

Occurrence of *Tetracampus ciliotheca* and *Proteocephalus glanduligerus* in *Clarias gariepinus* (Burchell, 1822) collected from the Vaal Dam, South Africa

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Cestodes are parasitic flatworms that live in the digestive tract of vertebrates as adults and often in the liver, muscle, haemocoel, mesentery and brain of various animals as larval stages. To identify the cestodes infecting *Clarias gariepinus* Burchell, 1822 (sharp-toothed catfish) in the Vaal Dam, a total of 45 host specimens were collected with the aid of gill nets between October 2011, January and April 2012. The fish were sacrificed and examined for cestode parasites. Two adult cestodes, *Tetracampus ciliotheca* Wedl, 1861 (prevalence 86.7%, mean intensity = 15, $n = 45$) and *Proteocephalus glanduligerus* (Janicki, 1928) (prevalence 51.1%, mean intensity = 5, $n = 45$) were found in the intestines of the catfish. Both *T. ciliotheca* and *P. glanduligerus* are new locality records. There were statistically insignificant differences in the infection of the male and female *C. gariepinus*. Fish with standard length ranging from 40 cm – 54 cm (≥ 3 years) had the highest prevalence and mean intensity while those ranging from 10 cm – 24 cm (< 1 year) had the lowest prevalence and mean intensity for both cestodes. The study highlights the importance of changing feeding habits of *C. gariepinus* with age on the prevalence and mean intensity of the two gastrointestinal cestode parasites.

Introduction

Cestodes represent a highly specific group within Neodermata that is characterised by several striking morphological features, the most obvious one being the evolutionary loss of a digestive tract throughout all developmental stages. According to Paperna (1996), cestodes occur almost exclusively in siluriform fish, most commonly in Clariidae and Polypteridae. In Africa, the helminth fauna of African teleosts has been studied since the middle 19th century, when Leydig (1853) and Wedl (1861) described the first tapeworms from bichirs and clariid fish, respectively. Khalil (1971) published the first checklist of parasites of freshwater fish in Africa and in its updated edition (Khalil & Polling 1997) a total of 359 species of helminths, including 61 species of adult and larval tapeworms (Cestoda), were reported. Adult tapeworms identified to the species level belong to the orders Amphilinidea (1 species), Caryophyllidea (20 species in 7 genera), Bothriocephalidea (13 species in 3 genera) and Proteocephalidea (21 species in 6 genera) (Khalil & Polling 1997).

The sharp-toothed catfish, *Clarias gariepinus* (Burchell, 1822) is one of the favoured fish species for aquaculture in Africa (Awachie & Ezwenwaji 1981). The catfish is an omnivorous fish and can survive in extremely harsh conditions, a feature that has made it favourable for culture in many parts of the world (Peteri, Nandi & Choridhury 1992). With the growing interest in the development of aquaculture in Africa, there is also an increase in the awareness of the role of parasites and diseases as major factors affecting fish farming (Paperna 1996). It is therefore imperative that the parasites that infect fish in natural waters are investigated to form the basis for management of parasite infections in fish farms.

The objectives of the present study were to specifically identify the cestodes collected from the sharp-toothed catfish based on their morphological features, and to note their prevalence and mean intensity in the Vaal Dam. This paper will complement other papers on the helminthic fauna of the same locality (e.g. Bertasso & Avenant-Oldewage 2005; Crafford & Avenant-Oldewage 2009, 2010, 2011; Degger, Avenant-Oldewage & Greenfield 2009; Retief, Avenant-Oldewage & Du Preez 2006, 2007, 2009).

Materials and methods

Study sites and surveys conducted

The study area was the Vaal Dam, which is located on the border between the Gauteng and Free State Province and is approximately 150 km south of Johannesburg. Surveys were conducted in October 2011, January and April 2012 in the dam (26°52.249'S, 28°10.249'E; Figure 1).

Collection of fish and parasites

A field laboratory was set up for each survey on University of Johannesburg Island. Sharptooth catfish were collected from the Vaal Dam using gill nets of varying stretched mesh sizes of 90 mm, 110 mm and 130 mm. Fish were sacrificed by severing the spinal cord behind the head and were then dissected by making an insertion from the anus towards the head. Once they had been dissected, the intestines were removed and placed in a 0.9% physiological saline solution in Petri dishes for examination.

The gastrointestinal tract was dissected from the rectum to the oesophagus and parasites encountered were carefully detached from the intestinal mucosa. The intestines were pulled open carefully using two sharp pointed tweezers to ensure that the cestodes were kept intact. Each cestode was carefully and slowly dislodged from the intestinal wall, ensuring that it remained intact. Cestodes were transferred to a clean sampling bottle containing 0.9% physiological saline solution, which was then shaken for a few minutes to remove debris and induce muscle fatigue, which in turn deters strong contraction of the scolices and relaxes them. Whilst swirling the sampling bottle, an equal amount of a hot alcohol-formaldehyde-acetic acid (AFA) solution was added to kill and fix the specimens. Specimens were then stored in 70% ethanol. The following literature was consulted for identification: Kuchta, Scholz and Bray (2008) for *Tetracampos ciliotheca* Wedl, 1861 and Mashego (2001) for *Proteocephalus glanduligerus* (Janicki, 1928)

Statistical analyses

Prevalence and mean intensity levels for the two cestodes showed no significant seasonal variations hence data collected over the three surveys were pooled. Infection levels

of fish were compared using Student's t test and Kolmogorov-Smirnov tests (SPSS V. 20 Statistical Package for Social Sciences, SPSS Inc.). To give an approximate indication of age, the Von Bertalanffy growth curve for *C. gariepinus* from River Asi, Turkey (Yalçın, Solak & Akyurt 2002) was used, since there are no such data from the Vaal Dam. Parasite prevalence and mean intensities were determined (Bush, Fernandez, Esch & Seed 2001).

Ethical considerations

The parasites were obtained from fish sampled for the approved projects of Messrs Beric Gilbert and Ebi Hussain since the fish were already dead after the sampling procedure. Ethical clearance was obtained from the UJ Faculty Ethics Committee in 2011 for both these projects. Fish were sampled according to the guidelines of a permit obtained from Gauteng Nature Conservation. Potential health and safety hazards were disclosed to the Ethics Committee. Staff and students were covered by the university third-party insurance. All researchers participated voluntarily.

Results

Two adult cestode species, *T. ciliotheca*, a pseudophyllidean (Figure 2) and *P. glanduligerus*, a proteocephalid were encountered in catfish examined from the Vaal Dam. Out of the 45 catfish examined, 39 (86.7%) were infected by *T. ciliotheca* whilst *P. glanduligerus* occurred in 23 (51.1%) of the examined fish (Table 1). *Tetracampos ciliotheca* was restricted to the anterior portion of the intestine whereas *P. glanduligerus* was found in the anterior and mid anterior portions of the intestines.

Variations in the infections of the different sexes were recorded (Table 1). More females were infected (prevalence = 51.1%,

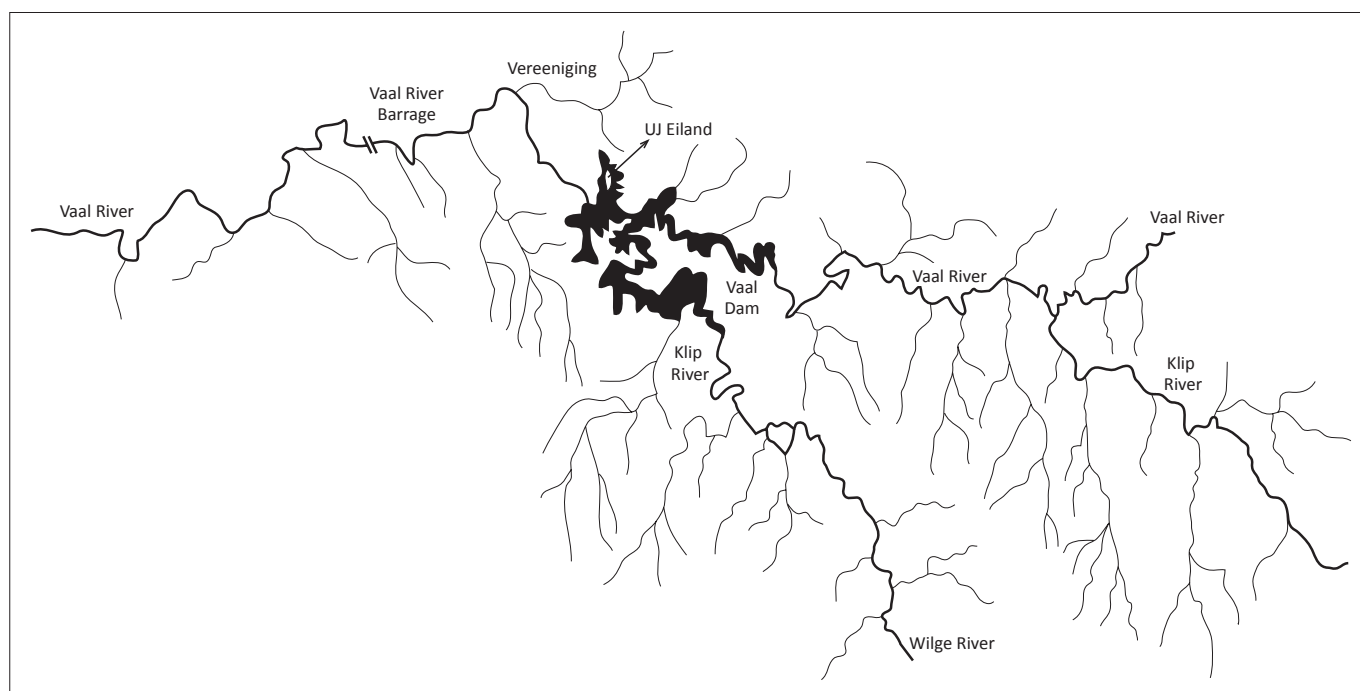


FIGURE 1: Map showing the position of the Vaal Dam and its tributaries.

mean intensity = 21) than males (prevalence = 33.3%, mean intensity = 9) for *T. ciliotheca*. A similar trend was noted for *P. glanduligerus* where the females were also more infected (prevalence = 35.6%, mean intensity = 8) than males (prevalence = 17.8%, mean intensity = 3). However, Student's *t*-tests revealed a lack of significant differences (*p* values > 0.05) in the prevalence and intensity of infection between sexes for both cestodes.

The effect of host age on parasite dispersion is presented in Table 2. Fish with standard length ranging from 40 cm – 54 cm (≥ 3 years) had the highest prevalence and mean intensity while those ranging from 10 cm – 24 cm (< 1 year) had the lowest prevalence and mean intensity for both cestodes (Table 2). Differences in prevalence

and intensity of infections were statistically significant (Kolmogrov-Smirnov tests, *p* values < 0.05).

Discussion

Tetracampos ciliotheca, previously known as *Polyonchobothrium clarias* Woodland, 1925 has a widespread distribution in siluroid fishes of Africa. Previous records of this cestode include those from Egypt (Amin 1978; Imam 1971; Eissa, Badran, Sohair & Heba 2010; Eissa, Zaki, Nadia & Zaki 2012), Nigeria (Aderounmu & Adeniyi 1972; Oniye, Adebote & Ayanda 2004; Goselle, Shir, Udeh, Abelau & Imandeh 2008) and from Senegal (Khalil 1973). In South Africa, *T. ciliotheca* was first recorded by Van As and Basson (1984) with subsequent findings by Mashego (2001), Barson and Avenant-Oldewage (2006), Madanire-Moyo, Luus-Powell and Olivier (2010) and Madanire-Moyo, Luus-Powell, Jooste and Olivier (2012). Chishawa (1991) and Douëllou (1992) recorded it incorrectly as a larval ptychobothriid from Lake Kariba (Zimbabwe), when in fact it was an adult. A detailed morphological description of this species from *Clarias gariepinus* is given by Barson and Avenant-Oldewage (2006), and the present specimens fit their description.

The genus, *Tetracampos* was recently resurrected by Kuchta *et al.* (2008) on the basis of an examination of new material from the type-host in Sudan, its comparison with type specimens of the taxa described from African catfish and a critical study of the literature, including the original description of *T. ciliotheca* by Wedl (1861). According to Kuchta *et al.* (2008), the descriptions and illustrations by Wedl (1861) correspond with those of the tapeworms recently found in African catfish as well as those previously placed in the genera *Polyonchobothrium* Diesing, 1854 and *Senga* Dollfuss, 1934 (Protasova 1977). Janicki (1928) provided a comprehensive description of *Polyonchobothrium cylindraceum* Janicki, 1928 from *Clarias anguillaris* Linnaeus, 1758. Tadros (1968) synonymised this cestode with *P. clarias*. Meggitt (1930) described *P. fulgidum* Meggitt, 1930 from the same host. Tadros

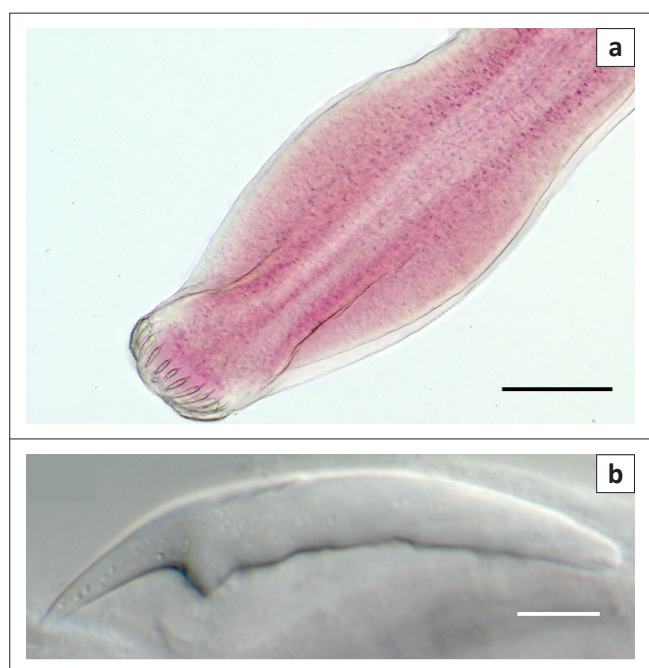


FIGURE 2: Light micrographs of acetocarmine stained *Tetracampos ciliotheca* (a) scolex scale bar = 30 µm; (b) rostellar hook scale bar = 100 µm.

TABLE 1: Intestinal cestode infection in relation to sex of *Clarias gariepinus* (Burchell, 1822) collected from Vaal Dam, South Africa.

Sexes	No examined	No infected with <i>T. ciliotheca</i> †	Prevalence %	Mean Intensity		No infected with <i>P. glanduligerus</i> ‡	Prevalence %	Mean Intensity	
				Mean	Intensity range			Mean	Intensity range
Male	21	16	35.6	9	5–30	8	17.8	3	1–9
Female	24	23	51.1	21	7–48	15	33.3	8	1–24
Combined	45	39	86.7	15	5–35	23	51.1	5	1–14

†, *T. ciliotheca* = *Tetracampos ciliotheca* Wedl, 1861.

‡, *P. glanduligerus* = *Proteocephalus glanduligerus* (Janicki, 1928).

TABLE 2: Intestinal cestode infection in relation to size of *Clarias gariepinus* (Burchell, 1822) collected from Vaal Dam, South Africa.

Parasite species	Statistical parameter	Length groups (cm) (Corresponding age groups†)			
		10–24 (< 1 year)	25–39 (≥ 1 year < 3 years)	40–54 (≥ 3 years)	Total
<i>Tetracampos ciliotheca</i> Wedl, 1861	No. of fish examined	6	11	28	45
	No. of fish infected	3	9	27	39
	% infection	6.7	20.0	60.0	86.7
<i>Proteocephalus glanduligerus</i> (Janicki, 1928)	No. of fish examined	6	11	28	45
	No. of fish infected	1	5	17	23
	% infection	2	11.1	37.8	51.1

†, data according to Yalçin, S., Solak, K. & Akyurt, I., 2002, 'Growth of the catfish *Clarias gariepinus* (Clariidae) in the River Asi (Orontes), Turkey', *Cybiurn* 26, 163–172.



(1968) synonymised all bothriocephalid genera possessing an apical disc armed with hooks, namely *Polyonchobothrium*, *Tetracampos* Wedl, 1861, *Senga* and *Oncobothriocephalus* Yamaguti, 1959. However, his synonymy has not been widely accepted, although Dubinina (1987) considered *Polyonchobothrium* and *Senga* to be synonymous. According to Kuchta and Scholz (2007), *P. clarias*, *P. cylindraceum* and *P. fulgidum* are conspecific with *T. ciliotheca* and are considered to be its junior synonyms.

Proteocephalids are common parasites of siluroids in Africa. However, only one species of proteocephalid cestodes, *P. glanduligerus* has been recorded in South Africa (Mashego 2001; Van As & Basson 1984; Madanire-Moyo *et al.* 2010) and from Zimbabwe (Barson, Bray, Ollevier & Huyse 2008). The cestode which was isolated from under the mucous lining of the intestine of *C. gariepinus* from the Vaal Dam matches the descriptions made by Freze (1965), Mashego (2001) and Barson and Avenant-Oldewage (2006). Proteocephalid cestodes have also been recorded in Zimbabwe (Barson 2004; Chishawa 1991; Douëllou 1992; Madanire-Moyo & Barson 2010) but were not identified to species level.

The prevalence values for *T. ciliotheca* and *P. glanduligerus* were 86.7% and 51.1%, respectively compared with 71% and 14%, respectively in *C. gariepinus* populations from Rietvlei Dam (Barson & Avenant-Oldewage 2006). Williams and Jones (1994) suggested that parasitism varies from one aquatic system to the other and this is influenced by the interplay of mixed biotic and abiotic factors.

The two parasites were found in the intestinal lumen and this finding is attributed to the fact that cestodes lack a digestive system. As adults, they reside in intestines of vertebrates, an environment extremely rich in nutrients that they take in through the outermost layer of their bodies, the syncytial neodermis called tegument (Chervy 2009). The neodermis of tapeworms bear microtriches, distinct elaborations of various shapes whose nomenclature was standardised by Chervy (2009) and which contribute to nutrient absorption.

An increase in size of fish is a reflection of length, which is usually considered as a measure of age (Yalçın *et al.* 2002). The juvenile fish (10 cm – 24 cm / < 1 year) had lower prevalence values while sub-adults (23 cm – 39 cm / ≥ 1 year < 3 years) and adults (40 cm – 54 cm / ≥ 3 years) had higher prevalence of infection for both cestode species as shown in Table 2. A possible explanation of this phenomenon is a change in diet from weeds, seeds, phyto- and zooplankton as juveniles to insect larvae, snails, crustaceans, worms and fish as adulthood is attained (Reed, Buchard, Hopson, Jennes & Yaro 1967). *Clarias* species are known to be omnivorous with a tendency towards carnivory as they age. The present findings tend to support that of Geets and Ollivier (1996), who postulated that herbivorous fish are generally considered to harbour fewer intestinal parasites than omnivorous or carnivorous ones (i.e. *C. gariepinus* juveniles tend to be herbivorous and could thus be expected to harbour fewer intestinal parasites).

Conclusion

Two adult cestodes, *T. ciliotheca* (prevalence 86.7%, mean intensity = 15, $n = 45$) and *P. glanduligerus* (prevalence 51.1%, mean intensity = 5, $n = 45$) were found in the intestine of the catfish. Parasite prevalence and mean intensity levels were related to the length of the host specimens. The study highlights the importance of changing feeding habits of *C. gariepinus* with age on the prevalence and mean intensity of the two gastrointestinal cestode parasites at the Vaal Dam. It may be advisable to incorporate antihelminthic therapy into the diet of prospective *C. gariepinus* broodstock obtained from the wild.

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Competing interests

The authors declare that they have no financial or personal relationship(s) which may have inappropriately influenced them in writing this article.

Authors' contributions

A.A-O. (University of Johannesburg) was the project leader. G.M-M. (University of Johannesburg) was responsible for collection of data, experimental design and first draft of manuscript.

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