OCHETOSTOMA ERYTHROGRAMMON (LEUCKART & RÜPPELL 1828) (ECHIURIDA) FROM ISIPINGO BEACH, NATAL, SOUTH AFRICA

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ABSTRACT

The first record of *O. erythrogrammon* from Isipingo was found in a crevice at the high-water mark. The specimen has a mucilaginous cap covering the posterior end of the trunk. The anatomy shows that the intestinal siphon terminates posteriorly at the opening of the rectal diverticulum into the rectum. There is a pair of anal vesicles beset with numerous stalked ciliated funnels. Replacement setae are found associated with each of the two functional setae. Each nephridium is provided with a single outgrowth which divides into two coiled appendages. There are 12 muscle bundles of limited extent.

INTRODUCTION

Ten species belonging to three echiurid genera have been recorded from South African waters, but these species have been based on relatively few specimens. The first recorded species is *Thalassema moebii* Greeff 1880 which was collected by von Weber " . . . an der Küste von Durban . . . " (Sluiter 1898 p. 444). Other *Thalassema* species have also been recorded and described, namely, a single specimen of *T. diaphanes* Sluiter 1888 from the Cape Town area (Wesenberg-Lund 1959a) in 28 m of water, one specimen of *T. philostracum* Fisher 1947 from Kosi Bay (Wesenberg-Lund 1963) and *T. neptuni* Gaertner 1774 from Port Elizabeth (Stephen and Cutler 1969).

In 1954 Jones and Stephen described, from numerous specimens, a new species — *Ochetostoma capensis* — which inhabits the burrows of *Upogebia africana* Ortmann 1894 in the Zwartkops River estuary, north of Port Elizabeth. *O. capensis* has also been recorded from Durban Bay (Day and Morgans 1956). A single specimen of *O. formosulum* (Lampert) 1883 was collected from a central sand bank in Durban Bay, and two specimens of *O. arkati* Prashad 1935 from Port Elizabeth (Wesenberg-Lund 1963) and 12 from the Cape Town area (Wesenberg-Lund 1959a). *O. erythrogrammon* is recorded from the Cape Town area (Wesenberg-Lund 1959a) and one specimen collected from Port Edward was originally determined as *O. kokotoniense* Fischer 1892 by Stephen in an unpublished work (Wesenberg-Lund 1963).

Recently Stephen and Cutler (1969) recorded three species of echiurid off the Natal Coast in the vicinity of Durban in water 46–138 m deep. These are *Echiurus antarcticus* Spengel 1912, *Thalassema indivisum* Sluiter 1900 and *T. neptuni*.

This work attempts to give a fairly detailed description of the anatomy of the Isipingo specimen of *O. erythrogrammon* because such details are wanting in the two earlier records of this species from South Africa, and because it differs in some aspects of detail from descriptions given for this species collected in other parts of the world.

The discovery of the Isipingo specimen of *O. erythrogammon* near the high tide level appears peculiar for this species.

Synonymy: *Ochetostoma erythrogrammon* Leuckart & Rüppell 1828;
Spengel 1912; Fischer 1926; Satô 1935.
Thalassema erythrogrammon Max Müller 1852; Greeff 1879;
Sluiter 1883, 1890, 1902; von Drasche 1881;
Rietsch 1886; Shipley 1899, 1902.
Thalassema caudex Lampert 1883; Rietsch 1886;
Shipley 1898; Sluiter 1902.
Thalassema kokotoniense Fischer 1892, 1895, 1914;
Shipley 1899; Sluiter 1902; Ikeda 1904.
Thalassema stuhlmanni Fischer 1892, 1895, 1914; Augener 1903.
Thalassema leptodermon Fischer 1892; Sluiter 1902; Augener 1903.
Thalassema multilineatum Fischer 1914.
Thalassema palense Ikeda 1924.

DESCRIPTION

The specimen was collected by Mr. L. G. Moodley of the Zoology Department, University of Durban-Westville, on 27 July 1970. It was found deep in a horizontal fissure between two slabs of sandstone and the lower slab was covered by only a thin layer of sand. The sandstone block was at the high water mark, and the fissure faced south.

The measurements of the specimen after narcotisation with magnesium sulphate, and immediately after preservation are:

	After narcotisation	*After preservation*
Length of trunk and proboscis ..	83,6 mm	81,5 mm
Length of proboscis	27,3 mm	27,0 mm
Diameter of proboscis	5,1 mm	5,3 mm
Diameter of trunk—anterior	5,0 mm	5,0 mm
„ middle	8,7 mm	9,8 mm
„ posterior	5,5 mm	5,5 mm

The ratio of trunk to proboscis is ca. 2: 1.

The colour of the live animal is off-white, tinged with green which proved, on closer study, to be caused by symbiotic algae. The proboscis tip is tinged with yellow. Apart from the proboscis and the anterior and posterior ends of the trunk, the animal is translucent. However, after preservation in 5 per cent formalin the colour is retained, but the translucent nature of the trunk is lost. The posterior end of the trunk is covered by a mucilaginous cap.

EXTERNAL MORPHOLOGY

Proboscis (Fig. 1). The long proboscis is of uniform diameter with a ventral groove throughout its length. The rim of the distal end of the proboscis is slightly thickened, but the diameter is the same as that of the proboscis itself. The groove is formed by the lateral margins folding ventrally and medially till they are only narrowly separated from each other.

The proboscis narrows slightly before joining the trunk and the proboscis folds join ventrally to form a shallow pocket at the base of which opens the mouth. At the junction of the proboscis with the trunk there is a narrow collar-like thickening which is light-yellow in colour, complete dorsally and incomplete ventrally.

The proboscis integument is beset with numerous very small, white papillae.

Trunk (Figs. 1 and 2). The trunk is about twice as long and broad as the proboscis and the posterior half is slightly thicker than the anterior half. Lying on either side of the mid-ventral line and 3–4 mm from the junction of the proboscis with the trunk is a pair of very small, blunt, yellow-brown hooks which project posteriorly. There are a pair of presetal nephropores, but these are only visible under the high power of the dissecting microscope. About 5 mm posterior to the hooks is the first pair of easily seen postsetal nephropores. A second pair of postsetal nephropores is indistinct and located 5 mm behind the first pair.

Completely covering and firmly adhering to the posterior 5 mm of trunk is a translucent mucilaginous cap which has a bluish tinge and is about 1–2 mm thick (Figs. 1 and 3).

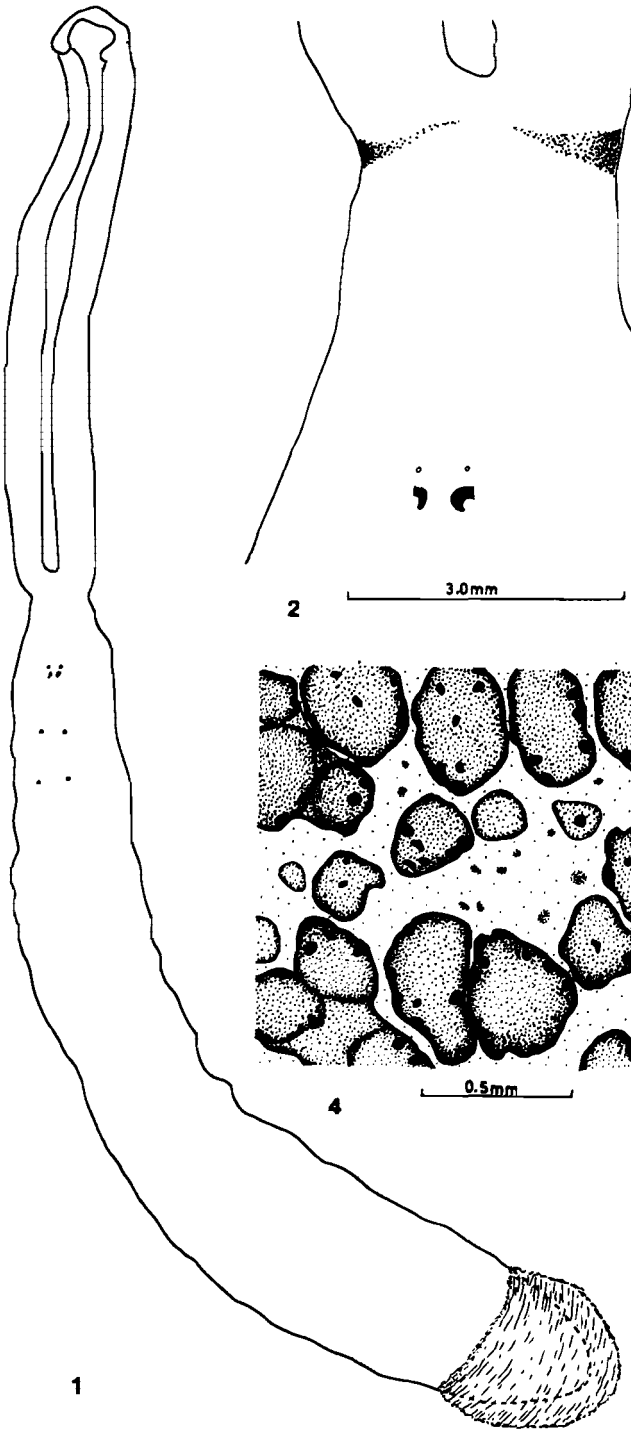
The integument of the trunk is papillate. In approximately the anterior third of the trunk the papillae are moderately large and scattered. The middle third of the trunk is covered with very small, indistinct, and scattered papillae, while the posterior third of the trunk is covered with numerous papillae, larger than those of the anterior trunk region. There are no clear dividing lines between these regions as the papillae become progressively smaller towards the middle and progressively larger towards the posterior end. All the trunk papillae are irregular in outline and of various sizes (Figs. 3 and 4).

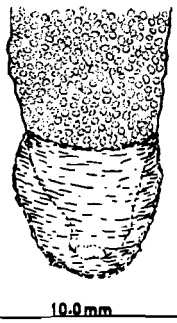
ANATOMY

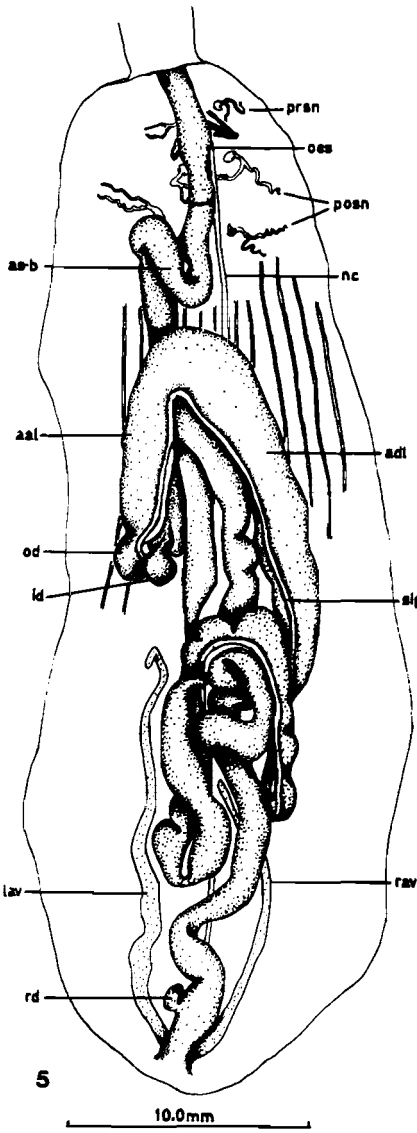
Alimentary canal (Figs. 5, 6, 7, 8 and 9). The very thin-walled alimentary canal is considerably longer than the trunk and folded on itself in a large number of descending and ascending limbs. Externally there are few points of reference for dividing the canal into regions.

The oesophagus is a straight tube of uniform diameter and extends from the mouth to just anterior to the intestinal ring blood vessel. The oesophagus is the only part of the alimentary canal with a complete ventral mesentry. Between the oesophagus and the intestine there is a dorsal transverse groove (Fig. 6).

The intestine, after the anterior S-bend, passes posteriorly for about half the length of the trunk and lies to the left of the nerve cord. It then turns through 180° and follows an anterior course. This last part of the canal is here designated, for descriptive convenience, the *anterior ascending limb*. The bend through 180°, mentioned above, is of particular interest as it is characterised by having an inner and an outer dilatation (Figs. 5 and 7). These two







dilatations are separated from each other and from the canal by pronounced constrictions.

A second characteristic feature of this particular region of the gut is the origin of the intestinal siphon from the inner dilatation (Fig. 7).

The anterior ascending limb turns posteriorly forming a longer *anterior descending limb* lying on the right. These two limbs appear as an inverted-V with the apex more or less touching the anterior intestinal S-bend. Both limbs appear to have thicker walls and a greater diameter than the rest of the alimentary canal.

The narrower intestine leads from the anterior descending limb and follows a tortuous course posteriorly. It ends as a more or less straight tube to the rectum which opens to the exterior by way of the terminal anus. That part of the gut lying posterior to the anterior descending limb is exceptionally thin-walled and it is surprising that it is not damaged by the passage of the tightly packed sand grains through the canal.

Apart from the extreme anterior part of the alimentary canal the gut is supported by irregularly arranged radiating muscle strands.

Rectal diverticulum. The rectal diverticulum is a small, spherical, thin-walled sac opening ventrally into the rectum. The intestinal siphon ends posteriorly at the opening of the diverticulum into the rectum (Figs. 5, 8 and 9).

Anal vesicles. There is a pair of blind-ending anal vesicles of which the left is longer than the right (Fig. 5). The distal end of the left vesicle is bent at right angles to the long axis (Figs. 5 and 10A). Scattered throughout the length of both vesicles are numerous ciliated funnels (Fig. 10A). Each funnel is bordered by a corona of large ciliated cells, with the cilia arranged in the form of an inverted cone. The funnel base is produced into a duct of uniform diameter before it opens into the lumen of the vesicle (Fig. 10B).

Blood vascular system. Dorsal to the oesophagus is a blood vessel which dilates posteriorly before joining the intestinal ring vessel on the right. From the ring vessel arises a mid-dorsal and a left lateral blood vessel, which later join to form a single vessel opening into the mid-ventral blood vessel (Fig. 6). The ventral blood vessel lies to the right of the ventral nerve cord. It was not possible to trace the course of the ventral blood vessel anteriorly beyond

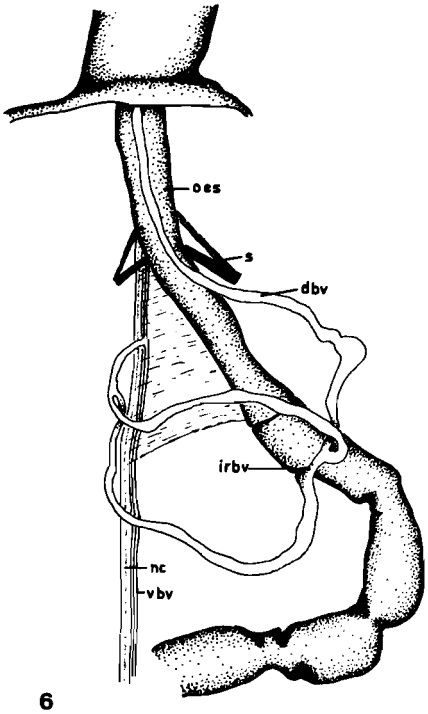
FIGURE 1
Ventral aspect of *O. erythrogrammon.*

FIGURE 2
Ventral aspect of anterior trunk and posterior proboscis illustrating the setae and presetal nephropores.

FIGURE 3
Posterior end of trunk with the mucilaginous cap

FIGURE 4
A piece of the integument of the posterior trunk showing the arrangement of the papillae.

FIGURE 5
Dorsal dissection of the trunk showing the organs in situ. (For abbreviations see page 530).



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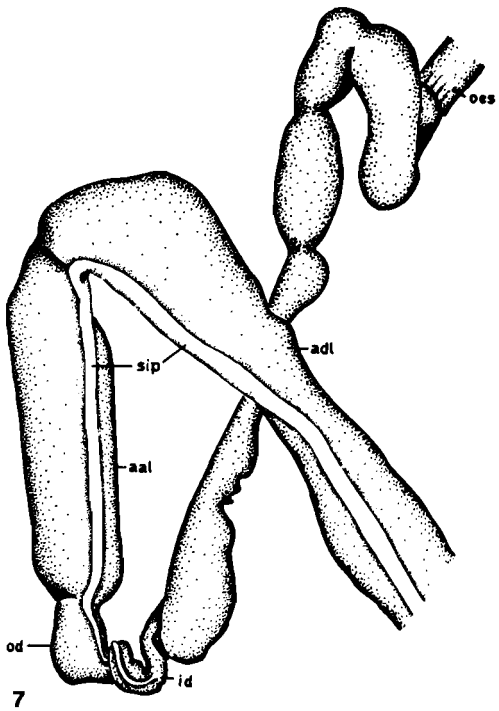

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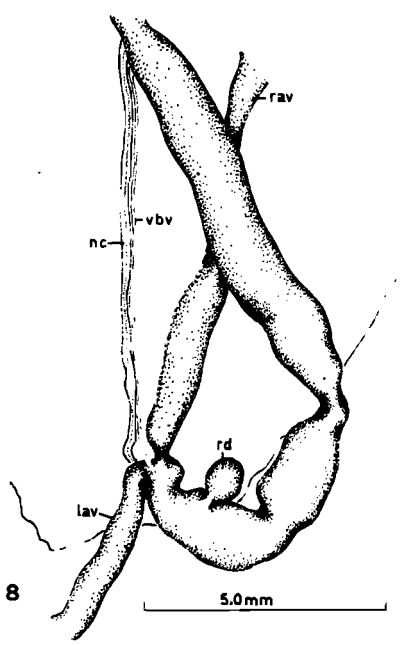

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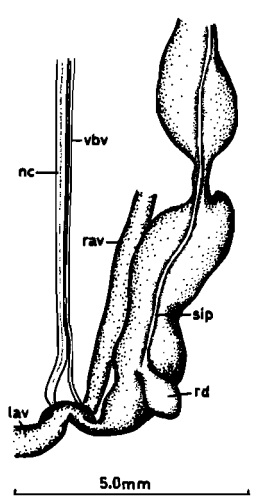

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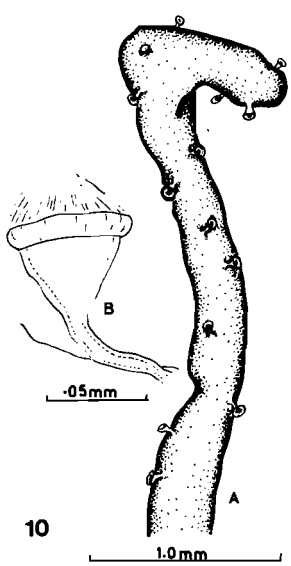

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the region of the setae. However, the vessel could be traced posteriorly to a point where it passes dorsally to the rectum (Fig. 8).

Ventral setae. The two ventral setae are characteristically hook-like (Figs. 2 and 11). When dissected out each seta is a long straight shaft with a terminal hook bent at right angles to the main axis of the shaft. The hook itself is short, circular in cross section, and tapers to a blunt point. The distal third of the shaft is marked by more or less equidistant, concentric rings, while the rest of the shaft is smooth and unmarked (Fig. 11).

Each seta is invested by connective tissue and supported by four radiating muscle strands among which are numerous smaller strands. The largest muscle strand of each seta is inserted on the inner end of the shaft and follows an anterior direction, and finds its origin lateral to the nerve cord (Fig. 12). There are no interbasal muscles.

A second, much smaller replacement seta, is embedded in connective tissue and lies closely applied to the latero-ventral surface of each functional seta.

The nephridia. There are three pairs of nephridia, one pair presetal in position, and the other two pairs postsetal (Fig. 5). The three pairs of nephridia are of the same basic structure, and are all more or less of the same size. However, the second pair appears to be slightly larger than the other two pairs (Fig. 5).

Each nephridial body is in the form of a hollow cone, the base of which forms the large, posteriorly directed nephrostome. Arising about half-way along the cone is a single, lateral outgrowth which divides into two long, coiled, lash-like appendages (Figs. 12 and 13).

Body musculature. The longitudinal musculature is largely in the form of a sheet. However, posterior to the last pair of nephridia, and extending to about the middle of the trunk, the longitudinal muscles are gathered into six bundles on either side of the mid-ventral line. Each bundle is of about the same thickness, and each is separated from the adjacent bundle by a narrow groove (Fig. 5).

FIGURE 6
Anterior end of the alimentary canal and the main blood vessels.

FIGURE 7
Part of the anterior end of the alimentary canal showing the start of the siphon from the inner dilatation.

FIGURE 8
The rectum and rectal diverticulum.

FIGURE 9
The posterior end of the alimentary canal showing the termination of the siphon. (For abbreviations see page 530.)

FIGURE 10A
The distal half of the left anal vesicle illustrating the scattered arrangement of the funnels.

FIGURE 10B
A single ciliated funnel showing the long duct before it enters the vesicle.

DISCUSSION

There is no doubt that this single echiurid specimen is *Ochetostoma erythrogrammon*. As this species has been recorded and described from numerous tropical and subtropical localities it can be expected that differences in habitat, size and structure are likely to be found.

This Isipingo specimen was found at the high water level, living in a sandstone crevice the opening of which did not face the open sea. In contrast to this other specimens of *O. erythrogrammon* have been collected from under rock (Stephen 1952), in muddy sand under stones in the mid-tide zone, and in large burrows (Stephen and Robertson 1952), and under coral blocks (Wesenberg-Lund 1954).

The colour and nature of the skin of *O. erythrogrammon* is variable, and it changes as a result of preservation in alcohol or formalin. Satô (1939 p. 358) states that the skin is " . . . beautifully bluish green . . . " when alive, and becomes a " . . . dirty grey when preserved in alcohol. The skin is generally thin and somewhat translucent, but in the region of both extremities of the body it becomes more or less thicker and opaque". Wesenberg-Lund (1954) reports that the skin is thick, tough and opaque. Stephen (1965) records the colour as being medium brown. The Port Edward specimen, and the specimens from Ghardaqa are reddish-brown in colour (Wesenberg-Lund 1957).

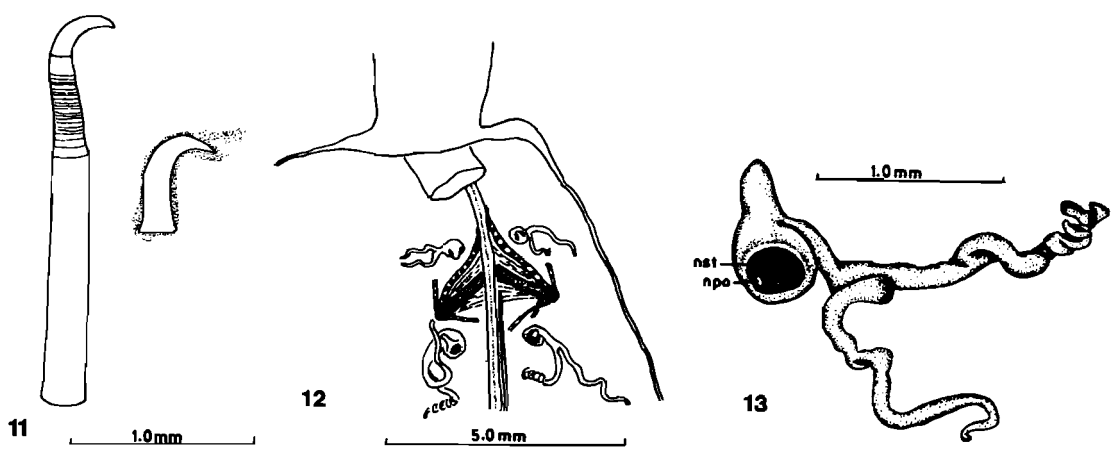

FIGURE 11
The left functional and non-functional (replacement) setae. The small non-functional seta is encased in connective tissue.

FIGURE 12
Anterior end of the trunk cavity illustrating the setae and associated musculature and the presetal and first pair of postsetal nephridia.

FIGURE 13
A single nephridium (the right one of the first postsetal pair). (For abbreviations see page 530.)

An interesting feature of the trunk of the Isipingo specimen is the presence of a thick, protective, mucilaginous cap covering the posterior 5 mm of the trunk. Such a cap of mucilage, which covers 10 mm of the posterior trunk, has been recorded in four specimens of *O. erythrogrammon* and a single specimen of *Thalassema indivisum*, all of which were collected in the waters round the Dahlak Islands (Stephen 1965).

The size and internal anatomy of the Isipingo specimen are very similar to the descriptions provided for other specimens of *O. erythrogrammon* taken from widely separated localities. However, there are some interesting features and differences which should be mentioned.

The number of longitudinal muscles varies from 12–18, and this factor is used as a taxonomic feature. The specimens of *O. erythrogrammon* collected from Zanzibar have 12 bundles, as does the single specimen from Isipingo. Stephen and Robertson (1952) state that the usual number of bundles for the species is 14, and that *O. sorbillans* is the only species having fewer than 14 muscle bundles. However, the dermal papillae in *O. sorbillans* are restricted to the posterior end of the body, whereas in *O. erythrogrammon* they are scattered all over the body, being small in the middle, and large at the ends. The Isipingo specimen agrees with *O. erythrogrammon* in respect of the distribution of the dermal papillae.

The extent of the longitudinal muscle bundles varies considerably. In the Isipingo specimen they are restricted to the middle of the body, whereas Satô (1939) illustrates the muscle bundles as extending the full length of the trunk.

The characteristic feature of the genus *Ochetostoma* is the presence of three pairs of nephridia (segmental organs), the anterior pair is presetal, and the posterior pairs postsetal. The *O. erythrogrammon*-type of segmental organs is striking in that "The lateral margins of the flattened funnel are drawn out in two spirally-coiled, lash-like furrowed, ciliated lobes." (Bock 1942, p. 69). Satô (1939, p. 359) in his description of *O. erythrogrammon* states that "Each of the nephridia is in the form of a sac provided with two short and slightly coiled spiral appendages."

The *O. erythrogrammon* specimen collected from Ghardaqa and described by Wesenberg-Lund (1957 p. 9) states that the three pairs of segmental organs are very long and slender tubes with long curled spiral appendages " . . . at their coelomic apertures." These descriptions of the segmental organs do not agree with the form in the Isipingo specimen in which the segmental organs are globular, and the appendages do not arise from the margin of the nephrostome but laterally from the main body of the nephridium as a single structure which divides into two coiled, lash-like appendages.

The paired anal vesicles of the Isipingo specimen are similar, in most respects, to the anal vesicles as described and illustrated from the many other specimens of *O. erythrogrammon*. The funnels, however, differ from all other descriptions.

Bock (1942) states that the funnels of the anal vesicles are sessile in the genus *Ochetostoma*, and in what she calls the *Thalassema neptuni*-type. She attaches great importance to the nature of these funnels in her work on the genus *Maxmülleria* for it is in this genus that the excretory organs are " . . . provided with long-stalked funnels." (Bock 1942 p. 23).

The many descriptions of *O. erythrogrammon* do not always refer to the funnels, but where reference is made to them they are always reported as being unstalked (e.g. Wesen-

berg-Lund 1954, Satô 1939). The Isipingo specimen of *O. erythrogrammon* appears to have sessile (unstalked) funnels, but on close examination the funnels have long stalks, the greater part of which lies against the vesicle before opening into it. There is a possibility that all the described specimens of *O. erythrogrammon* have stalked funnels, but give the impression of being unstalked.

The presence of a rectal diverticulum in the Isipingo specimen does not appear to be of taxonomic significance. Satô (1935 p. 325) after studying many specimens from the Palan Islands, concludes that in *O. erythrogrammon* " . . . the rectal diverticulum is present in some specimens, while in some other specimens it is absent." It has been reported in only a few descriptions of *O. erythrogrammon* (e.g. Wesenberg-Lund 1959b, 1963, and Satô 1939). Such a diverticulum is found in other species of *Ochetostoma*, e.g. *O. capensis* (Jones and Stephen 1954), and *O. zanzibarense* (Stephen and Robertson 1952). Bock (1942) states that most *Thalassema* species possess a rectal diverticulum.

SUMMARY

1. This is the first record of an echiurid collected from Isipingo in Natal.
2. The habitat of the animal was a crevice in a sandstone block situated at the highwater mark.
3. Structurally this specimen agrees in most respects with other *O. erythrogrammon* specimens.
4. The posterior end of the trunk is covered with a thick mucilaginous cap.
5. The trunk has 12 longitudinal muscle bundles which are restricted in extent.
6. Apart from the functional setae there is a pair of non-functional (replacement) setae.
7. There are three pairs of nephridia, one pair presetal and two pairs postsetal. They are all more or less of the same size and structure, and each has a single lateral outgrowth which divides into two coiled, lash-like appendages.
8. The paired anal vesicles are provided with numerous, scattered and stalked ciliated funnels.

ABBREVIATIONS

aal	anterior ascending limb
adl	anterior descending limb
as-b	anterior s-bend of alimentary canal
dbv	dorsal blood vessel
id	inner dilatation
irbv	intestinal ring blood vessel
lav	left anal vesicle
nc	nerve cord
npo	nephropore
nst	nephrostome
od	outer dilatation
oes	oesophagus

posn	postsetal nephridia
prsn	presetal nephridium
rav	right anal vesicle
rd	rectal diverticulum
s	seta
sip	siphon
vbv	ventral blood vessel

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* Not seen in the original.