Some aspects of the anatomy of *Ochetostoma caudex* (Echiura) from the east coast of southern Africa with remarks on its taxonomic status

R. Biseswar
Department of Zoology, University of Durban-Westville, Durban

The degree of variation within the species *Ochetostoma caudex* was determined from 32 specimens collected from the east coast of southern Africa. The shape and distribution of the dermal papillae were uniform in all the specimens. The number of longitudinal muscle bands ranged from 14 to 21 with 16 to 19 being the most common. In most specimens the anal vesicles were almost equal to or slightly longer than the trunk and were covered with numerous, unstalked ciliated funnels. A comparison of *O. caudex* with related species (*O. australiense, O. palense, O. indosinense* and *O. erythrogrammon*) revealed differences which justify the retention of *O. caudex* as a distinct species. Hence the contention by some authors that *O. caudex* and *O. erythrogrammon* are synonymous, appears unjustified. *O. griffini* and *O. multilineatum* may prove to be conspecific with *O. caudex*. *O. kokotoniense* and *O. stuhlmanni* are too poorly known for a detailed comparison.

S. Afr. J. Zool. 1983, 18: 47 – 55

Die omvang van variasie binne die spesie *Ochetostoma caudex* is met behulp van 32 voorbeelde wat langs die ooskus van suidelike Afrika versamel is, bepaal. Die vorm en verspreiding van die huidpapille was uniform by al die voorbeelde. Die aantal lengtespierstroke het gevarieer van 14 tot 21 met 16 tot 19 die algemeenste aantal. By die meeste voorbeelde was die anaalbuise net so lank of selfs ietwat langer as die romp en hulle word bedek deur 'n groot aantal ongesteelde gesilieerde tregters. 'n Vergelyking van *O. caudex* met verwante spesies (*O. australiense, O. palense, O. indosinense* en *O. erythrogrammon*) openbaar verskille wat die behoud van *O. caudex* as 'n afsonderlike spesie regverdig. Gevolglik is die standpunt van sommige outeurs dat *O. caudex* en *O. erythrogrammon* sinoniem is, ongegrond. *O. griffini* en *O. multilineatum* mag blyk gelyksoortig te wees met *O. caudex*. *O. kokotoniense* en *O. stuhlmanni* is te swak bekend vir 'n gedetailleerde vergelyking.

S.-Afr. Tydskr. Dierk. 1983, 18: 47 – 55

R. Biseswar
Department of Zoology, University of Durban-Westville, Private Bag X54001, Durban 4000, Republic of South Africa

Received 25 May 1982; accepted 20 December 1982

Three echiuran genera are known from South African waters, namely, *Echiurus* Guérin-Méneville 1831, *Ochetostoma* Leuckart and Rüppell 1828, and *Thalassema* Lamarck 1801.

Twenty-eight species have been assigned to the genus *Ochetostoma* but the generic position of at least eight of these is in doubt (Stephen & Edmonds 1972). The following five species have been recorded from South African waters: *O. arkati* (Prashad 1935); *O. capensis* Jones & Stephen 1955; *O. erythrogrammon* Leuckart & Rüppell 1828; *O. mercator* Wesenberg-Lund 1954 and *O. formosulum* (Lampert 1883).

Both Satô (1939) and Wesenberg-Lund (1939, 1963) consider *O. caudex* (Lampert 1883) and several other closely related species in this genus to be synonymous with *O. erythrogrammon*. Although *O. erythrogrammon* is fairly well known, *O. caudex* was based on a single specimen described as *Thalassema caudex* from the Red Sea by Lampert (1883). *O. caudex* was rediscovered (Shipley 1898 and Prashad 1935), but the descriptions are very brief and based on few individuals. Furthermore, the internal anatomy of *O. caudex* has not been thoroughly investigated and practically nothing is known of the variations that occur within the species. Stephen & Edmonds (1972) are also of the opinion that there is insufficient knowledge of the range of variation within this species and several others. Hence they have '. . . refrained from considering them as synonymous until a closer study can be made of additional specimens' (p 427). A number of species in the genus *Ochetostoma* cannot be recognized positively on the basis of the existing literature.

The aim of this investigation was to determine whether knowledge of the anatomy of more individuals of the species *O. caudex*, will be of help in its taxonomic evaluation.

Materials and Methods

This investigation is based on 32 specimens of *O. caudex* collected at three localities along the east coast of southern Africa. Eight specimens were collected on 27 May 1977 at Embotyi (30°31′S/29°41′E) on the Transkei coast. These specimens were found under small, flat stones overlying coarse, clean sand in the intertidal zone.

The remaining 24 specimens were collected on the Natal coast over a period extending from March 1981 to October

1982 from Isipingo Beach (29°05′S/20°56′E) and Park Rynie Beach (31°19′S/30°44′E). These echiurans were also found in the intertidal zone close to the high water mark. Practically all those from Isipingo were found in a rocky cave facing the sea. Most of the specimens from Park Rynie Beach were found in sand under a projecting ledge of rock facing the shore. Sometimes as many as 15 specimens were collected in the same habitat suggesting that this species is gregarious. Occasionally isolated specimens were also found under loose rocks in the littoral zone.

Living specimens were photographed both in the fully extended and contracted states. Measurements were taken after the specimens were narcotized and preserved in formalin. All the specimens were subsequently dissected to determine the range of variation of various structures and organs. Gross morphology was studied with the aid of a camera lucida while detailed investigations of certain structures, such as the anal vesicles and nephrostomal lips were made with the scanning electron microscope. Furthermore, the anal vesicles and nephrostomal lips were serially sectioned for histological details.

Results

Size of specimens

Of the 32 specimens, 11 were sexually mature since gametes were present in the nephridia. The trunk length of sexually mature specimens ranges from 72 to 105 mm and the proboscis length from 20 to 49 mm (Table 1). The size of these animals, however, varies considerably depending on their state of contraction at fixation.

Table 1 Measurements in millimetres of sexually mature specimens

Length of trunk & proboscis	Trunk length	Proboscis length	Greatest diameter of trunk
130	93	37	15
123	97	27	12
112	80	32	12
105	74	31	11
149	105	44	16
96	72	24	12
115	79	36	10
123	74	49	13
102	75	27	12
124	86	38	12
95	75	20	14
Average			
115,9	82,7	33,2	12,6

External features

The following description of the external features is based on all 32 specimens.

Proboscis

The fleshy, pale-yellow proboscis (Figure 1) is non-deciduous. It has a shallow ventral groove along its entire length. In living specimens the proboscis is spatulate whereas in preserved specimens the lateral edges tend to curl inwards forming a tubular structure. In most of the specimens the lateral edgs of the proboscis are tinged with green. When fully extended, the proboscis is almost as long as the trunk.

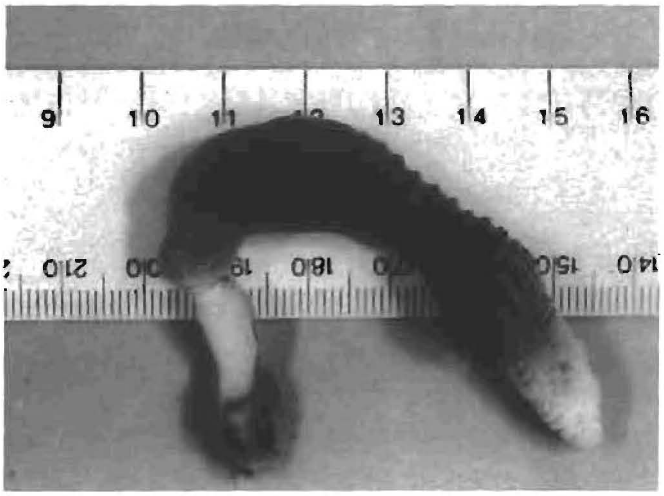

Figure 1 Lateral view of living specimen illustrating the general body form and the shape of the proboscis.

Trunk

The body is cylindrical, tapering more towards the posterior end (Figure 1). Living specimens have reddish-purple longitudinal stripes marking the longitudinal muscle bands while the interspaces are bluish-grey. However, there is variation in the colouration of the trunk; in some specimens the longitudinal bands are dark brown. The posterior end of the trunk is white and here the brightly coloured longitudinal bands become inconspicuous. In some, the extreme posterior end of the trunk is tinged with bright green. Specimens preserved in formalin become brown in colour. The body wall is relatively thick, tough and opaque except in the antero-ventral region of the trunk where it is somewhat translucent.

The entire integument of the trunk is densely covered with papillae. These papillae are minute, transversely elongated and arranged regularly in circular rows over most of the trunk except posteriorly where they are more prominent, and round to ovoid in shape. The posterior papillae appear as white spots and do not have any definite pattern or arrangement. The shape and distribution of the papillae are uniform in all the specimens. Under certain states of contraction of the trunk, rings of rounded prominences appear on the longitudinal muscle bands.

In formalin-preserved specimens, a white mucous cap encases the extreme posterior end of the trunk but this is not apparent in living specimens.

A pair of small pointed yellowish-brown setae is located antero-ventrally about 5 to 7 mm posterior to the proboscis-trunk junction. Just anterior to the setae is the first pair of nephropores while the remaining two pairs are post-setal in position. Both the setae and nephropores are visible to the unaided eye.

Setae

The setae (Figure 2) are elongate, cylindrical, hook-like structures, tapering towards the tip. The terminal end is

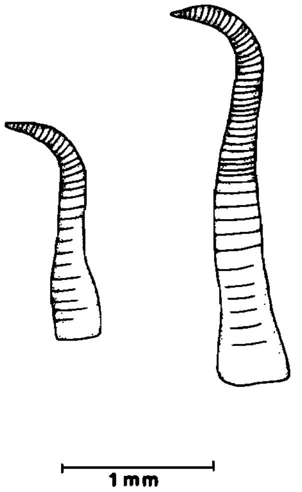

Figure 2 The left non-functional (replacement) and the functional setae.

curved at right angles to the main axis of the shaft and directed posteriorly. The distal third of the seta which protrudes from the ventral body wall has numerous closely arranged concentric markings. These markings, however, are less pronounced and sparsely arranged in the proximal two-thirds of the shaft.

As in other species belonging to the genus *Ochetostoma*, the setae are located in special sacs and are supported by numerous radiating muscle bands. These muscles have a cone-like arrangement and radiate from the base of the setal sac to the body wall. The largest muscle bands insert on the medial aspect of the shaft. Among the thicker muscle bands a number of finer strands are present. There is no interbasal muscle present in *O. caudex*.

In some specimens replacement setae are present and are about half the size of the functional ones. They are enclosed in their own sheaths and do not appear to protrude from the ventral body wall. No variations in the structure of the setae were observed.

Internal anatomy

Alimentary canal

The alimentary canal (Figure 3) of *O. caudex* is of considerable length and highly convoluted, forming several loops. It is attached to the body wall at several points by thin mesenteric strands. The mouth is situated more or less on the ventral side of the extreme anterior end of the trunk at the base of the proboscis. It leads into a somewhat dilated muscular pharynx which is attached to the body wall by numerous radiating muscle strands. The oesophagus is a straight tube of uniform diameter attached to the body wall anteriorly by a ventral mesentery. At the posterior end of the oesophagus is a dorsal constriction which probably demarcates it from the remainder of the alimentary canal. Just posterior to the constriction, the intestine forms a loop and then pursues a complex course through the body cavity.

The gizzard and crop cannot be distinguished as there are no distinct boundaries externally.

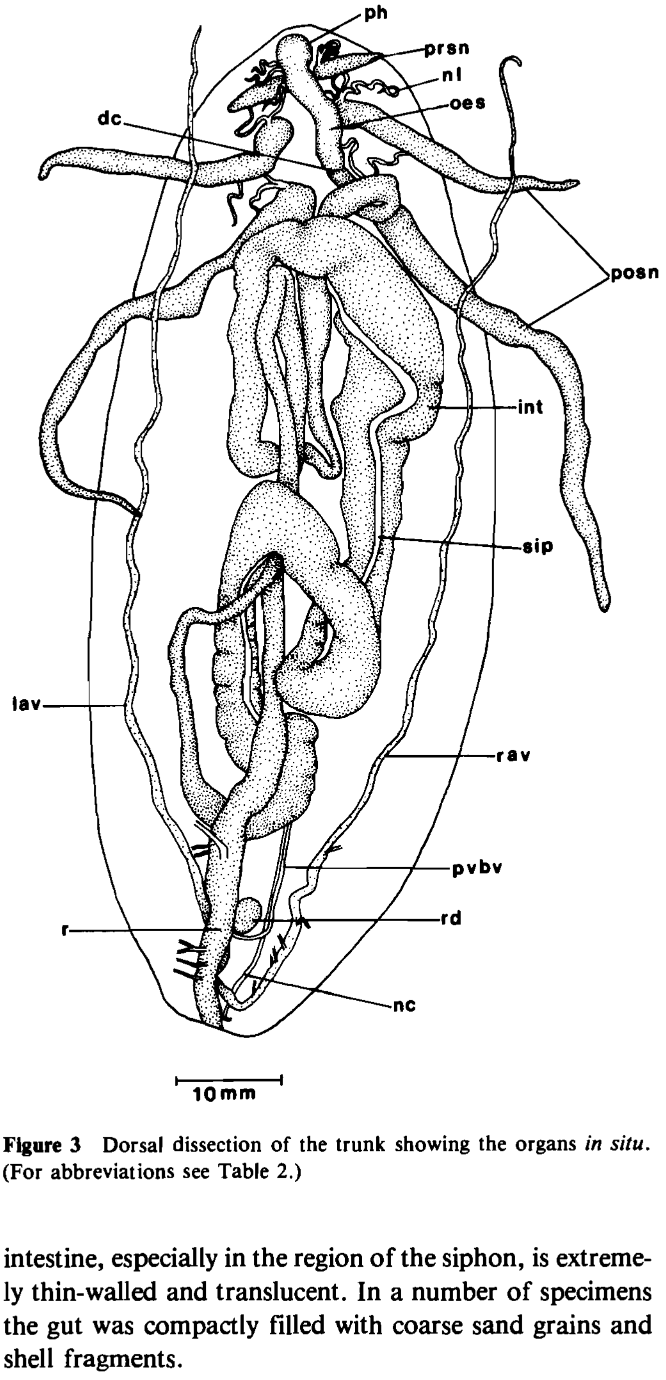

Figure 3 Dorsal dissection of the trunk showing the organs *in situ*. (For abbreviations see Table 2.)

By far the greater part of the alimentary canal is formed by the intestine proper. As in other members of this genus, the middle portion of the alimentary canal is subdivided into the pre-siphonal, siphonal and post-siphonal regions. The intestine, especially in the region of the siphon, is extremely thin-walled and translucent. In a number of specimens the gut was compactly filled with coarse sand grains and shell fragments.

The intestine leads into a more or less straight tube, the rectum, which opens to the exterior by way of the terminal anus. The rectal diverticulum, a small spherical sac opening ventrally into the rectum, was found in all the specimens.

Anal vesicles

The anal vesicles or anal sacs are paired, elongate, blind-ending tubes which lie in the coelom and open into the rectum just posterior to the rectal diverticulum (Figure 3). Proximally, they are fastened to the body wall by a number of connective tissue strands but distally they weave loosely through the coils of the alimentary canal. In most of the specimens the anal vesicles were found to be almost equal to or slightly longer than the trunk. They were shorter and extended up to about the middle of the trunk in a few specimens. In one specimen the right anal vesicle was as long as the trunk but the left one was only about one-third its length. The length of these vesicles appears to depend also on the degree to which they are contracted.

The outer surface of these vesicles, facing the coelom, is covered with numerous minute, unstalked, ciliated funnels (Figure 4). These funnels are more or less cone-shaped and scanning electron micrographs show numerous projections around the rim or lip from which groups of long cilia arise (Figure 5). Light microscopic studies of longitudinal sections of the funnels, however, reveal that the inside of the cup is also heavily ciliated. Cross-sections of the anal sacs show that the wall consists of three layers (Figure 6).

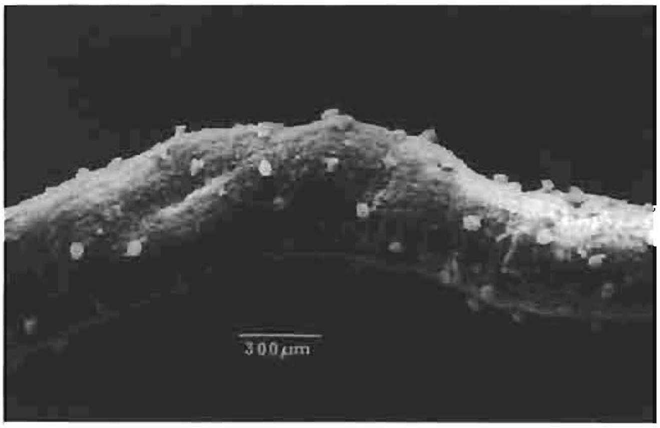

Figure 4 Scanning electron micrograph of part of anal vesicle showing the distribution of the funnels.

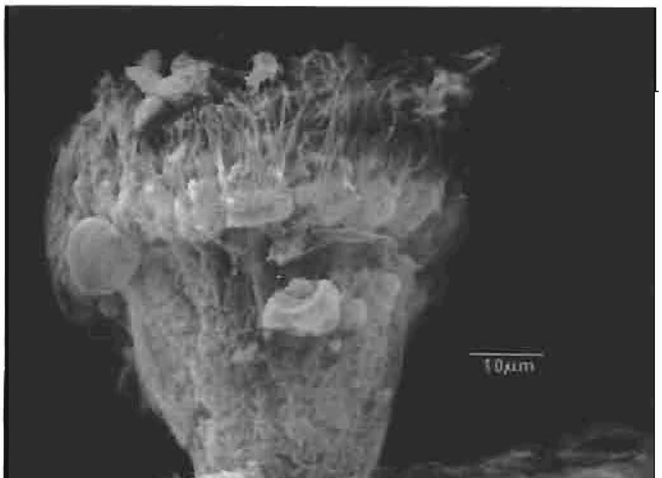

Figure 5 Scanning electron micrograph of a single funnel.

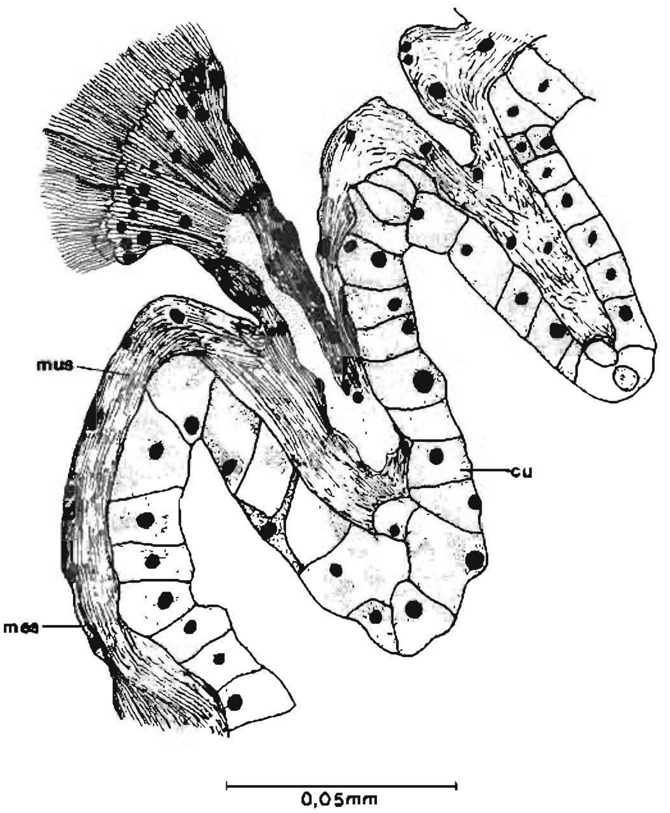

Figure 6 Cross-section illustrating the histological structure of the anal vesicle. (For abbreviations see Table 2.)

The outer surface is lined by a mesothelial layer of squamous cells which is continuous with the walls of the funnel. Immediately beneath the squamous cells is the muscle layer which in turn is followed by a layer of cuboidal epithelial cells with granular cytoplasm around the lumen of the sac. The role of the anal sacs in producing a filtrate of coelomic fluid through the ciliary activity of the funnels has been clearly demonstrated in *Bonellia viridis* by Harris & Jaccarini (1981).

Nephridia

The three pairs of nephridia (Figures 3, 7) or segmental organs are located in the anterior part of the body cavity on either side of the nerve cord. One pair lies anterior to the ventral setae, while the other two pairs are post-setal in position. The nephridia have the same basic structure but increase in size posteriorly, the third pair being the largest.

Each nephridium consists of an elongate vesicle with a pair of deeply grooved nephrostomal lips that extend into

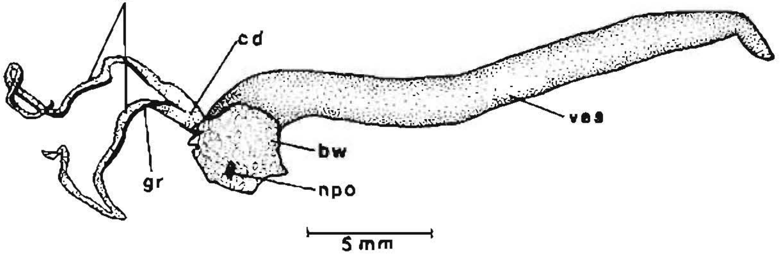

Figure 7a A single nephridium of a sexually mature female (the right one of the first post-setal pair). (For abbreviations see Table 2.)

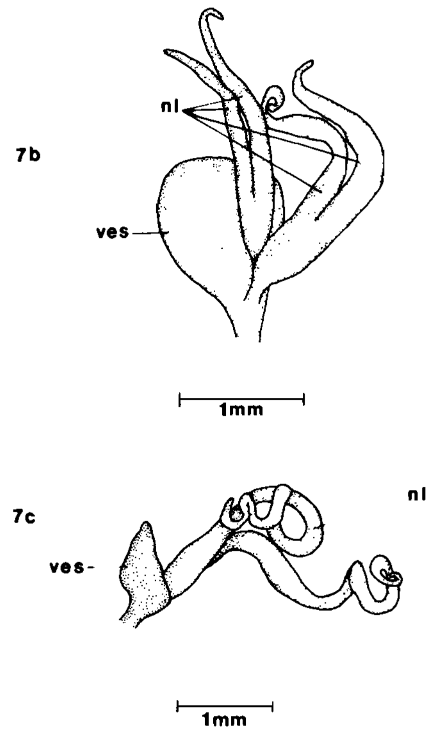

Figure 7b & c Variation in the structure of the nephridia. (b) First pre-setal nephridium from the left. (c) Left nephridium (first of the post-setal pair). (For abbreviations see Table 2.)

long, coiled whip-like structures or flagella. Histological study of the structure of the flagellum shows that it is composed of muscle fibres and loose connective tissue with a groove on one side that is lined with ciliated cuboidal cells (Figure 8). The two flagella unite proximally to form a short and narrow duct which opens into the base of the nephridial vesicle. The ciliated nephrostomal lips serve to convey the reproductive cells from the body cavity into the vesicle. In some cases, coelomocytes were observed in the grooves.

The size of the nephridial vesicles varies according to the state of maturity of the animal. In sexually mature specimens the second and third pairs of vesicles are enormously developed and distended owing to the presence of gametes.

The nephridia of *O. caudex* sometimes show variations from the normal condition. In one individual, the vesicle of one of the nephridia was small and globular in shape with two pairs of nephrostomal lips, while in another specimen, although the vesicle was small, the nephrostomal lips were rather elongate. Occasionally, variations were also observed in the number and position of the nephridia. In one specimen the nephridia on the right were in the normal position but on the left, four were present; one pre-setal and the remaining three post-setal. The third and fourth nephridia were situated very close to each other. In yet another individual, only two post-setal nephridia were present on the left although those on the right were normal.

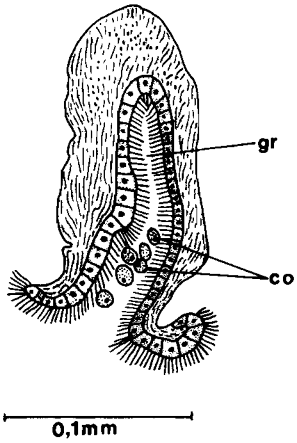

Figure 8 Cross-section of the nephrostomal lip illustrating the ciliated groove. (For abbreviations see Table 2.)

Blood vascular system (Figure 9)

With some minor variations, the blood system does not show any marked deviation from the general pattern described in other closely related species. The dorsal blood vessel is a very prominent vessel which lies dorsal to the foregut. Posteriorly this vessel joins the intestinal ring vessel. There is a conspicuous dilation present at the posterior end of the dorsal vessel. Anteriorly this vessel continues into the proboscis, dorsal to the pharynx.

From the ring vessel arise two neuro-intestinal vessels which pass anteroventrally. A small dilation is also present on the left lateral vessel at its point of origin. The mid-ventral vessel gives off smaller vessels to the oesophagus. The two neuro-intestinal vessels unite ventrally to form a single vessel which then splits into the anterior and posterior ventral vessels. The former passes forward ventral to the oesophagus and pharynx and enters the proboscis, while the latter continues alongside the ventral nerve cord and then passes dorsally to supply the rectum just posterior to the rectal diverticulum. Both the dorsal and neuro-intestinal vessels lie loosely in the coelom unattached by mesenteries either to the gut or the body wall.

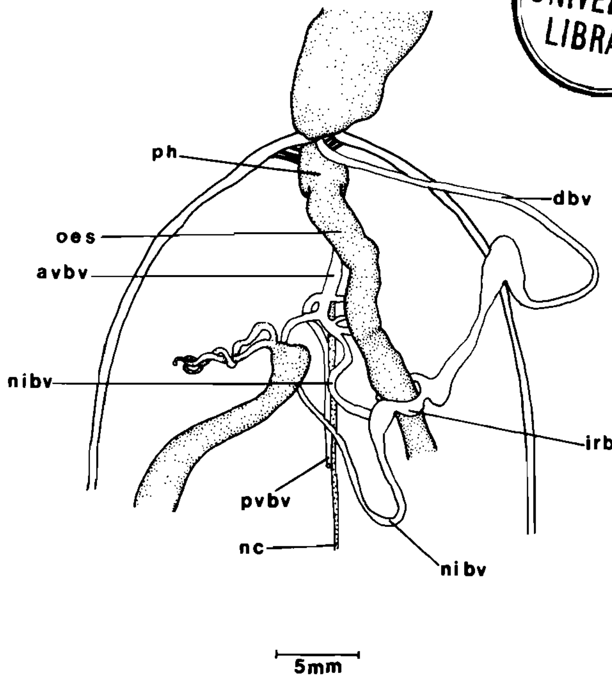

Figure 9 Anterior part of the alimentary canal illustrating the blood vessels. (For abbreviations see Table 2.)

Table 2 Key to abbreviations

avbv	anterior ventral blood vessel
bw	body wall
cd	common duct
co	coelomocytes
cu	cuboidal epithelium
dbv	dorsal blood vessel
dc	dorsal constriction
gr	groove
int	intestine
irbv	intestinal ring blood vessel
lav	left anal vesicle
mes	mesothelial layer
mus	muscle layer
nc	nerve cord
nibv	neuro-intestinal blood vessel
nl	nephrostomal lips
npo	nephropore
oes	oesophagus
ph	pharynx
posn	post-setal nephridia
prsn	pre-setal nephridium
pvbv	posterior ventral blood vessel
r	rectum
rav	right anal vesicle
rd	rectal diverticulum
ves	vesicle
sip	siphon

Trunk musculature

In the 32 dissected specimens, the number of longitudinal muscle bands ranged from 14 – 21. In the majority of the specimens (24) this number varied from 16 – 19. In seven specimens, however, the number was found to be between 19 – 21, while in only a single individual the muscle bands ranged from 14 – 16. Variations in the number may occur in different regions of the trunk of the same individual owing to the splitting of the longitudinal muscle bands. There seems to be no correlation between the number of longitudinal muscle bands and the size of specimens. In one specimen, for instance, where the proboscis was only 13 mm in length and the trunk 24 mm, there were 20 – 21 muscle bands present. The oblique muscles between the longitudinal muscle bundles are fasciculated.

Discussion

According to Stephen & Edmonds (1972) the distribution of this species is as follows: Red Sea and Indian Ocean (Lampert 1883); Rotuma (Shipley 1898); Andaman and Nicobar Islands (Prashad 1935). Its discovery on the east coast of southern Africa has considerably extended its range of distribution. However, it is not surprising for this typically Indian Ocean species to be distributed as far west as the east coast of South Africa.

Lampert (1883) gives no details regarding the size of his specimens of *O. caudex*. The description provided by Shipley (1898) of his specimens from Rotuma, however, mentions 18 to 25 mm for the length of the proboscis and 50 to 70 mm for the length of the trunk. Prashad's description (1935) of *O. caudex* is based on three specimens that were well preserved and his largest specimen had a total length of 73 mm (54,5 mm for the length of the trunk and 18,5 mm for the length of the proboscis). Measurements of sexually mature specimens from South Africa reveal large sizes for the species.

The South African specimens of *O. caudex* differ in certain respects from the description provided by Lampert (1883). According to the above author the papillae on the body wall lie on raised ridges which correspond to the longitudinal muscle bands. Careful observation of living specimens, however, has shown that the longitudinal ridges are not permanent structures but become evident only under certain states of contraction. When the animal is completely relaxed these longitudinal ridges become less pronounced and in well-narcotized specimens, the body appears relatively smooth. The South African specimens also differ in that the papillae are distributed over the entire surface of the trunk and are not confined to the longitudinal muscle bands as stated by Lampert (1883). Unfortunately Shipley (1898), gives no details regarding the nature and distribution of the dermal papillae for his Rotuma specimens. The distribution of the dermal papillae of the South African specimens, however, is very similar to the description provided by Prashad (1935). A noticeable feature of *O. caudex* is that the shape and distribution of the papillae are uniform in all the specimens. This seems to be an important characteristic of this species and may be diagnostic. This is further substantiated by the fact that authors who have described species of *Ochetostoma* have not reported variations within the species as far as the shape and arrangement of the papillae are concerned.

Lampert (1883) and Shipley (1898) report the presence of 16 to 18 muscle bands in *O. caudex* while Prashad (1935) mentions 18 to 19. In the South African specimens, however, the number ranges from 14 to 21. Since the description of *O. caudex* by the early authors was based on few specimens, very little was known of the variation in the number of longitudinal muscle bands within this species.

From the descriptions of *O. erythrogrammon* by several authors (Shipley 1899; Satô 1935, 1939; Stephen & Robertson 1952; Wesenberg-Lund 1954, 1957, 1959a, 1959b; Webb 1972) it is evident that there is a considerable variation in the number of longitudinal muscle bands in this species also. According to Stephen & Edmonds (1972) the number in *O. erythrogrammon* usually ranges from 13 to 18. Stephen & Robertson (1952) and Webb (1972), however, report the presence of only 12 longitudinal muscle bands. Therefore it is apparent that the number of longitudinal muscle bands cannot be used as a reliable taxonomic criterion because of the considerable overlap that occurs among several closely related species.

The most recent systems of classification of the phylum Echiura are these of Stephen & Edmonds (1972) which have been modified from those of Bock (1942) and Fisher (1946, 1949). Stephen & Edmonds (1972) state that they have been unable to construct a complete key to the genus *Ochetostoma* and have encountered problems especially in the classification of those species that possess three pairs of nephridia and 12 to 18 longitudinal muscle bands. The species falling into this group include: *O. caudex; O.*

kokotoniense and *O. stuhlmanni* (Fischer 1892); *O. australiense* Edmonds 1960; *O. palense* (Ikeda 1924); *O. griffini* (Wharton 1913); *O. indosinense* Wesenberg-Lund 1939 and *O. erythrogrammon*.

Satô (1939), mainly because of the considerable overlap in the number of longitudinal muscle bands, considers *O. caudex, O. kokotoniense* and *O. stuhlmanni* to be synonymous with *O. erythrogrammon* while Wesenberg-Lund (1939, 1963), in addition to these, also includes *O. palense* and *O. multilineatum* (Fischer 1914) in the synonymy.

O. kokotoniense and *O. stuhlmanni* have been very briefly diagnosed and described and on the basis of the existing literature it is extremely difficult to make satisfactory comparisons with other closely related species. The former species, from Zanzibar, is known from a single specimen in which the proboscis was missing while the latter has been described from three mutilated specimens from the same locality (Stephen & Edmonds 1972). *O. kokotoniense* possesses 17 to 18 longitudinal muscle bands and therefore cannot be separated from *O. caudex* on the basis of this feature. However, it differs from *O. caudex* in the nature and arrangement of the dermal papillae. According to Stephen & Edmonds (1972) smaller papillae are distributed over the whole surface in definite transverse rows, interrupted by rings of larger papillae.

The length of the trunk of *O. stuhlmanni* averages 20 mm and the proboscis 5 mm (Shipley 1899). Stephen & Edmonds (1972) have incorrectly given the length of the proboscis as 0,5 mm. The specimens comprising this species appear to be much smaller when compared to *O. caudex*. However, this size difference cannot be used as a reliable distinguishing feature since Shipley's description does not mention whether the specimens studied were juvenilies or sexually mature individuals. Another difference of lesser significance appears to be in the length of the anal vesicles which in *O. stuhlmanni* are only half as long as the trunk (Shipley 1899). Stephen & Edmonds (1972) have refrained from placing *O. stuhlmanni* in the synonymy of *O. kokotoniense* mainly because of the difference in the number of longitudinal muscle bands. More detailed redescriptions based on additional specimens from or near the type locality are required before the taxonomic position of these two species can be satisfactorily determined.

O. australiense is known from numerous specimens from the eastern coast of Australia and closely resembles *O. erythrogrammon* (Stephen & Edmonds 1972). The description of this species by Edmonds (1960) is based on 21 specimens, 12 of which were dissected. It differs from *O. caudex* in the number of longitudinal muscle bands. According to Edmonds (1960), the number is usually 12 to 13, occasionally 11 to 14. Another distinguishing feature lies in the dermal papillae, which in *O. australiense* are small and flat and confined to the anterior and posterior surfaces of the trunk. Differences are also apparent in the colour; living specimens are red but preserved specimens are pale pink or straw coloured. The proboscis also is unlike that of *O. caudex*. In living specimens the proboscis is white and when fully extended appears to be quite flat, more or less ribbon-like in appearance (Edmonds 1960).

In their monograph, Stephen & Edmonds (1972) state that an interbasal muscle is present in *O. australiense*. However, this does not correspond to Edmonds' original description (1960) of the species.

O. palense, described as *Thalassema palense* by Ikeda (1924) from the Palau Islands, Japan, differs from *O. caudex* in several respects. The animals are uniformly bright green in life. The trunk is pear-shaped and the integument is very thin and somewhat transparent except in the anterior and posterior regions where it is a little thicker and opaque. Ikeda's description (1924) mentions 15 longitudinal muscle bands that are confined only to a small anterior portion of the trunk. Another distinguishing feature is that the alimentary canal is rather short in relation to the size of the animal. Furthermore, there are comparatively few unstalked funnels present on the anal vesicles and there is no rectal diverticulum.

O. griffini, originally described as *Thalassema griffini* by Wharton (1913), is known from numerous specimens from the Philippines. According to the above author, the length of the trunk of the largest specimens ranges from 120 to 140 mm when fully extended and the proboscis from 50 to 80 mm. Stephen & Edmonds (1972) have incorrectly given the length of the trunk as 12 to 14 mm in their monograph. This gives an erroneous impression of the relative proportions of the proboscis and trunk. The anal vesicles appear to differ slightly from those of *O. caudex*. Wharton's description (1913) mentions that the anal vesicles are clear and transparent sacs about one-half the length of the body. Another difference is that the papillae in the posterior end of the trunk are arranged in more or less definite rings (Wharton 1913). Besides these two relatively minor differences, it is difficult to find any other feature that will distinguish *O. griffini* from *O. caudex* and it seems very likely that the two species are identical. Furthermore, the habitats of both appear to be very similar.

The description of *O. indosinense* by Wesenberg-Lund (1939) is based on a single specimen from Nhatrang, South Annam. The most important differences between *O. indosinense* and *O. caudex* lie in the nature of the proboscis, the body wall and the nephrostomal lips. According to Wesenberg-Lund (1939), the proboscis is slightly bifurcated, the ventral rims crenated and its dorsal surface is covered with ovoid or cylindrical papillae. In addition the trunk, unlike that of *O. caudex*, is pointed at each end and the body wall is very much thinner and transparent in the middle. An important distinguishing feature is that the oblique muscle layer is very thin and continuous. The nephrostomal lips, although elongate, are not coiled. Furthermore, a rectal diverticulum is absent. Differences are also apparent in the colour of the animals. In the live specimen, the proboscis is light green and the body is pink (Wesenberg-Lund 1939).

O. multilineatum, described originally as *Thalassema multilineatum* by Fischer (1914), is based on a single specimen from the West African coast. It differs from *O. caudex* in possessing anal vesicles which are only one-quarter the length of the body. Since the proboscis was lacking in the type specimen, it is very likely that this structure is deciduous in *O. multilineatum*. The maximum number of longitudinal muscle bands in *O. caudex* is not known to exceed 21 whereas in *O. multilineatum* these muscles are gathered into 21 to 22 longitudinal bands (Fischer 1914). Apart from these minor differences it is difficult to find any other feature that will clearly distinguish *O. multilineatum* from *O. caudex* and these two species may well be synonymous.

O. erythrogrammon, originally described from the Red Sea, has been reported from numerous localities from both the Indian and Pacific Oceans. From the description of this species by Stephen & Edmonds (1972) it is evident that the colour of the proboscis differs from that of *O. caudex*. The dorsal surface of the proboscis is bright green and the ventral side is yellow with a violet line on each side.

Satô (1935, 1939) states that the dermal papillae in *O. erythrogrammon* are distributed quite irregularly being more closely crowded and larger at the two ends of the trunk. According to Stephen & Robertson (1952) the papillae occur all over the body, being small and scattered in the middle, but more crowded and larger at the ends. Wesenberg-Lund (1957, 1959a) states that the papillae are densely crowded at the ends of the trunk and are arranged in rings at the posterior end. In the central part the skin is distended and transparent. Webb (1972) in his description of a single specimen of *O. erythrogrammon* from Isipingo Beach, mentions that the middle third of the trunk is covered with very small, indistinct and scattered papillae, while in the posterior third the papillae are larger and more numerous. Hence the shape and distribution of the papillae in *O. erythrogrammon* differ from those of *O. caudex*.

From the literature on *O. erythrogrammon* it is evident that the integument of these two species is also different. Both Satô (1939) and Webb (1972) state that the integument of *O. erythrogrammon* is generally thin and translucent except in the region of both extremities of the trunk. In contrast to this, practically the entire integument of *O. caudex* is relatively thick and opaque.

According to Satô (1939) the colour of the trunk of *O. erythrogrammon* is bluish-green in the fresh state and hence unlike that of *O. caudex*.

In contrast to the numerous unstalked funnels present on the anal vesicles of *O. caudex*, Wesenberg-Lund (1954, 1959a) reports the presence of a few unstalked funnels in *O. erythrogrammon*. However, Webb (1972) states that the funnels have long stalks, the greater part of which lie against the vesicle. Very little is known of the structure of these funnels in *O. erythrogrammon* and more detailed investigations are required before further comparisons can be made. Detailed scanning electron microscopic studies may reveal new features of taxonomic value.

Despite the overlap in the number of longitudinal muscle bands in *O. erythrogrammon* and *O. caudex*, it is interesting to note that the maximum number of muscle bands in the former is not known to exceed 18.

Wesenberg-Lund (1959a, 1959b) also reports the presence of a rectal diverticulum in all the specimens of *O. erythrogrammon* investigated by her. Satô's contention that the rectal diverticulum is present in some specimens of *O. erythrogrammon* but apparently absent in others requires verification.

In conclusion, although *O. caudex* and *O. erythrogrammon* appear to be closely related there are certain differences, especially in the nature of the integument and in the shape and distribution of the dermal papillae, which are sufficiently distinctive to warrant separation at species level. Other differences of lesser importance, such as the range in variation of the longitudinal muscle bands and the distribution of the funnels on the anal vesicles, also tend to set the species apart. In the light of the available information, Satô (1939) and Wesenberg-Lund (1939, 1963) are unjustified in assuming that these two species are conspecific. More detailed investigations on both the species would probably shed more light on the position.

Acknowledgements

I wish to thank Mr F.L. Farquharson and Mr A.S. Thandar for critically reading the manuscript and making some helpful suggestions; Messrs K.S. Ganga, G.K. Moodley and G.C. Naidu for assistance with the collection of specimens; Dr H. Baijnath for the photography and Mrs J. Evers for the electron micrographs. The loan of some excellent literature on echiurans by Mr L.G. Moodley is also gratefully acknowledged.

References

BOCK, S. 1942. On the structure and affinities of *'Thalassema' lankesteri* Herdman and the classification of the group Echiuroidea. *Göteborgs K. Vetensk.-O. Vitterh Samh. Handl.* 2: 1 – 94.

EDMONDS, S.J. 1960. Some Australian echiuroids (Echiuroidea). *Trans. Roy. Soc. S. Aust.* 83: 89 – 96.

FISCHER, W. 1914. Beiträge zur Kenntnis des Meeresfauna West Afrikas. *Beitr. Kennt. Meeresfauna Westft.* 1: 57 – 84.

FISHER, W.K. 1946. Echiuroid worms of the Norh Pacific Ocean. *Proc. U.S. natn. Mus.* 96: 215 – 292.

FISHER, W.K. 1949. Additions to the echiuroid fauna of the North Pacific Ocean. *Proc. U.S. natn. Mus.* 99: 479 – 497.

HARRIS, R.R. & JACCARINI, V. 1981. Structure and function of the anal sacs of *Bonellia viridis* (Echiura:Bonellidae). *Mar. Biol. Ass. U.K.* 61: 413 – 430.

IKEDA, I. 1924. Further notes on the gephyrea of Japan, with descriptions of some new species from the Marshall, Caroline and Palau Islands. *Jap. J. Zool.* 1: 23 – 44.

LAMPERT, K. 1883. Über einige neue *Thalassema*. *Z. wiss Zool.* 39: 334 – 342.

PRASHAD, B. 1935. On a collection of echiuroids of the genus *Thalassema* Lamarck in the Indian Museum, Calcutta. *Rec. Indian Mus.* 37: 39 – 44.

SATÔ, H. 1935. Sipunculoidea and Echiuroidea of the West Caroline Islands. *Sci. Rep. Tôhoku Univ.* (4) 10: 299 – 329.

SATÔ, H. 1939. Studies on the Echiuroidea, Sipunculoidea and Priapuloidea of Japan. *Sci. Rep. Tôhoku Univ.* (4) 14: 339 – 460.

SHIPLEY, A.E. 1898. Report on the gephyrean worms collected by Mr Stanley Gardiner at Rotuma and Funafuti. *Proc. zool. Soc. Lond.* 1898: 468 – 473.

SHIPLEY, A.E. 1899. Notes on a collection of echiurids from the Loyalty Islands, New Britain and China Straits, with an attempt to revise the group and to determine its geographical range. *Willey, A. Zool. Results.* 3: 335 – 356.

STEPHEN, A.C. & EDMONDS, S.J. 1972. The phyla Sipuncula and Echiura. Trustees of the British Museum (Natural History), London.

STEPHEN, A.C. & ROBERTSON, J. 1952. A preliminary report on the Echiuridae and Sipunculidae of Zanzibar. *Proc. R. Soc. Edinb.* 64(b) 22: 426 – 444.

WEBB, M. 1972. *Ochetostoma erythrogrammon* (Leuckart & Rüppell 1828) (Echiurida) from Isipingo Beach, Natal, South Africa. *Zool. afr.* 7: 521 – 532.

WESENBERG-LUND, E. 1939. Echiurids collected in French Indo-China by C. Dawydoff. *Archs Zool. exp. gén.* (Notes et Revue). 81: 45 – 53.

WESENBERG-LUND, E. 1954. Sipunculids and echiurids collected by Mr G. Ranson in 1952. *Bull. Mus. natn. Hist. nat. Paris* 26: 376 – 384.

WESENBERG-LUND, E. 1957. Contributions to the knowledge of the Red Sea, No. 3. Sipunculoidea and Echiuroidea from the Red Sea. *Bull. Sea Fish Res. Stn Israel.* 14: 1 – 15.

WESENBERG-LUND, E. 1959a. Sipunculoidea and Echiuroidea from Tropical West Africa. *Atlantide Rep.* 4: 177 – 210.

WESENBERG-LUND, E. 1959b. Sipunculoidea and Echiuroidea from Mauritius. *Vidensk. Meddr. dansk. naturh. Foren.* 121: 53 – 73.

WESENBERG-LUND, E. 1963. South African sipunculids and echiurids from coastal waters. *Vidensk. Meddr. dansk. naturh. Foren.* 125: 101 – 146.

WHARTON, L.D. 1913. A description of some Philippine *Thalassemae* with a revision of the genus. *Philipp. J. Sci.* 8: 243 – 270.