

# Parasitic infections of the African dwarf crocodile (*Osteolaemus tetraspis*) and the ornate Nile monitor (*Varanus ornatus*) from Nigeria

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## Abstract

The parasitic infections of market derived *Osteolaemus tetraspis* from the rainforest and *Varanus ornatus* from locations in the savanna-mosaic and the rainforest of southern Nigeria were investigated. Parasites recovered from *O. tetraspis* included members of the Pentastomida, Trematoda and Nematoda. An undescribed pentastomid belonging to the family Sebekidae was recovered from *O. tetraspis*. The same parasite was also found to parasitize *V. ornatus* from the rainforest. Other parasites found in *O. tetraspis* were *Pseudoneodiplostomum thomasi*, *Dujardinascaris* sp. and larva of a *Camallanus* sp. *Varanus ornatus* from the rainforest and the derived savanna had some parasites including *Duthiersia fimbriata*, an unidentified pseudophyllidean cestode and *Tanqua tiara* in common. *Cosmocerca ornata* and *Oswaldocruzia hoepli* were restricted to hosts from the derived savanna while the unidentified trematode occurred only in lizards from the rainforest. The unidentified pseudophyllidean cestode bears a close resemblance to *Probothriocephalus*, a cestode previously reported only from deep water teleosts. *Pseudoneodiplostomum thomasi* and *Duthiersia fimbriata* are new locality records for Nigeria.

## Keywords

*Osteolaemus tetraspis*, *Varanus ornatus*, parasitic infections, Nigeria

## Introduction

Three crocodile species (*Crocodylus niloticus*, *C. catapRACTUS* and *Osteolaemus tetraspis*) and three monitor lizards (*Varanus niloticus*, *V. ornatus* and *V. exanthematicus*) are known to occur in Nigeria (Bayless and Luiselli 2000). In Africa and elsewhere information on the parasitic infections of crocodiles are richly available: Botswana (Junker *et al.* 2006a, b; Riley and Huchzermeyer 1995a), Congo (Graber 1981; Riley and Huchzermeyer 1995b, 2000; Riley *et al.* 1997), Ghana (Fischthal and Thomas 1968), South Africa (Junker *et al.* 1999, 2000), Australia (Platt *et al.* 1991), Belize (Tellez and Paquet-Durand 2011), Brazil (Ostowski de Núñez 2003), Cuba (Groschaft and Barus 1970) and Mexico (Moravec 2001; Villegas and González-Solis 2009). In contrast, there is a dearth of information on parasites infecting varanids. Leiper (1908) mentioned finding *Tanqua tiara* in *Varanus ornatus* from

Natal, while Edmund *et al.* (2000) reported a case of pentastomiasis in *V. exanthematicus* illegally imported from West Africa. In Nigeria, little is known about the parasite fauna infecting crocodiles and varanids. Baylis and Lane (1920) reported the nematode *Tanqua tiara* in *V. exanthematicus* sourced from an undisclosed location in Nigeria, while Avery (1971) found *Abbreviata baylisi*, *Ophidascaris filaria* and *Proteocephalus nilotica* in the same host. The only information available in the literature regarding the occurrence of a helminth infection in a crocodile from Nigeria is that of Ajibade *et al.* (2010), who reportedly found the eggs of *Ascaris lumbricoides* in the fecal samples of a zoo-kept *C. catapRACTUS*. Nothing is known of the parasitic infections of *V. ornatus*.

In view of the dearth of information on the parasitic infections of these herptiles in Nigeria, we undertook this study, investigating the parasitic infections in market-derived

**Table I.** Parasites recovered from *O. tetraspis* and *V. ornatus* from southern Nigeria

Parasite	Host	Site of Infection
<b>Cestoda</b>		
<i>Duthiersia fimbriata</i>	<i>V. ornatus</i>	Small intestine
Unidentified pseudophyllidean cestode	<i>V. ornatus</i>	Small intestine
<b>Trematoda</b>		
<i>Pseudoneodiplostomum thomasi</i>	<i>O. tetraspis</i>	Small intestine
Unidentified juvenile trematode	<i>V. ornatus</i>	Small intestine
<b>Nematoda</b>		
<i>Camallanus</i> sp.	<i>O. tetraspis</i>	Small intestine
<i>Cosmocerca ornata</i>	<i>V. ornatus</i>	Small intestine
<i>Dujardinascaris</i> sp.	<i>O. tetraspis</i>	Large intestine/rectum
<i>Tanqua tiara</i>	<i>V. ornatus</i>	Small intestine
<i>Oswaldocruzia hoeplii</i>	<i>V. ornatus</i>	Small intestine
<b>Pentastomida</b>		
<i>Sebekia</i> sp.	<i>O. tetraspis</i>	Lungs
	<i>V. ornatus</i>	Lungs

*O. tetraspis* and *V. ornatus*, with origins in locations within the rainforest and derived savanna of southern Nigeria.

## Materials and methods

Eleven *O. tetraspis* and six *V. ornatus* were purchased from local markets in Benin City, Nigeria. According to the vendors, these animals were purchased from hunters in rainforest

locations in Edo State (05°44'–07°34'N and 05°04'–06°45'E) and Delta State, (05°00'–06°31'N and 05°00'–06°45'E), in southern Nigeria. Four other *V. ornatus* were sourced from locations in the derived savanna, in the northern part of Edo State, Nigeria. The snout-vent lengths (SVLs) were measured and the herps euthanized. The gastro-intestinal tract as well as other organs of the viscera were examined for parasites.

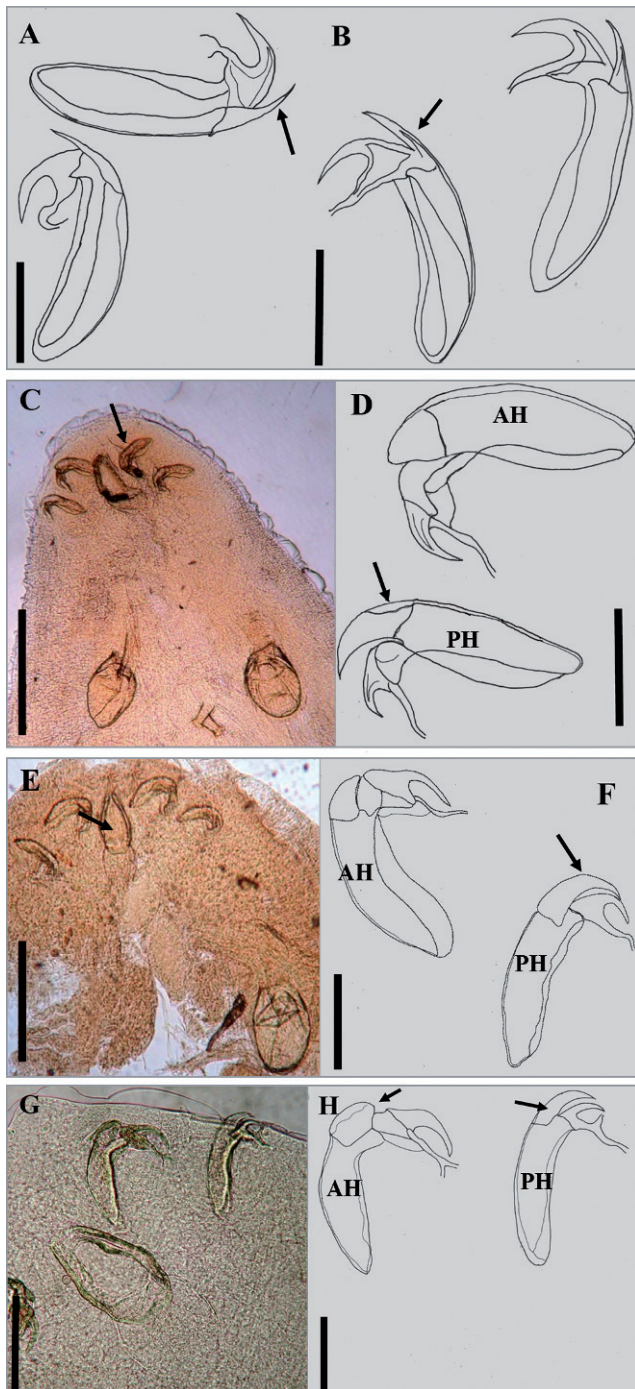
Isolated trematodes and cestodes were flattened and fixed with 5% formol-saline under cover slip pressure on a micro-

**Table II.** Prevalence of parasitic infections in *Osteolaemus tetraspis*

Parasite	Prevalence (%) (n = 11)	Mean intensity ± SD
<b>Pentastomida</b>		
<i>Sebekia</i> sp.	1/11(9.1)	2.0
<b>Trematoda</b>		
<i>Pseudodiplostomum thomasi</i>	5/11(45.5)	34.8±11.54
<b>Nematoda</b>		
<i>Dujardinascaris</i> sp.	9/11(81.8)	6.3±1.92
<i>Camallanus</i> sp.	1/11(9.1)	1.0

**Table III.** Prevalence of parasitic infections in *Varanus ornatus*

Parasite	Derived Savanna (n = 4)		Rainforest (n = 6)	
	Prevalence (%)	MI ± SD	Prevalence (%)	MI ± SD
<b>Pentastomida</b>				
<i>Sebekia</i> sp.	–	–	3/6(50)	5.3±2.08
<b>Cestoda</b>				
<i>Duthiersia fimbriata</i>	3/4(75)	22.7±7.51	3/6(50)	4.3±0.58
Unidentified pseudophyllidean cestode	1/4(25)	2.0	1/6(16.7)	3.0
<b>Trematoda</b>				
Unidentified trematode	–	–	2/6(33.3)	5.5±2.12
<b>Nematoda</b>				
<i>Tanqua tiara</i>	3/4(75)	6.3±2.52	5/6(83.3)	23.2±6.53
<i>Cosmocerca ornata</i>	1/4(25)	1.0	–	–
<i>Oswaldocruzia hoeplii</i>	1/4(25)	10.0	–	–



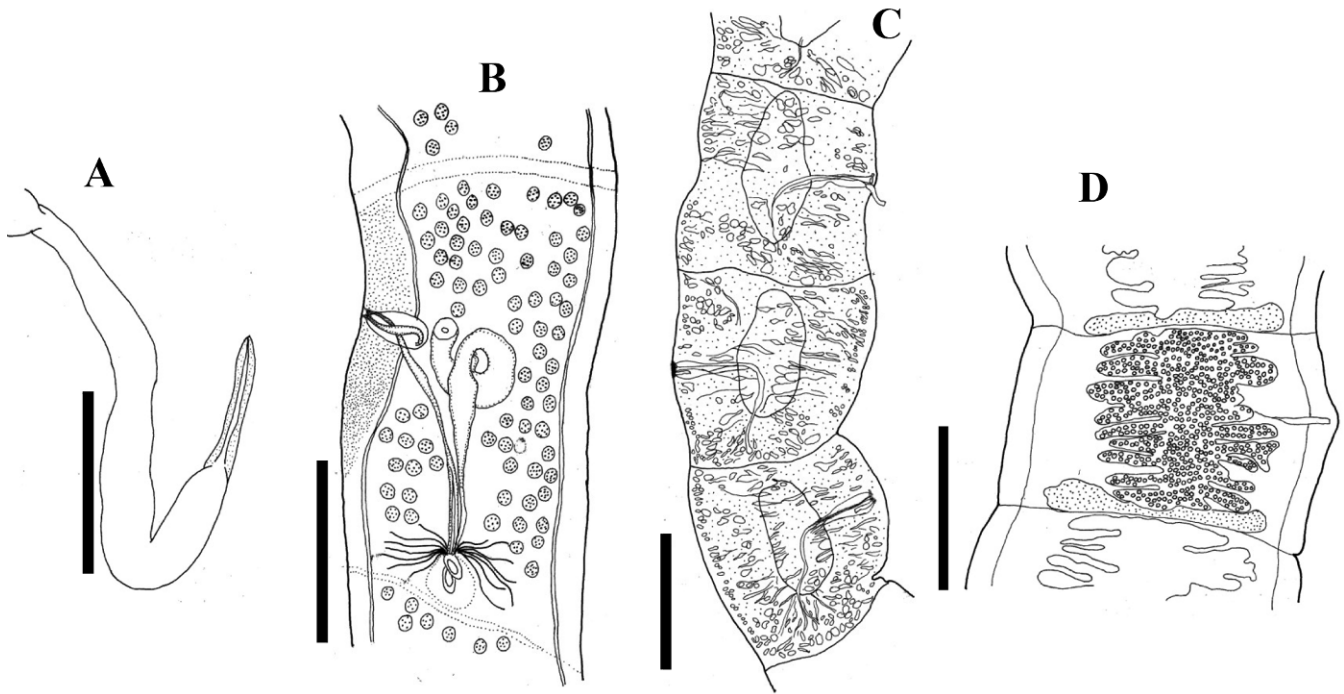
**Fig. 1A-H.** Features of the Sebekid pentastomid infecting *O. tetraspis* and *V. ornatus*. Double-hooked nymphs from *O. tetraspis* (A), *V. ornatus* (B); C, anterior end of male parasite from *O. tetraspis* showing hooks, buccal cadre and copulatory spicules and D, hooks of male parasite from *O. tetraspis*; E, anterior end of male parasite from *V. ornatus* showing hooks, buccal cadre and copulatory spicules and F, hooks of male parasite from *V. ornatus*; G, anterior end of female parasite from *V. ornatus* showing hooks and buccal cadre and H, hooks of female parasite from *V. ornatus*. Note the double-hooked posterior hooks adult males from *O. tetraspis* (D), *V. ornatus* (F) and adult female from *V. ornatus* (H) as indicated by the black arrows. AH, anterior hook, PH, posterior hook. Scale bars: A, B, D, F, H = 0.1 mm; G = 0.2 mm; C, E = 0.5 mm

scope slide and later stained with acetocarmine. The nematodes recovered were fixed in hot 70% alcohol, while the pentastomids were preserved in 70% alcohol-saline. For the purpose of examining the pentastomid hooks, the worms were decapitated and flattened on a microscope slide under a cover slip, by applying gentle pressure after adding a drop of Hoyer's medium. Photomicrographs were taken with a Coolpix Digital Camera (3.34 mega pixels) attached to a Nikon Alpha-Photo-2 Microscope. Line drawings were made from slide-mounted specimens with the aid of a drawing tube attached to an Olympus Vanox Research Microscope. Prevalence and mean intensity of parasites were estimated according to Bush *et al.* (1997).

## Results

The SVLs of the crocodiles ranged from 39 cm to 102 cm while those of the varanids were from 27 cm to 160 cm. The parasites recovered and their site of infection is shown in Table I. Three parasite taxa were recovered from *O. tetraspis* and these included nymphs and males of a pentastomid belonging to the family Sebekidae. Details of the nymphal hooks, cephalothorax of the male and features of the adult male hooks are shown in Figs 1A, C and 1D, respectively. The nymphal hooks were double hooked (Fig. 1A) while in the adult male, only the posterior hooks retained the double hook (Fig. 1D) as indicated by the black arrow. Other parasites recovered from the crocodiles were the trematode, *Pseudoneodiplostomum thomasi* and two nematode species, *Dujardinascaris* sp. and larva of a *Camallanus* sp. Although *Dujardinascaris* sp. had a higher prevalence (83.3%), *P. thomasi* had the highest intensity of infection (34.8 parasites/infected host) (Table II).

The varanids procured from the savanna-mosaic harboured no pentastomids but those from the rainforest were infected with pentastomids of the family Sebekidae with a prevalence value of 50% (Table III). Features of the nymphal hooks, male cephalothorax and adult male hooks are shown in Figs 1B, 1E and 1F. The nymphal hooks were double-hooked (Fig. 1B) as observed in specimens recovered from *O. tetraspis*. Adult male parasites had posterior hooks that had pointed fulcra extension (Fig. 1F). In the adult female parasites, the anterior hooks had a cowl-like anterior extension of the fulcrum (Fig. 1G) but the posterior hooks had a sharp fulcra extension (Fig. 1H). Two cestodes, *Duthiersia fimbriata* and an unidentified pseudophyllidean (Fig. 2), an unidentified trematode (Fig. 3) and the nematode *Tanqua tiara* were other parasites recovered from the varanids procured from the rainforest (Table III). The parasites recorded from varanids sourced from the derived savanna included *D. fimbriata*, the unidentified pseudophyllidean cestode, *T. tiara*, *Cosmocerca ornata* and *Oswaldocruzia hoepfli*. *Duthiersia fimbriata* and *T. tiara* were the most prevalent parasites in both the derived savanna and rainforest varanids (Table III).

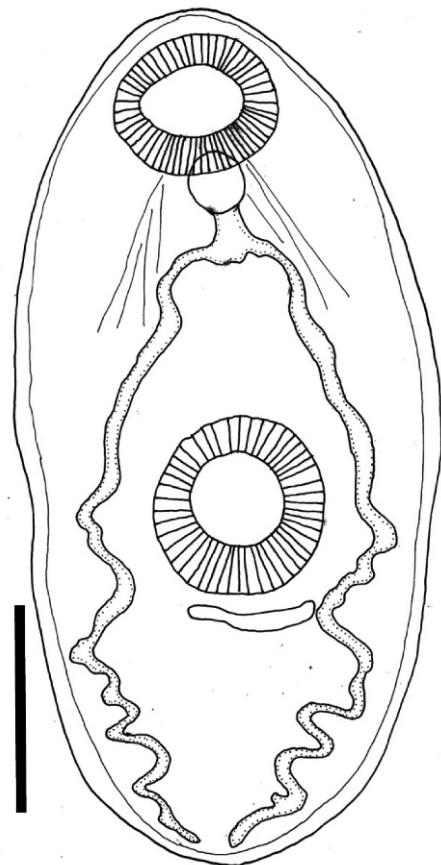


**Fig. 2.** Unidentified pseudophyllidean cestode infecting *V. ornatus*. A, scolex B, young mature proglottid; C, late mature proglottid; D, gravid proglottid. Scale bars: A, C = 1 mm; B, D = 0.5 mm

## Discussion

The host specimens investigated in this study were all young animals. Such indiscriminate exploitation has serious implications for the conservation of these animals. Of the four endoparasites recovered from *O. tetraspis*, *P. thomasi*, *Dujardinascaris* sp. and pentastomids have been previously reported from crocodiles by other investigators (Dollfus 1935; Sprent 1977; Fischthal and Thomas 1968; Graber 1981; Riley and Huchzermeyer 1995 a, b, 2000; Riley *et al.* 1997; Junker *et al.* 2006a).

Based on the morphology of the nymphal hooks of the pentastomid recovered from *O. tetraspis* and *V. ornatus* (Fig. 1A and 1B), it is obvious that these parasites belong to the family Sekebiidae. Members of this family known to infect *O. tetraspis* include *Sebekia okavangoensis* (Riley and Huchzermeyer 1995a), *Agema silvaepalustris* (Riley *et al.* 1997), *Alofia parva* (Riley and Huchzermeyer 1995b). The parasite recovered from this study differed from *S. okavangoensis* in that the posterior hooks were double-hooked and lacked the patch of prominent spines on the dorsal surface characteristic of this species. The oral cadre is also not typical of a *Sebekia* sp. neither is it U-shaped as in *Alofia* sp. It appeared ovoid as in *Agema* but the shape of the copulatory spicules, which were more robust, separated it from this genus. Although the blade on the anterior hook pair were larger than the posterior pair as in *Agema*, the presence of a cowl in the anterior hook of the parasite from the present study further differentiated it from *Agema silvaepalustris*. What is of interest and worthy of note is that *O. tetraspis* shares this parasite with *V. ornatus*,



**Fig. 3.** Unidentified juvenile trematode infecting *V. ornatus*. Scale bar: 0.5 mm

since the features of the parasites recovered from both hosts are basically the same. This finding is perhaps a new occurrence that deserves further investigation and proper identification of the parasite reported herein.

Dollfus (1935) described *P. thomasi* from *O. tetraspis* from the Congo. Fischthal and Thomas (1968) reported this trematode in *C. niloticus* from Ghana. This is the first report of this parasite from Nigeria and therefore represents a new distribution record. Groschaft and Barus (1970) considered the specimens they recovered from *Crocodylus rhombifer* from Cuba as morphologically similar to *P. thomasi*. Moravec (2001) re-examined ten original specimens of the *Pseudoneodiplostomum* sp. reported by Groschaft and Barus and compared them with the specimens he recovered from *Crocodylus moreletii* from Mexico. Moravec (2001) observed that the specimens were very similar to the specimen previously described from *C. rhombifer*. The material from *C. rhombifer* differed from *P. thomasi* in having a more elongate tribocytic organ and a shorter posterior segment, a different length ratio of both segments and in its geographical distribution. Moreover, unlike *P. thomasi*, the vitellaria of the Cuban material never extended posteriorly below the level of the posterior testis. Moravec (2001) therefore named the Cuban and Mexican specimens as *P. groschafti*. The specimens recovered in this investigation were far larger than *P. groschafti*. Whereas the total length of *P. groschafti* was 2.298 mm, the specimen recovered in this study measured between 4.080 mm to 4.450 mm, dimensions which are also higher than the type specimen of *P. thomasi* (Dollfus 1935; Dubois 1936). Dollfus recorded a length range of 2.85 mm to 3.09 mm while Dubois had a range of between 2.53 mm to 2.95 mm. Except for this size difference, other morphological characteristics of the materials from this study are those of *P. thomasi*.

*Dujardinascaris* is a cosmopolitan ascaridoid genus with 18 species described till date and almost all are restricted to Crocodylia in fresh and salt waters (Sprent 1977; Graber 1981; Baker 1987; Goldberg *et al.* 1991; Sprent *et al.* 1998). Most of the specimens (adult and larvae) in this study were recovered from the stomach of the crocodiles as similarly reported by Moravec (2001). Some specimens were however recovered from the small intestine. While we found a prevalence of 81.8% in this study and 100% was reported by Moravec (2001), Villegas and Gonzalez-Solis (2009) reported a prevalence of 3.85% from stomach-flushed *Crocodylus acutus* in Mexico. The low value obtained by Villegas and Gonzalez-Solis (2009) may reflect more on the collection method rather than the true infection value in the specimens examined.

*Camallanus* sp. has not been previously reported to infect crocodiles. More crocodile specimens need to be examined to confirm if this was an accidental infection or that crocodiles represent a new host record for this nematode.

Although the varanids from the derived savanna had a higher parasite species richness than those lizards procured from the rainforest, some parasites were common to lizards

from both bioclimatic zones. These included *D. fimbriata*, the unidentified pseudophyllidean cestode and *T. tiara*. *Cosmocerca ornata* and *O. hoeplii* were the other parasites recorded in the derived savanna specimens while the unidentified pentastomid and an unidentified trematode were recovered only from the lizards sourced from the rainforest (Table II).

*Duthiersia fimbriata* and an unidentified pseudophyllidean were the cestodes recorded from *V. ornatus* in this study. *Duthiersia fimbriata* is a common parasite in varanids. Prevalence values of 75% and 50% were recorded in specimens procured from the derived savanna and rainforest varanids, respectively. Mettrick (1963) reported *D. fimbriata* from *V. niloticus* in northern Rhodesia (now Zimbabwe) and it also occurred in the *V. exanthematicus* reported to have died from pentastomiasis caused by an undescribed *Sambonia* species (Edmund *et al.* 2000). *Duthiersia expansa*, the Asian variant of *Duthiersia* (Woodland 1940), infects *Varanus salvator* in Malaysia (Brooks and Palmieri 1992). We observed that older/larger specimens of *V. ornatus* had lower worm burdens when compared with younger/smaller host specimens. It may be that adult hosts develop immunity with age. This report of *D. fimbriata* in *V. ornatus* in Nigeria also represents a new locality record for this parasite.

The unidentified pseudophyllidean cestode was recovered from only two host specimens. The parasite was characterized by a scolex with weak bothria and a long neck (Fig. 2A). The testes were numerous and distributed all over the medullar; the ovary was bilobed (Fig. 2B) as described for the genus *Probothriocephalus* (Bray *et al.* 1994), which is reported to infect deep water teleosts. As also described for this genus, the genital openings were irregularly alternating with protrusible cirrus, which we observed in both young and mature proglottids (Fig. 2C). The uterus which is narrow at the base and expanded closer to the genital pore in the mature proglottid (Fig. 2B) became sacculate in the gravid segment (Fig. 2D). From the close resemblance between *Probothriocephalus* and the unidentified pseudophyllidean found in this study, it is possible that other species of this genus infect vertebrates other than teleosts.

A trematode parasite recovered from the stomach of two varanids procured from rainforest locations (Fig. 3) could not be identified as all the specimens obtained were immature and lacking distinct reproductive structures. More hosts need to be examined to recover adult specimens for definitive identification and description.

Amongst the five nematodes recovered from the *V. ornatus*, *T. tiara* was the most frequently encountered, with a prevalence and mean intensity of 75% and 4.75, respectively, in hosts procured from the derived savanna and 83% and 19.33, respectively, in varanids sourced from the rainforest. Infection with *T. tiara* appears to be a common occurrence in varanids because Baylis and Lane (1920) also reported infection with this parasite in *V. exanthematicus* investigated in Nigeria.

*Cosmocerca ornata* and *O. hoeplii* were only recorded from lizards procured from the derived savanna. *Cosmocerca*

*ornata* has been reported to infect a wide range of reptiles and amphibians (Baker 1981). Aisien *et al.* (2003) found this parasite in amphibians of the savanna mosaic of Nigeria. *Oswaldocruzia hoepplii* recorded in this study has previously been reported to infect amphibians and reptiles in East, West and Central Africa (Baker 1987), and also in *V. exanthematicus* (Sprent 1985). Several species of *Oswaldocruzia* including *O. chameleonis*, *O. cricogaster*, *O. gracilepis*, *O. gassmanae*, *O. johnstoni*, *O. hoepplii* and *O. perreti* have been reported to infect amphibians and reptiles in East, West and Central Africa (Durette-Desset and Vaucher 1979; Baker 1987).

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