sp.	65	1 (1.54)	10	l0±l 24
	T. ciliotheca	65	3 (4.62)	28	9.33±0.59
Heterobranchus longifilis	*W acuminata*	15	1 (6.67)	5	5±0.2
	W. longicauda	15	1 (6.67)	7	7±0.202
	M. woodlandi	15	I (6.67)	6	6±0.21
Chrysichthys auratus	*W. longicauda*	19	5 (26.32)	55	1l±0.l 1
	W. virilis	19	2 (10.53)	15	7.5±0.38
	W. minuta	19	1 (5.26)	3	3±0
Auchenoglanis occidentalis		31	0	0	0

Male *H. longifilis* had similar prevalences of *W. longicauda* and *M. woodlandi* while in the females, *W. acuminata* was the only cestode recovered. Male *C. auratus* had a higher prevalence of *W. longicauda* and a low prevalence of *W. virilis*. There was a high prevalence of *W. longicauda* in female *C. auratus* and similar low prevalences of *W. virilis* and *W. minuta*. No cestode was recovered from either sex of *Auchenoglanis occidentalis* in this study (Table 3).

Table 2: Seasonal variations in the prevalence and intensity of cestode infection in fish species from River Galma, Zaria, Nigeria.

		Seasons*				No. infected (%)	No. of Cestodes (MI)
		Wet			Dry		
Fish Species	Cestode Species	No. of fish examined	No. infected (%)	No. of Cestodes (MI)	No. of fish examined		
Heterobranchus bidorsalis	*W. acuminata*	32	1 (3.13)	2 (2)	33	1 (3.03)	3 (3)
	W. virilis	32	2 (6.25)	17 (8.5)	33	10 (30.30)	43 (4.3)
	M. woodlandi	32	l (3.13)	4 (4)	33	3 (9.09)	18 (6)
	Proteocephalus sp.	32	0	0	33	1 (3.03)	10 (10)
	T. ciliotheca	32	0	0	33	3 (9.09)	28 (9.33)
Heterobranchus longifilis	*W. acuminata*	3	0	0	12	1 (8.33)	5 (5)
	W. longicauda	3	0	0	12	1 (8.33)	7 (7)
	M. woodlandi	3	0	0	12	1 (8.33)	6 (6)
Chrysichthys auratus	*W. longicauda*	19	5 (26.32)	55 (11)	0	0	0
	W. virilis	19	2 (10.53)	15 (7.5)	0	0	0
	W. minuta	19	1 (6.67)	3 (3)	0	0	0
Auchenoglanis occidentalis		18	0	0	13	0	0

Key: No. — Number. MI— Mean Intensity.

Table 3: Prevalence and intensity of gastrointestinal cestode infection in relation to sex of fish species from River Galma, Zaria, Nigeria.

		Sex*				NI (%)	NC (MI)
		Male			Female		
Fish species	Cestode species	NE	NI (%)	NC (MI)		NE	
Heterobranchus bidorsalis	*W. acuminata*	25	1 (4.00)	1 (1)	40	1 (2.50)	4 (4)
	W. virilis	25	1 (4.00)	23 (23)	40	7 (17.5)	37 (5.29)
	M. woodlandi	25	1 (4.00)	11 (11)	40	2 (5.00)	13 (6.5)
	Proteocephalus sp.	25	0	0	40	l (2.50)	10 (10)
	T. ciliotheca	25	1 (4.00)	10 (10)	40	2 (5.00)	18 (9)
Heterobranchus longifilis	*W. acuminata*	7	0	0	8	1 (l 2.5)	5 (5)
	W. longicauda	7	1 (14.28)	7 (7)	8	0	0
	M. woodlandi	7	1 (14.28)	6 (6)	8	0	0
Chrysichthys auratus	*W. longicauda*	8	2 (25.00)	20 (10)	11	3 (27.27)	35 (11.67)
	W. virilis	8	1 (12.5)	6 (6)	11	1 (9.09)	9 (9)
	W. minuta	8	0	0	11	l (9.09)	3 (3)
Auchenoglanis occidentalis		13	0	0	18	0	0

Key: NE — Number examined. NI — Number infected. NC — Number of cestodes. MI — Mean intensity.

Gastrointestinal cestode infection of catfish species in relation to size (Standard length)

Infection by cestodes on the gastrointestinal tract of fish according to standard length is shown in Figure 1. *C. auratus* had the highest prevalence of cestode infection in the length range 16.0-23.9 cm, while *H. bidorsalis* had its highest cestode prevalence in the length range 24.0-31.9 cm and similar prevalences within the length ranges 8.0-15.9 cm and 16.0-23.9 cm. All *H. longifilis* examined were within the length range of 16.0-23.9 cm. No infection by cestodes was recorded in *A. occidentalis* in all the length ranges examined. A negative correlation was observed in *C. auratus* (-0.365) and *H. bidorsalis* (-0.043) indicating an increase in cestode infection with decrease in standard length of fish.

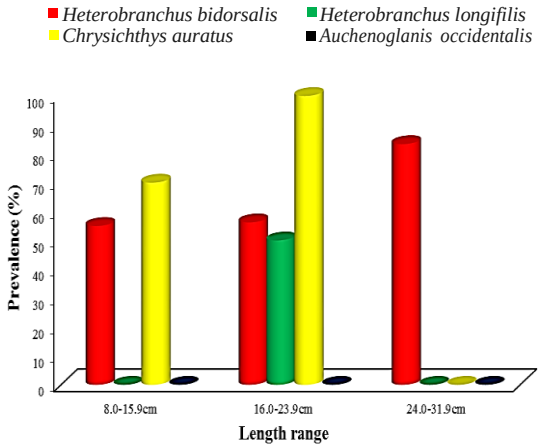


Figure 1. Cestode prevalence in relation to size of catfish species from River Galma, Zaria.

Discussion

The recovery of diverse cestode species from catfishes in this study suggests that there may be large populations of copepods, which are the major intermediate hosts of these cestodes, in and around River Galma. In addition, given the fact that the catfishes examined, especially *H. bidorsalis* and *H. longifilis* are predatory, it is possible that they could have consumed other fish (secondary intermediate hosts of the cestodes) (Paperna, 1980; Scholz, 1999). Predatory fishes have been reported to show greater species richness in terms of helminth infection (Luque and Poulin, 2004).

The most prevalent cestode in the clariids in this study was *W. virilis*, whose prevalence is most likely related to their diet. *Wenyonia* species have been reported to use tubificid worms such as *Tubifex tubifex* as intermediate host, and these worms are likely food for clariids (Ibraheem and Mackiewicz, 2006); however, the stomach contents of fish were not examined or analysed in this study to ascertain this. The annelid acquires infection by ingesting embryonated eggs of this cestode and when the annelid is ingested by a fish (definitive host), they in turn become infected (Ibraheem and Mackiewicz, 2006). Copepods have also been reported to serve as intermediate hosts of *Wenyonia* species (Kuchta *et al* 2008).

The higher diversity of cestodes found *in H. bidorsalis* compared to the other species of fish in this study may be as a result of the high activity of this fish (Lenfant and JoHansen, 1972; Fagbenro *et al* 1993) in terms of their ability to cover wide ranges of a water body (Fagbenro, 1992), thereby giving them greater exposure to intermediate hosts.

Prevalence of *W. longicauda* appeared to be high in *C. auratus*, this may be due to its diet which is said to include a variety of invertebrates such as insect larvae and nymphs, crustaceans and annelids (Bailey, 1994). These invertebrates may have acted as intermediate hosts of the cestode. Fagbenro *et al* (1993) attributed the high prevalence of helminths in *H. bidorsalis* to direct infection via diet or through predation on cichlids by adult fish; Akinsanya *et al* (2010) and Kawe *et al* (2016) also suggested the same reasons for the high prevalence of helminths in the gastrointestinal tract of *C. nigrodigitatus* and *C. gariepinus* respectively.

The high seasonal prevalence of infection that was observed during the dry season in *H. bidorsalis* could be as a result of lower water level in River Galma, which forms small pools in the dry season thereby enabling the fishes come in contact with intermediate hosts of these parasites more frequently. However, the higher prevalence in the wet season, observed in C. *auratus* suggests the availability of more food in the form of intermediate hosts, thereby providing a greater chance of infection. No *C. auratus* was obtained in the dry season probably due to the tendency of the fish to hibernate (Sturm, 1984), which coincided with sampling and collection period of this study. According to Akankali *et al* (2011) *Chrysichthys* species breed during the wet (rainy) season. Also, in the wet season, *H. longifilis* was not infected by cestodes, which coincided with their breeding season (June to October) (Akankali *et al* 2011). The higher prevalence of cestodes observed in female than male fish (1.60: 1.00) in this study maybe the consequence of having more females than males in the sample. The physiological state of females which could reduce their resistance to helminth infection could also be responsible (Emere, 2000; Emere and Egbe, 2006; Abdel-Gaber *et al* 2015). Ayanda (2009) attributed the higher prevalence of infection in female *C. gariepinus* to increased intake of a greater variety of food items.

The higher cestode prevalence in male than female *H. longifilis* in this study could be a consequence of reduced resistance of male fish to helminth infection during their breeding season. Folstad and Karter (1992) attributed higher prevalence of infection in male fish to immune-suppression by steroid hormones during spawning, which have been suggested as a major contributing factor to greater susceptibility of male fish to parasite invasion. Anosike *et al* (1992) and Oniye *et al* (2004) also reported a higher prevalence of cestodes in male than female *C. gariepinus*, Akinsanya *et al* (2010) also reported a higher prevalence of cestodes in male than female *C. gariepinus*, and *S. clarias.*

The higher prevalence of infection observed in larger *H. bidorsalis* in this study could be attributed to the availability of more space for attachment and accommodation of the parasite, as suggested by Matouke *et al* (2011) in a study of acathocephalans of cichlids and mormyrids.

It could also be associated with longer time of exposure of larger fish to the environment. Higher prevalence of cestodes in larger fish has also been reported in *Lates niloticus* (Emere, 2000), and *C. gariepinus* from Lake Manzala, Egypt (Abdel-Gaber *et al* 2015).

The higher prevalence in smaller *C. auratus* may be related to lower level of immunity at this stage; Akinsanya *et al* (2007) and Morenikeji *et al* (2013) also attributed the higher prevalence of infection to susceptibility of the smaller-sized fish. However, the 100% prevalence of cestode infection recorded in larger C. *auratus* (16.0-23.9 cm long) in this study might have been due to the low sample size.

Heterobranchus longifilis appeared not to be as readily available as the other fishes used in this study. This fish has been reported to be more active at night and feeding off what is available (Skelton, 1993). It is therefore unlikely that it would come across many helminth intermediate hosts to include in its diet, for this reason.

The seemingly posteriorly deformed specimen of *W. minuta* recovered from *C. auratus* in this study was noted by Scholz *et al* (2011) that "*Wenyonia minuta*, which has never been found since its original description by Woodland (1923), based on a single, apparently deformed specimen was found in *C. auratus* at Khartoum, Sudan". The deformity of *W. minuta* specimen recovered from *C. auratus* during this study and from Khartoum is quite remarkable and unlikely to be a mere coincidence; this calls for further investigation by way of collecting more infestation data and immunological studies. It is suggested here, that the deformity might probably have resulted from some immunological interaction between *W. minuta* and *C. auratus*.

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References

Abdel-Gaber, R., El Garhy, M. and Morsy, K. 2015. Prevalence and intensity of helminth parasites of African catfish *Clarias gariepinus* in Lake Manzala, Egypt. *ABB 6:* 464-469.

Akankali, J. A., Seiyaboh, E. I. and Abowei, J. F. N. 2011. Fish Breeding in Nigeria. *Int. J. Anim. Vet. Adv. 3(3):* 144-155.

Akinsanya, B., Hassan, A. A. and Adegbaju, W. A. 2010. Impacts of helminth parasites on *Clarias gariepinus* and *Synodontis clarias* from Lekki Lagoon, Lagos, Nigeria. *Report and Opinion 2(11):* 42-48.

Akinsanya, B., Otubanjo, O. A. and Ibidapo, C. A. 2007. Helminth bio load of *Chrys ichthys nigrodigitatus* (Lacepede 1802) from Lekki Lagoon Lagos, Nigeria. *Turk. J. Fish. Aquat. Sci. 7:* 83-87.

Anosike, J. C., Omoregie, E., Ofojekwu, P. C. and Nweke, I. E. 1992. A survey of helminth parasites of *Clarias gariepinus* in Plateau State, Nigeria. J. *Aqua. Sci. 7:* 39-43.

Ayanda, O. 1. 2009. Comparison of parasitic helminths infection between the sexes of *Clarias gariepinus* from Asa Dam Ilorin, North-Central Nigeria. *Sci. Res. Essays 4:* 357-360.

Bailey, R. G. 1994. Guide to the fishes of the River Nile in the Republic of Sudan. *J. Nat. Hist. 28:* 937-970.

Emere, M. C. 2000. Parasitic infection of the Nile perch *(Lates niloticus)* in River Kaduna. *J. Aqua. Sci. 31:* 34-45.

Emere, M. C. and Egbe, N. E. L. 2006. Protozoan parasites of *Synodontis clarias* (A freshwater fish) in River Kaduna. *BEST. 3:* 58-64.

Fagbenro, O. A. 1992. The dietary habits of the clariid catfish, *Heterobranchus bidorsalis* (Geoffroy St. Hilaire 1809) in Owena Reservoir, south-western Nigeria. *Trop. Zool. 5:* 11-17.

Fagbenro, O. A., Adedire, C. O., Owoseni, E. A. and Ayotunde, E. O. 1993. Studies on the biology and aquaculture potential of feral catfish *Heterobranchus bidorsalis* (Geoffroy St. Hilaire, 1809) (Clariidae). *Trop. Zool. 6:* 67-79.

Folstad, I. and Karter, A. J. 1992. Parasites, bright males, and the immunocompetence handicap. *Am. Nat. 139 (3):* 603-622.

Froese, R. and Pauly, D. 2017. (Eds.). World Wide Web electronic publication. www.fishbase.org, version (06/ 2017).

Ibraheem, M. H. and Mackiewicz, J. S. 2006. Scolex, development, morphology and mode of attachment of *Wenyonia virilis* Woodland, 1 923 (Cestoidea, Caryophyllidea). *Acta. Parasitol. 51(1):* 51-58.

Kawe, S. M., God'spower, R. O., Balarabe, M. R. and Akaniru, R. I. 2016. Prevalence of Gastro-intestinal helminth parasites of *Clarias gariepinus* in Abuja, Nigeria. Sok. J. *Vet. Sci. 14(2):* 26-33.

Klinger, R. E and Floyd, R. F. 2002. Introduction to freshwater fish parasites. *UF-IFAS Ext.* 13pp.

Kuchta, R., Scholz, T., Brabec, J. and Bray, R. A. 2008. Suppression of the tapeworm order Pseudophyllidea (Platyhelminthes: Eucestoda) and the proposal of two new orders, Bothriocephalidea and Diphyllobothriidea. *Int. J. Parasitol. 38:* 49-55.

Lenfant, C. and Johansen, K. 1972. Gas exchange in gill, skin and lung breathing. *Respir. Physiol. 14:* 211-218.

Luque, J. L. and Poulin, R. 2004. Use of fish as intermediate hosts by helminth parasites: A comparative analysis. *Acta. Parasitol. 49(4):* 353-361.

Mack iewic z, J. S. and Bever ley-Burton, M. 1 967. *Monobothrio ides woodlandi* sp. nov. (Cestoidea: Caryophyllidea) from *Clarias mellandi* Boulenger (Cypriniformes: Clariidae) in Zambia, Africa. Proc. Helminthol. *Soc. Wash. 34(2):* 125-128.

Madanire-Moyo, G. and Avenant-Oldewage, A. 2013. Occurrence of *Tetracampos ciliotheca* and *Proteocephalus glanduligerus* in *Clarias gariepinus*

(Burchell, 1822) collected from the Vaal Dam, South Africa. Onderstepoort J. *Vet. Res. 80(1):* 1-5.

Matouke, M. M., Aken'Ova T. 0. and Nock, I. H. 2011. Acanthocephalan infections of cichlids and mormyrids in River Galma, Zaria. *JTB. 9:* 56-62.

Morenikeji, 0. A., Salawu, M. T., Sowunmi, A. A. and Odaibo, A. B. 2013. Comparative survey of helminth parasites of *Clarias gariepinus* (Burchell, 1822) and *Clarias pachynema* (Boulenger, 1903) from the Ogun River and Asejire Dam in South-West Nigeria. *Int. J. Fish. Aquac. 5(1):* 7-11.

Oniye, S. J., Adebote, D. A. and Ayanda, O. I. 2004. Helminth parasites of *Clarias gariepinus* (Teugels) in Zaria, Nigeria. *J. Aqua. Sci. 19:* 71-76.

Paperna, I. 1980. Parasites, infections and diseases of fish in Africa. *CIFA Technical Paper 7.* Rome: FAO, 2l6pp.

Scholz, T. 1999. Life cycles of species ofProfeocepña/as, parasites of fishes in the Palearctic Region: A review. *J. Helminthol. 73:* 1-19.

Scholz, T., De Chambrier, A., Beletew, M., and Mariaux, J. 2009. Redescription of *Proteocephalus glanduligerus* (Cestoda: Protocephslidea) a parasite of clariid catfishes in Africa with a unique glandular apical organ. *J. Parasitol. 95(1):* 160-168.

Scholz, T., Jirku, M. and Mahmoud, Z. N. 2011. Revision of *Wenyonia* Woodland, 1923 (C estoda: Caryophyllidea) from catfishes (Siluriformes) in Africa. *Syst. Parasitol. 79:* 83-107.

Skelton, P. H. 1993. *A complete guide to the freshwater fishes of southern Africa.* Southern Book Publishers. 388pp.

Sturm, M. G. De L. 1984. On the biology of the catfish *Chrysichthys auratus* (Geoffroy) in the man-made Tiga Lake in northern Nigeria. *Freshw. Biol. 14:* 43-51.

Ukoli, F. M. A. 1972. Occurrence, morphology and systematics of caryophllaeid cestodes of *Wenyonia* Woodland, 1923, from fishes in River Niger, Nigeria. *J. WA Sci. Assoc. 17(1):* 49-67.

Williams, H. and Jones, A. 1994. *Parasitic worms of fish.* Taylor and Francis, Bristol, United Kingdom, 593pp.

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