



Gastric nematodes of Nile crocodiles, *Crocodylus niloticus* Laurenti, 1768, in the Okavango River, Botswana

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ABSTRACT

JUNKER, K., WALLACE, K., LESLIE, A.J. & BOOMKER, J. 2006. Gastric nematodes of Nile crocodiles, *Crocodylus niloticus* Laurenti, 1768, from the Okavango River, Botswana. *Onderstepoort Journal of Veterinary Research*, 73:111–114

The ascaridoid nematodes *Dujardinascaris madagascariensis* Chabaud & Caballero, 1966, *Dujardinascaris dujardini* (Travassos, 1920), *Gedoelestascaris vandenbrandeni* (Baylis, 1929) Sprent, 1978 and *Multicaecum agile* (Wedl, 1861) Baylis, 1923 were recovered from the stomach contents of *Crocodylus niloticus* Laurenti, 1768 from the Okavango River, Botswana, together with *Eustrongylides* sp., a dioctophymatoid nematode usually parasitizing piscivorous birds. *Dujardinascaris madagascariensis* was present in most of the infected hosts, while the remaining species were mostly represented in single collections in one to three hosts. All four ascaridoid nematodes represent new geographic records.

Keywords: Ascaridoidea, crocodilians, *Crocodylus niloticus*, nematodes, Nile crocodiles

INTRODUCTION

A number of gastrointestinal nematodes from crocodilian hosts have been reported in the literature (Baker 1983). Amongst these the ascaridoid nematodes belonging to the subfamily Heterocheilinae and Anisakinae are some of the most prominent species (Sprent 1977, 1978, 1979a, b).

Eight of the 11 genera are included in the subfamily Heterocheilinae parasitize crocodilians, namely *Brevimulticaecum* Mozgovoy, in Skrjabin, Shikhobalova & Mozgovoy, 1952, *Dujardinascaris* Baylis, 1947, *Gedoelestascaris* Sprent, 1978, *Hartwichia* Chabaud &

Bain, 1966, *Multicaecum* Baylis, 1923, *Ortleppascaris* Sprent, 1978, *Trispiculascaris* Skrjabin, 1916 and *Typhlophorus* Von Linstow, 1906 (Sprent 1983). The genus *Terranova* Leiper & Atkinson, 1914 is included in the subfamily Anisakinae (Sprent 1979a).

The genera *Hartwichia* and *Trispiculascaris* have as yet only been recorded from the African continent, while *Brevimulticaecum* occurs in South and North American crocodilians, and *Typhlophorus* seems exclusive to India. *Gedoelestascaris* and *Multicaecum* have both been found in Africa and Australasia, whereas *Ortleppascaris* is known from African as well as South and North American hosts.

To date, *Terranova* and *Dujardinascaris* are the only ascaridoid genera occurring throughout the entire range of the crocodilians' geographic distribution, with representatives in the Neotropics, Africa and Australasia (Sprent 1977, 1978, 1979a, b, 1983). Even genera with a wide geographic distribution are generally characterized by strict species separation with respect to the various geographic areas. *Multi-*

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caecum agile (Wedl, 1861) Baylis, 1923 and *Terranova crocodillii* (Taylor, 1924) Hartwich, 1957, in fact, are the only two species that have been listed from Africa as well as Australia.

In this paper we report on some nematodes recovered from the stomach contents of Nile crocodiles, *Crocodylus niloticus* Laurenti, 1768, in Botswana.

MATERIAL AND METHODS

During August 2003 to August 2005 a study was conducted by one of us (K. Wallace) on the composition of the diet of Nile crocodiles from the Okavango River, Botswana. The stomach contents of the crocodiles were pumped into separate containers and macroscopically examined. Nematodes present in these contents were collected and fixed in 70% ethanol. They were subsequently cleared in lactophenol and identified using the descriptions of the authors listed below. Nematodes were recovered from 57 crocodiles.

The results compiled herein are not based on a complete collection of the helminth parasites, for which the hosts would have had to be sacrificed, but represent incidental findings from the stomach contents of the various crocodile hosts.

RESULTS

The ascaridoids *Dujardinascaris madagascariensis* Chabaud & Caballero, 1966, *Dujardinascaris dujardini* (Travassos, 1920), *M. agile* and *Gedoelstascaris vandenbrandeni* (Baylis, 1929) Sprent, 1978 were recovered from the crocodiles. One male and one female specimen of the dioctophymatoid genus *Eustrongylides* Jägerskiöld, 1909 were present in a single host.

Helminth diversity was low in the Nile crocodiles examined, with the genus *Dujardinascaris* being the most commonly encountered. *Dujardinascaris madagascariensis* was recovered from most of the infected hosts, while the remaining species, *D. dujardini*, *G. vandenbrandeni* and *M. agile*, only occurred in a few (1–3) of the crocodiles.

The majority of the crocodiles (46) were only parasitized by one ascaridoid species, usually *Dujardinascaris madagascariensis*. Two of the ascaridoid species were present at the same time in only six hosts. Multiple infections with more than two species per host were not encountered.

DISCUSSION

While it is difficult to distinguish between some of the females of the various *Dujardinascaris* spp., *D. madagascariensis* is distinct from the other four African species in that the vagina opens through a distinct papilla between the lips of the vulva. In some of our specimens remains of copulatory cement could still be observed on the papilla. The majority of the male specimens were assigned to *D. madagascariensis* on the basis of the length of their spicules. The spicules of *D. dujardini* are distinctly longer than those of *D. madagascariensis*, whereas the spicules of both *Dujardinascaris gedoelsti* Sprent, 1977 and *Dujardinascaris puylaerti* Sprent, 1977 are considerably shorter (Sprent 1977). *Dujardinascaris petterae* Sprent, McKeown & Cremin, 1998 has short, unequal spicules (Sprent, McKeown & Cremin 1998). A single male specimen possessed the typical trifurcate gubernaculum of *D. dujardini* and a single female with a sinuous vagina, but without a vaginal papilla was assigned to the same species.

All the parasites reported in this study have previously been reported from crocodiles.

Dujardinascaris dujardini has been recorded from *C. niloticus* and *Crocodylus cataphractus* from Africa, as well as from *Crocodylus porosus* in India (Yamaguti 1961). Sprent (1977) lists "crocodile" as its type host and the Nile crocodile as additional host from Zambia and the Democratic Republic of the Congo. More recently, *D. dujardini* was reported from *C. niloticus* from Egypt (El-Dien Mahmoud 1999). *Dujardinascaris madagascariensis* is listed from *C. niloticus* and *C. cataphractus* in Madagascar, Angola and the Democratic Republic of the Congo (Sprent 1977). However, the recovery of *D. dujardini* and *D. madagascariensis* from crocodiles in Botswana represents a new geographic record for these parasites.

Three additional representatives of the genus *Dujardinascaris* have been reported from the African continent. Sprent *et al.* (1998) described *D. petterae* from *Osteolaemus tetraspis* in the Congo. *Dujardinascaris gedoelsti* Sprent, 1977 and *D. puylaerti* Sprent, 1977 were collected from *C. niloticus* in the Republic of the Congo (Sprent 1977). The latter species was also present in Zambia (Sprent 1977). None of the above three species was recovered from crocodiles in Botswana.

Gedoelstascaris vandenbrandeni is one of two species that Sprent (1978) removed from the genus *Dujardinascaris* and placed in a new genus, namely *Gedoelstascaris*. *Gedoelstascaris vandenbrandeni*

occurs only in African crocodiles and has been recorded from *C. niloticus* and *C. cataphractus* in Angola, Zambia and the Democratic Republic of the Congo. Its Australian counterpart, *Gedoelestascaris australiensis* (Baylis 1931) Sprent, 1978, parasitizes *Crocodylus johnstoni* and *C. porosus* and has been found in hosts from Australia as well as the Solomon Islands (Sprent 1978). There are no previous records of *G. vandenbrandeni* in Botswana.

Of the four ascaridoid nematodes found in this study, *M. agile* is the only one with a geographic distribution extending beyond the African continent and utilizing hosts other than African crocodilians. Its type host is *C. niloticus* from Egypt, but it has also been recovered from *C. cataphractus* and was recorded from the Republic of the Congo, Zambia and Zimbabwe. Hosts from the Australasian region are *C. palustris*, *C. johnstoni* and *Gavialis gangeticus*. India and Australia are listed as localities (Sprent 1979b). Botswana constitutes a new geographic record for *M. agile*.

Literature regarding the prevalence and intensity of gastric nematode infections in crocodiles and alligators is scant and the data on both are somewhat variable (Cherry & Ager 1982; Ladds & Sims 1990; Goldberg, Bursey & Aquino-Shuster 1991). The latter might be explained by the fact that not many concise studies regarding the gastric nematode fauna of crocodilians have been conducted and findings often represent the data from few or single hosts.

Ladds & Sims (1990) report a prevalence of 41% for *Dujardinascaris mawsonae* Sprent, 1977 in young crocodiles belonging to two species, *C. porosus* and *Crocodylus novaeguineae*, in Papua New Guinea. The range of intensity of infection is given as 1–20, but as many as 60 and 100 worms were recovered from two crocodiles in good condition. Histological examination of the gastric wall revealed the presence of *Capillaria* sp. in 60% of the hosts.

Dujardinascaris waltoni Sprent, 1977 was the only nematode parasite present in *Alligator mississippiensis* in South Florida. It was collected from 93% of the hosts and the mean intensity of infection was high (89%), with a maximum burden of 413 specimens per alligator (Cherry & Ager 1982).

Contrary to our findings, *Dujardinascaris* was the least prevalent ascaridoid genus in *Caiman yacare* in Paraguay, but was nevertheless the one with the highest mean intensity of infection. *Brevimulticaecum baylisi* Travassos, 1933 had the highest prevalence followed by *Ortleppascaris alata* Baylis, 1947 (Gold-

berg *et al.* 1991). The genus *Brevimulticaecum* is exclusive to caimans and alligators in the New World (Sprent 1979). The genus *Ortleppascaris* is represented in Africa by a single species, *Ortleppascaris nigra* Gedoelest, 1916 from *C. niloticus* and *C. cataphractus* (Sprent 1978), but was not present in the crocodiles in Botswana.

No clear picture regarding the occurrence of multiple infections with ascaridoid nematodes emerges from the literature. Some authors report single species infections (Cherry & Ager 1982; Ladds & Sims 1990), while others list three or four species, without, however, specifying how many of these were recovered per individual host (Goldberg *et al.* 1991; Scott, Simcik & Craig 1997). Scott *et al.* (1997) examined the helminth fauna of 50 American alligators and came to the conclusion that the infracommunity structure was “depauperate when compared to homoiothermic hosts”, a statement which complies with the well documented fact that the helminth diversity of reptiles, in general, is less pronounced than that of mammalian and avian hosts (Hering-Hagenbeck & Boomker 2000).

With the exception of *Eustrongylides* sp., all the parasites were collected from their typical predilection site in the host, but *D. dujardini*, *D. gedoelsti* and *G. vandenbrandeni* have also been reported from the intestine (Sprent 1977; Sprent *et al.* 1998). The genus *Eustrongylides* occurs in the wall of the proventriculus of its piscivorous avian final hosts and utilizes fish as intermediate hosts (Measures 1987).

Little is known about the life-cycle of any of the parasites found during this study, but fishes seem to play an important role as intermediate hosts of all the species (Sprent 1977, 1978, 1979a, b). Studies on the stomach contents of Nile crocodiles reveal a significant change in their feeding habits as the individuals grow larger. Despite this ontogenetic food-shift, fish remain one of the most important dietary items throughout the crocodiles’ lifespan. Fish were found in the stomachs of 60% of crocodiles ranging from 2.5–3.0 m in total length, and fish were still recovered from nearly 40% of specimens > 4.5 m, (Ross 1989; Alderton 1992). As one of the main prey items, fish would appear to be the intermediate host of choice to ensure the successful completion of the life-cycle of these gastric nematodes.

ACKNOWLEDGEMENTS

This study was made possible by a grant to A.J. Leslie by the National Research Foundation and the

Earthwatch Institute, USA. We thank the Department of Wildlife and National Parks, Botswana and the Ministry of Environment, Wildlife and Tourism, Botswana. Our thanks also go to Pertec International and the entire Okavango Crocodile Project field team.

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