Pentastomid infections in cichlid fishes in the Kruger National Park and the description of the infective larva of *Subtriquetra rileyi* n. sp.

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ABSTRACT

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During 1995, studies were conducted on the pentastome fauna of the cichlid fishes *Tilapia rendalli* and *Oreochromis mossambicus* in the Kruger National Park. The prevalence of infective pentastome larvae was 40,5% in *T. rendalli* and 9,2% in *O. mossambicus*. Encapsulated nymphs of *Leiperia cincinnalis* were taken from the mesentery, while *Sebekia wedli* was either encapsulated or free-living in the swim bladder. The subtriquetrids moved about freely in the swim bladder. *L. cincinnalis* was present in 0,5% of *T. rendalli* and 0,8% of *O. mossambicus* and additional descriptions and measurements of the nymphs are presented. *S. wedli* was present in 2,5% of *O. mossambicus* and a new *Subtriquetra* species, for which the name *Subtriquetra rileyi* n. sp. is proposed, in 7,5%. This ratio in *T. rendalli* was 40,5% and 2,2%, respectively. Of the infected *T. rendalli*, 89% harboured one or two sebekiid larvae, while a single fish harboured eight. Fish infected with *S. riieyi* contained only one larva each.

The condition factor of infected *T. rendalli* was compared statistically to that of uninfected fish and no significant difference found. However, infected fish were significantly shorter and lighter than uninfected ones.

S. rileyi differs from the other three known *Subtriquetra* spp., *Subtriquetra subtriquetra*, *Subtriquetra megacephala* and *Subtriquetra shipleyi* in both hook size and annulus counts. Furthermore, *S. subtriquetra* occurs in South American crocodilians (Riley 1986), and *S. megacephala* and *S. shipleyi* in crocodilians in India (Fain 1961). This is the first record of the genus occurring in Africa and although adult specimens of *S. rileyi* n. sp. were not obtained, we assume that the new species is specific to Nile crocodiles.

Keywords: *Caiman sclerops*, cichlid fishes, crocodiles, *Crocodylus niloticus*, *Crocodylus palustris*, Kruger National Park, *Leiperia cincinnalis*, *Oreochromis mossambicus*, pentastomids, *Sebekia wedii*, *Subtriquetra rileyi*, *Tilapia rendalli*

INTRODUCTION

Pentastomes were first described in crocodiles more than a century ago and it was assumed from an early stage that fish were the intermediate hosts of these endoparasites. Rudolphi (1819, cited by Sambon 1922) was one of the first to report on crocodilian pentastomids found in the South American caiman, *Caiman sclerops*, and described them as *Pentastoma proboscideum*. Bremser (1824, cited by Sambon 1922) collected pentastomids from the mouth cavity of *Caiman sclerops*, which he thought to be identical to those described by Rudolphi. Sambon (1922) created the genera *Sebekia* and *Subtriquetra* to accommodate the specimens collected by Rudolphi (1819) and Bremser (1824) which were renamed *Sebekia*

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oxycephala Sambon, 1922 and *Subtriquetra subtriquetra* Sambon, 1922, respectively. The nymphal form of the latter species was found in the intestine of the cichlid fish *Acara coscudo* by Natterer (cited by Sambon 1922).

Currently two families of crocodile pentastomes are known. These are the family Sebekidae which contains the genera *Sebekia*, *Leiperia* Sambon, 1922, *Alofia* Giglioli, 1922, *Selfia* Riley, 1994 and *Agema* Riley, Hill & Huchzermeyer, 1997, and the family Subtriquetridae, which contains the single genus *Subtriquetra* (Heymons 1935; Fain 1961; Riley 1994; Riley, Hill & Huchzermeyer 1997). To date, three species of *Subtriquetra* are known, namely *S. subtriquetra*, *Subtriquetra megacephala* and *Subtriquetra shipley*. In this article, we describe the infective larvae of a fourth species, which we believe to be endemic to Africa, and for which we propose the name *Subtriquetra rileyi* n. sp.

Little is known about the distribution of pentastome infections in freshwater fish in Africa. The existing data mainly refer to Central Africa and are mostly restricted to the naming of those fish that act as intermediate hosts for *Leiperia cincinnalis* Sambon, 1922 (Fain 1961).

This paper presents some of the results of a postgraduate study on pentastomes in South Africa (Junker 1996). As part of the study two cichlid species, Mozambique bream, *Oreochromis mossambicus* Peters, 1852 and red-breasted bream, *Tilapia rendalli swierstrai* Boulanger, 1896, were examined for the prevalence and intensity of pentastome infections. The aim was to assess the suitability of *O. mossambicus* and *T. rendalli* as intermediate hosts and to determine their pentastome fauna, as well as to investigate the biology of pentastomes in their intermediate hosts.

The fishes were chosen because they are common and widespread in the Kruger National Park (KNP) and occur in all the rivers in which Nile crocodiles, *Crocodylus niloticus*, are found. *O. mossambicus* inhabits the east coastal rivers of the lower Zambesi system down to the Bushman System in the Eastern Cape Region and is widespread in rivers of the Northern Province and KwaZulu-Natal. *O. mossambicus* prefers standing waters and does not occur in fast-flowing rivers. It is a mouth-breeder and due to a high tolerance of changes in salinity and temperatures can breed in saline as well as in fresh water. The diet of *O. mossambicus* consists mainly of algae, diatoms and detritus but insects and small invertebrates are readily taken by large individuals. *O. mossambicus* is an important species in aquaculture as well as in commercial and subsistence fisheries (Skelton 1993).

T. rendalli is present in the Cunene, Okavango and Zambesi Systems and is also found in Mozambique and Zaire. In South Africa, it occurs in the Lowveld of Mpumalanga and the Northern Province, and in KwaZulu-Natal. Like *O. mossambicus*, *T. rendalli* is euryhaline and eurythermic. Its preferred habitat is quiet, well-vegetated water along river littorals, backwaters, floodplains and swamps where it feeds mainly on water plants, algae and aquatic invertebrates and even small fish. *T. rendalli* is valued in aquaculture and fisheries, and as angling species (Skelton 1993).

MATERIALS AND METHODS

O. mossambicus ($n = 119$) and *T. rendalli* ($n = 185$) were caught with baited hand-lines in the Phabeni Dam in the KNP on two occasions during February 1995.

Fish were weighed to the nearest gram and the total length measured from the tip of the snout to the most distal tip of the caudal fin (Skelton 1993). After opening the fish by ventral incision, the surface of the viscera and tissues surrounding the gastro-intestinal tract were examined macroscopically for the presence of pentastome larvae. The swim bladders were removed and placed in separate vials in phosphate buffered saline (PBS). Within 4 h of collection, the swim bladders were examined under a stereoscopic microscope between two perspex slides while applying gentle pressure. Pentastomes were removed from the respective tissues by blunt dissection.

All pentastomes were transferred into PBS and either used for experimental infections or fixed in cold 70% ethanol and mounted in Hoyer's medium for identification. Measurements were taken from whole mounted specimens according to the methods described by Riley, Spratt & Winch (1990) (Fig. 1B, C).

Measurements of the oral cadre of four specimens of *S. rileyi*, in which this structure was slightly laterally orientated, correlated well with those taken from two oral cadres in frontal view. Annuli were counted either by including those annuli that were bordered anteriorly and posteriorly by a complete row of spines (Winch & Riley 1986b), or by counting the total number of annuli, including incomplete ones.

Prevalence and intensity (*sensu* Margolis, Esch, Holmes, Kuris & Schad 1982) of pentastome infections in the fish were determined and the condition factor (C) of the fish was calculated using the formula:

$$C = 100 \text{ [body mass (g)]} \div \text{total length (cm)}$$

In order to evaluate the impact of infection on the hosts, the independent, bilateral U-Test of Wilcoxon, Mann and Whitney was used to compare the body-mass, total length and condition factor of infected *T. rendalli* to those of uninfected ones. No biometrics were done with data of *O. mossambicus*, as we considered the number of infected fish ($n = 11$) to be too low to give reliable results.

RESULTS

The overall prevalence of pentastome infections in *T. rendalli* was 40,5% and 9,2% in *O. mossambicus*; both families of pentastomes were collected from both cichlid species.

All sebekiid larvae, with the exception of two nymphs of *L. cincinnalis*, were assigned to *Sebekia wedli* Giglioli, 1922, the identification of which was confirmed by experimental infection of final hosts (Junker 1996).

The larvae of *S. wedli* (Table 1) possess double hooks and the posterior half of each annulus carries a row of spines. The first 2–3 rows of spines are incomplete. Chloride cells are arranged in a line along the anterior edge of each annulus. The bud-shaped oral cadre is open anteriorly but fibrous material between the two prongs may make it to appear closed. Annulus counts vary from 71–79.

The main measurements of the encysted larvae of *L. cincinnalis* taken from the mesentery of *O. mossambicus* and *T. rendalli* are listed in Table 2. Their elongated, slender appearance, together with a distinctly rounded head and large double hooks, clearly distinguishes the larvae of *L. cincinnalis* from other sebekiid larvae. Chloride cells are distributed over the entire width of each annulus. Annuli are equipped with a row of minute spines on the posterior border. The heavily chitinized oral cadre resembles that of the genus *Alofia*: it is U-shaped with a peg-like extension into the oesophagus. The oral cadre appears very small. The hooks are double; the spike is slender and only slightly curved while the hook itself is robust and strongly curved.

The prevalence and intensity of larval *Sebekia* and *Subtriquetra* in *T. rendalli* and *O. mossambicus* are presented in Table 3. While *T. rendalli* was predominantly parasitized by *S. wedli* and only a few fish were

TABLE 1 The main characteristics of infective larvae of *Sebekia wedli* recovered from *Oreochromis mossambicus* and *Tilapia rendalli* out of the Phabeni Dam, Kruger National Park. All measurements in micrometres unless otherwise indicated

Specimen number	Number of annuli	Body length (mm)	Body width (mm)	Mouth dimensions			Hook length	Fulcrum length
				Overall length	Cadre length	Cadre width		
LM2	76,0	5,3	0,7	188,6	116,4	65,6	78,7	171,4
LM3	75,0	6,0	0,6	170,6	105,0	62,3	74,9	170,6
LM4	74,0	5,4	0,6	155,8	100,0	65,6	*n*	159,1
LM5	75,0	5,4	0,5	160,7	108,2	67,2	68,9	150,1
LM6	72,0	4,4	0,6	141,0	100,0	64,0	74,2	154,2
LM7	72,0	3,9	0,6	154,2	103,3	54,1	75,4	134,5
LM8	71,0	4,7	0,5	137,8	93,5	55,8	76,5	163,2
LM9	79,0	*n*	0,7	200,1	131,2	70,5	76,7	182,9
LM10	76,0	5,0	0,7	182,0	126,3	62,3	84,5	171,8
LM11	75,0	*n*	0,7	185,3	113,2	64,0	74,9	177,1
LM13	76,0	4,8	0,7	180,4	113,2	64,0	90,2	188,2
Mean	74,6	5,0	0,6	168,8	110,0	63,2	77,5	165,7
(SD)	(2,3)	(0,6)	(0,1)	(20,3)	(11,5)	(4,7)	(5,9)	(15,6)

n = not measured

TABLE 2 The main characteristics of infective larvae of *Leiperia cincinnalis* recovered from *Oreochromis mossambicus* (LM20) and *Tilapia rendalli* (LM19) out of the Phabeni Dam, Kruger National Park. All measurements in micrometres unless otherwise indicated

Specimen number	Number of annuli	Body length (mm)	Body width (mm)	Mouth dimensions			Hook length	Fulcrum length
				Overall length	Cadre length	Cadre width		
LM19	100	22,4	1	377,2	280,6	119,6	242,7	545,1
LM20	*n*	27,0	1	405,6	314,6	132,6	286,7	567,0

n = not measured

infected with *S. rileyi*, this ratio was reversed in *O. mossambicus*.

The intensity of infection in the fish examined was low. Of the 75 infected *T. rendalli*, 47 (63 %) harboured single sebekiid larvae and 20 (27 %) had two. The remaining eight of the fish had more than two larvae in the swim bladder, a single one harbouring eight. A total of 132 *S. wedli* larvae were recovered from the 75 infected fish. The four *T. rendalli* infected with *S. rileyi* each contained one larva.

Similar results were obtained for *O. mossambicus*. The three fish infected with *S. wedli* had one, two and eight larvae, respectively. All but one of those that were infected with *S. rileyi* had single larvae.

All sebekiid larvae, except for those of *L. cincinnalis*, which was encysted on the mesentery of both fish species, had invaded the swim bladder. Within *T. rendalli*, 77% of these larvae were encysted, whereas only 23% occurred free. Approximately the same ratio was found in *O. mossambicus* (64% and 36%, respectively). All larvae of *S. rileyi* were freely mobile in the swim bladders of both intermediate hosts.

The comparison of infected *T. rendalli* (n = 75) to uninfected fish (n = 110) showed that infected fish were significantly (P = 0,05) shorter and lighter than uninfected ones (63 g and 14 cm vs. 76 g and 15 cm). The condition factor, however, did not differ significantly between the two groups (45 and 51, respectively). No pathological examination was done on infected fishes but neither obvious lesions nor any signs of stress caused by the developing pentastomes were detected.

Description of *Subtriquetra rileyi* n. sp. (Table 4)

TYPE HOSTS AND LOCALITY

Oreochromis mossambicus and *Tilapia rendalli* from the Phabeni Dam (25°1′S, 31°15′0

.E), Kruger National Park, South Africa.

TYPE MATERIAL

Six syntype specimens, all mounted in Hoyer's medium, deposited in the collection of the British Museum (Natural History), No. BMNH 1998.71.1–6.

TABLE 3 Prevalence and intensity of *Sebekia wedli* and *Subtriquetra rileyi* n. sp. in *Tilapia rendalli* and *Oreochromis mossambicus* from the Phabeni Dam, Kruger National Park

Host	*Tilapia rendalli* (n = 185)				*Oreochromis mossambicus* (n = 119)			
Parasite	No. positive	Prevalence	Intensity		No. positive	Prevalence	Intensity	
		%	Mean	Range		%	Mean	Range
Sebekia wedli	75	40,5	1,8	1–8	3	2,5	3,7	1–8
Subtriquetra rileyi	4	2,2	1,0	1	9	7,5	1,1	1–2

TABLE 4 Main characteristics of the infective larvae of *Subtriquetra rileyi* n. sp. out of *T. rendalli* and *O. mossambicus* from the Phabeni Dam, Kruger National Park. All measurements in micrometres unless otherwise indicated

Specimen number	Number of annuli	Body length (mm)	Body width (mm)	Mouth dimensions			Hook length		Base length		Fulcrum length	
				Cadre	Overall	Width	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
3#6	28 (33)	2,7	0,8	193	221	–	–	329*	–	182*	–	–
4#6	28 (32)	2,9	1,0	209	246	76	317	336*	170	170*	–	–
5#6	28 (34)	3,4	0,9	207	242	78	362	362	189	192	–	–
6#6	28 (33)	3,0	1,1	196	230	74	324*	317*	175*	179*	557	511*
1#6	30 (36)	4,0	1,3	212	242	[106]	337	331	188	178	[616]	531
2#6	30 (35)	3,1	0,9	207	242	–	366*	–	179*	–	–	–
Mean	28,6	3,2	1,0	204	237	76	341	335	180	180	557	521
(SD)	(0,9)	(0,5)	(0,2)	(7,6)	(9,6)	(2,0)	(22,1)	(16,6)	(8,2)	(7,9)	–	(14,1)

Mouth dimensions of specimens 1#6 and 2#6 were taken from frontal view, the oral cadres of the remaining specimens were positioned slightly laterally

* Only a single feature measured

[ ] Data not included in mean and SD

( ) Total number of rows of spines, including incomplete ones

ETYMOLOGY

The species is named after Dr John Riley, University of Dundee, United Kingdom, in recognition of his extensive contribution to the knowledge of the pentastome parasites.

DESCRIPTION

The living infective larvae of the new species could be easily distinguished from the sebekiids by their bright red colour. The body is elliptical (Fig. 1A), ventrally flattened and dorsally convex. The dorsal vault is more pronounced anteriorly, reaching its maximum shortly before the cephalothorax and quickly sloping to a flattened anterior border. The margins of the body remain flat.

The anterior and posterior hooks are simple, slender and sharply pointed (Fig. 1B; 2A, B). The anterior hooks are slightly longer than the posterior ones. Their fulcra extend far into the cephalothorax and their surface appears finely granular (Fig. 1A; 2B). The hooks form a curved line in the centre of which lies the oval oral opening (Fig. 2A). The latter is supported by a heavily chitinized oral cadre (Fig. 1C), which is closed anteriorly. Deep longitudinal grooves mark the surface of the anterior prongs. In lateral view, the oral cadre has the shape of half a walnut shell. The almost parallel anterior prongs curve dorso-ventrally in such a way that the posterior and anterior ends point ventrally. The mouth is superficial.

The abdomen carries conspicuous rows of sharply pointed, projecting spines (Fig. 2A–C) but on the first two or three annuli, these are incomplete. The spines emerge in the mid-annular region. The total length of the spines is 52,6 µm, 37,2 µm of which are embedded in the cuticle, while 15,4 µm are free. Chloride cells are disposed in a single row in the anterior half of each annulus (Fig. 2D).

DISCUSSION

Little is known about the intermediate hosts of the pentastome parasites of crocodiles. In this study, *L. cincinnalis* was recovered from *O. mossambicus* and *T. rendalli*. Thus, both cichlid species must be added to the list of intermediate hosts of *L. cincinnalis* as given by Fain (1961).

The measurements of the infective larvae of *L. cincinnalis* from *O. mossambicus* and *T. rendalli* fit in well with the data provided for three double-hooked nymphs from *Pelamatochromis robustus* (Riley & Huchzermeyer 1996). At the same time they reflect some of the intraspecific variation of all the morphogical characteristics emphasized by the latter authors. The infective larvae we recovered from the fishes were only slightly smaller than those found in the aorta of *C. niloticus* (Junker 1996).

Adult *S. wedli* were mentioned by Wedl as early as 1861, establishing the Nile crocodile as its final host (Sambon 1922) but nothing is recorded as regards its intermediate hosts. *O. mossambicus* and *T. rendalli* are therefore the first intermediate host records for this parasite.

Annulus counts as well as hook- and mouth dimensions were used to distinguish *S. wedli* from the infective larvae of other sebekiids. The presence of double hooks and the annular rows of spines indicated that the larvae we recovered had reached the infective stage (Riley 1986; Winch & Riley 1986a). The identification of the larvae as *S. wedli* was later confirmed by experimentally infecting final hosts with encysted larvae recovered from *O. mossambicus* and *T. rendalli* (Junker 1996).

Both cichlid species are preyed upon by *C. niloticus* (Branch 1994). Both fish species are bottom feeders and therefore readily exposed to the pentastomes while feeding on detritus or water plants. The eggs of *S. wedli* containing the infective stages must be ingested, while the free-living primary larvae of *Subtriquetra* hook onto the fish and penetrate the skin (Vargas 1975; Winch & Riley 1986b). The prevalence of infection with *S. wedli* is markedly higher in *T. rendalli* than in *O. mossambicus* (40,5% and 9,2%, respectively). The opposite was true of *S. rileyi*.

From a physiological standpoint, both fish species are suitable intermediate hosts. It appears that behavioural differences, especially feeding behaviour, accounts for the higher intensity of *S. wedli* in *T. rendalli* and the higher intensity of *S. rileyi* in *O. mossambicus*. However, Winch & Riley (1986b) found *Tilapia zilli*, to be an unsuitable host for the development of *S. subtriquetra* and the primary larvae were all killed around the time of the first moult.

Nothing has yet been published on the prevalence of crocodile pentastomes in fish intermediate hosts in Africa. Low levels of infection have been reported for several intermediate hosts of *S. oxycephala*, a species present in South American crocodilians, by Winch & Riley 1986a who found one infective larva in each of four *Aequidens pulcher* and one *Tilapia* sp.. Boyce, Cardeilhac, Lane, Buergelt & King (1984) recorded a prevalence of 60% and a mean intensity of 9,1 *S. oxycephala* in mosquito fish, *Gambusia affinis*. Both the prevalence and the intensity of *S. oxycephala* in mosquito fish is considerably higher than that of *S. wedli* in *T. rendalli* and *O. mossambicus*. High pentastome burdens appear to be rare.

The infective larvae recovered from the fish show a high degree of site selection. *S. rileyi* was found exclusively in the swim bladder, which conforms to the

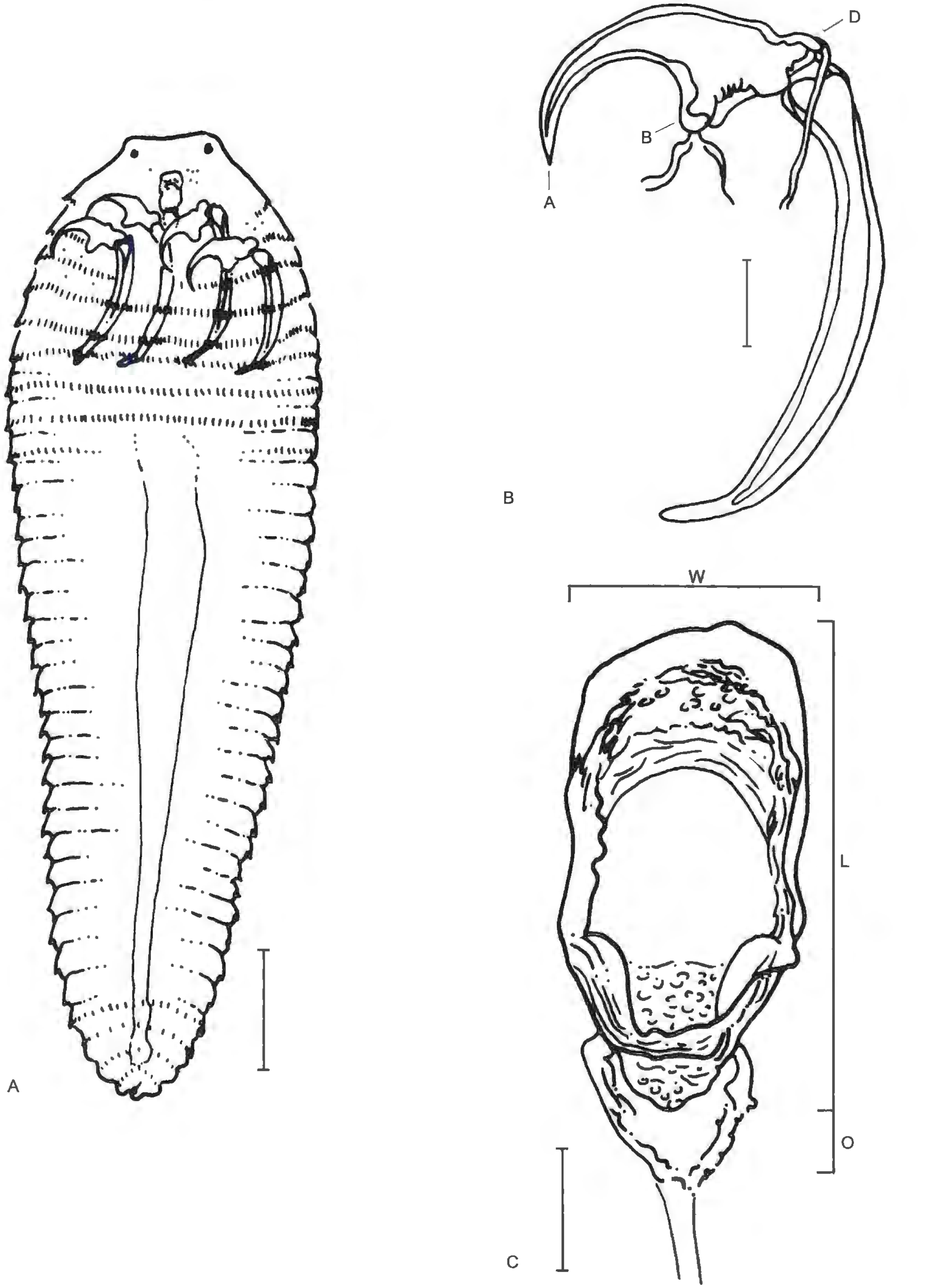

FIG. 1 A. Infective larva of *Subtriquetra rileyi* n. sp. Scale bar: 500 µm. B. Left posterior hook; length (AD) and base length (BD). Scale bar: 100 µm. C. Oral cadre. Cadre length (L), overall length (L + O) and width (W) as illustrated. Scale bar: 50 µm

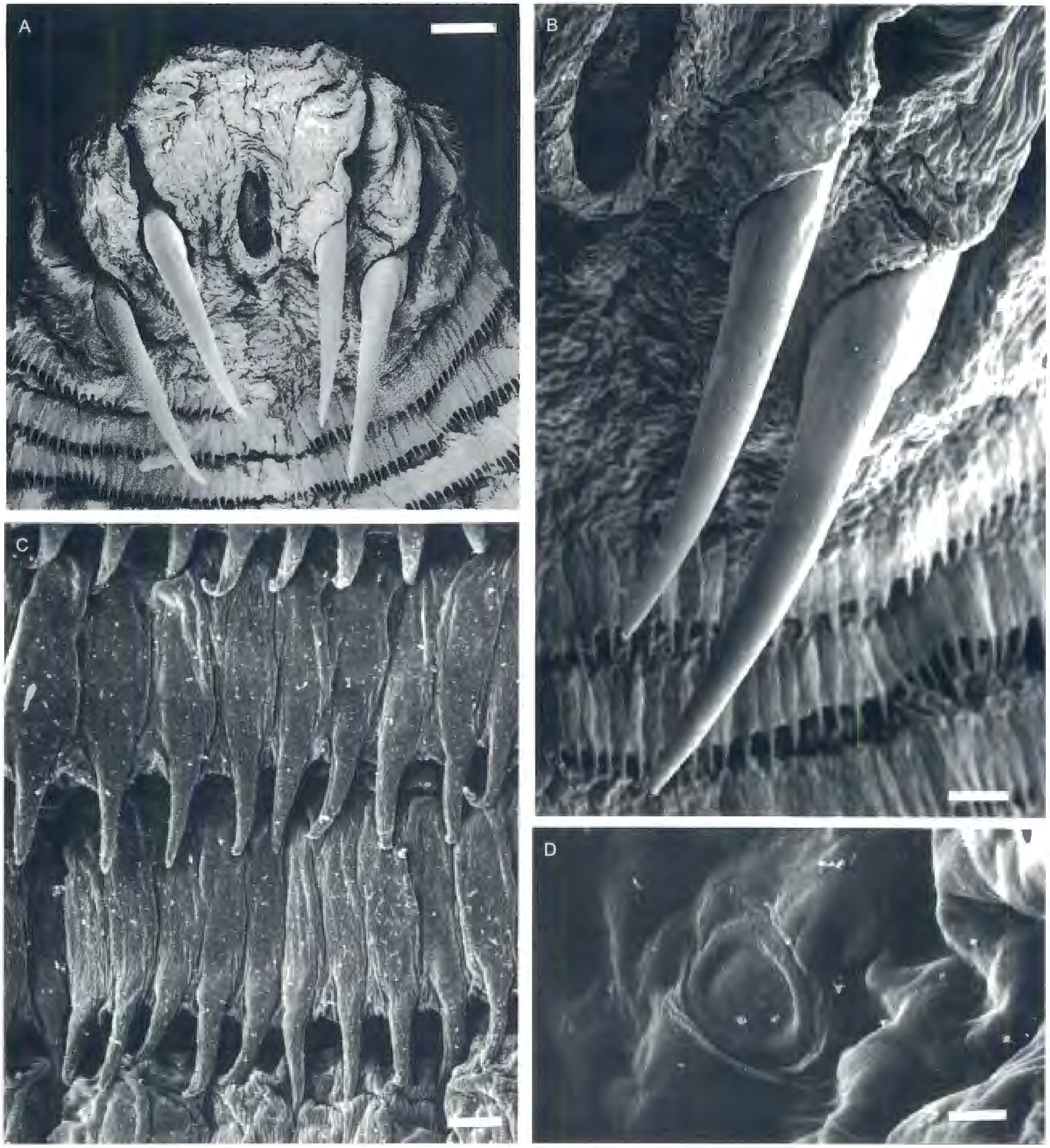

FIG. 2 A. Scanning electron micrograph of an infective larva of *Subtriquetra rileyi* n. sp. showing the oral cadre situated between the two pairs of single hooks and the rows of spines covering the annuli. Scale bar: 60 µm. B. Detail of the left hook pair. The surfaces of the hooks appear finely granular. Scale bar: 20 µm. C. Detail of the prominent annular spines. Scale bar: 9 µm. D. Detail of a chloride cell. Scale bar: 10 µm

findings of Vargas (1975) and Winch & Riley (1986b). The available information for *Sebekia* spp. indicates that larvae occur at a variety of sites, such as muscle, kidney, liver, mesentery, swim bladder or free in the abdominal cavity (Overstreet, Self & Vliet 1985; Boyce, Kazacos, Kazacos & Engelhardt 1987; Riley 1986). Infective larvae of *S. wedli* were typically encountered in the swim bladder, where they encyst without causing any apparent damage to the host tissue. The ratio of free-living to encysted *S. wedli* larvae in *T. rendalli* and *O. mossambicus* is similar to that found for *S. oxycephala* in experimentally infected fish (Winch & Riley 1986a). These authors report that 80% of the infective larvae of *S. oxycephala* were contained in a cyst of host origin in the swim bladder of experimentally infected fish. The fact that only the last larval stage is encysted is considered typical for the genus *Sebekia* in fish (Winch & Riley 1986a).

Infected *T. rendalli* examined in this study were found to be significantly shorter and lighter than uninfected *Tilapia*. A possible explanation could be a negative effect of the pentastomes on the development of their intermediate hosts, slowing the growth rate of infected fish. Once ingested, the hatched primary larvae penetrate the intestinal wall and start migrating within the host (Esslinger 1962a,b; Self 1969; Winch & Riley 1986a). This, and the activity of subsequent developmental stages, could quite easily cause extensive damage to host tissues affecting their normal function (Boyce 1985; Boyce & Kazacos 1991). However, comparison of the conditional factors of the two fish species in this study gave no indication of retarded development in infected fish. This suggests the possibility that shorter body-length and lower mass are not a result of but rather the cause for the infection. If the susceptibility to pentastome infections varied in different age groups, juvenile fish would be more likely to become infected. Different behaviour and feeding habits of the fish, as well as the behaviour of the primary larva of *Subtriquetra* could account for this. The eggs of *S. wedli* need to be swallowed, whereas primary larvae of *Subtriquetra* only need to make contact with the skin. Young *T. rendalli* mainly feed on detritus (Skelton 1993), prefer quiet, well-vegetated areas and often remain in such areas for extended periods of time (Boomker 1980, personal observation). The young of *O. mossambicus* are more mobile and could have a better chance to come into contact with larger numbers of the primary larvae of *S. rileyi*.

Sebekia mississippiensis causes extensive damage in swordfish, *Xiphophorus helleri*, whereas only a mild inflammatory response was elicited in mosquito fish (Boyce *et al.* 1987). *S. subtriquetra* was highly pathogenic in small fish, but bigger fish were able to tolerate up to seven infective larvae (Winch & Riley 1986b). These findings emphasize that the pathology of pentastomid infections depends on several factors, such as intensity of infection, the size ratio of the host and parasite as well as previous infections (Self 1972). No macroscopically visible pathological lesions were evident in any of the fish examined in this study. When the size of the fish is compared to the size of the pentastomes, and considering the low intensity of infection, it seems feasible that the developing pentastome larvae do not seriously affect their hosts.

The conspicuous red coloration of *Subtriquetra* spp., which results from haemoglobin in the haemocoel, is considered a characteristic of this genus (Riley 1986). Studies on the larval development of *S. subtriquetra* conducted by Winch & Riley (1986b) show that the outer segmentation only becomes prominent in the last three larval stages and that only the last two larval stages carry simple hooks. Based on those findings, we conclude that our larvae actually represent the infective stage, since the annuli were well developed and the hooks simple. The conformity of the measurements also gave no indication of the presence of different developmental stages.

The comparison of the morphological characteristics of the proposed new species and infective larvae of *S. subtriquetra* (Winch & Riley 1986b) suggests that they belong to two different species (Table 3). This is even more likely since the findings indicate that the South American and African sebekiid pentastomes differ distinctly (Winch & Riley 1986b). The infective larvae of *S. rileyi* are bigger than those of *S. subtriquetra*, the body is longer (3,2 mm vs. 2,5 mm) as are the hooks and fulcra (338 ± 18,7 and 533 ± 23,1 μm vs. 232,8 ± 3 μm and 359,2 ± 3,5 μm, respectively), and the oral cadre length (204 μm vs. 163,3 μm).

There are no detailed descriptions of larval forms of the two other known species of *Subtriquetra*. Shipley (1898) re-examined an adult female of *S. megacephala* from *Crocodylus palustris* from India that had been described by Baird (1853) as *Porocephalus megacephalus* (synonym *Pentastoma megacephalum*). He counted from 40 to 50 annuli (Shipley 1898) and an illustration of the same specimen (Sambon 1922) shows 43 annuli before becoming diffuse in the anterior part of the drawing. Several pentastomids, including *S. subtriquetra*, attain the final number of annuli during the infective larval stage (Esslinger 1962a; Sachs, Rack & Woodford 1973; Riley, Spratt & Presidente 1985; Winch & Riley 1986a, b). In view of the difference between the number of annuli in *S. rileyi* and *S. megacephala* this criterion alone can discriminate between the two species.

The infective larvae isolated from cichlids in the KNP carry large hooks, whereas the hooks of adult *S. shipleyi* were described as relatively small and smaller than those of *S. subtriquetra* but measurements were not provided (Hett 1924).

To date there have been no reports of a *Subtriquetra* sp. from Africa and the presence of infective larvae of *Subtriquetra* in the two cichlid species indicates that *C. niloticus* may be a suitable final host. However, we did not find adult specimens in two crocodiles we examined (Junker 1996).

Comparison between adult pentastomes and infective larvae must be done with circumspection and we conclude that the genus *Subtriquetra* is represented on the African continent by a distinctive species.

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