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OBSERVATIONS ON HELMINTHS PARASITIC IN WARTHOGS AND BUSHPIGS

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The material on which the following study is based was recovered from more than 30 warthogs and several bushpigs. The majority of the specimens were from the northern areas of Portuguese East Africa and sent to Onderstepoort for study by Dr. J. J. Travassos Santos Dias. Some warthog specimens were collected by the game wardens from the different Zululand National Game Reserves. The writer wishes to express his sincere thanks to these gentlemen for their services in collecting, preserving and sending the specimens to this Institute. A very striking finding was that in the material collected from the large intestine of animals in Portuguese East Africa, there was not a single representative of the genus *Murshidia*, only the genus *Oesophagostomum* being represented. Amongst the specimens from Zululand there was not a single oesophagostome, the material consisting only of the species *Murshidia hamata* and *M. pugnicaudata*. A small collection of warthog worms from Pilgrim's Rest, Northern Transvaal, contained three females of *Murshidia hamata*, about a dozen males and females of *Oesophagostomum mwanzae* and a few females of *O. moçambiquei* sp. nov. Pilgrim's Rest is about midway between Northern Moçambique, where the worms from Portuguese East Africa were collected, and the Zululand game reserves and it is interesting that from this area representatives of both genera were present in the same host.

LIST OF HELMINTHS IN THE ONDERSTEPOORT COLLECTION FROM WARTHOGS AND BUSHPIGS

Host	*Parasite*	*Locality*
Warthog..... (*Phacochoerus aethiopicus*)	*Gastrodiscus aegyptiacus*.....	Northern Moçambique
	Moniezia mettami.....	Zululand
	Paramoniezia phacochoeri.....	Zululand
	Ascaris phacochoeri.....	Northern Moçambique and Zululand
	Murshidia hamata.....	Pilgrim's Rest and Zululand
	Murshidia pugnicaudata.....	Zululand
	Oesophagostomum eurycephalum.....	Northern Moçambique
	**Oesophagostomum moçambiquei* sp. n.	Northern Moçambique and Pilgrim's Rest
	Oesophagostomum mpwapwae.....	Northern Moçambique
	Oesophagostomum mwanzae.....	Northern Moçambique and Pilgrim's Rest
	Oesophagostomum oldi.....	Northern Moçambique
	**Oesophagostomum santos-diasi* sp. n...	Northern Moçambique
	Oesophagostomum simpsoni.....	Northern Moçambique
	Oesophagostomum yorkei.....	Northern Moçambique
	**Setaria castroi* sp. n.....	Northern Moçambique

† Deceased on 12 April, 1964

Received for publication on 25 September, 1963.—Editor

Host	*Parasite*	*Locality*
Bushpig..... (*Potamochoerus porcus*)	*Gastrodiscus aegyptiacus*.....	Northern Moçambique
	**Globocephalus versteri* sp. n.....	Mara, Northern Transvaal
	Oesophagostomum aethiopicum.....	Mara, Northern Transvaal
	**Ascarops strongylina*.....	Mara, Northern Transvaal
	**Physocephalus sexalatus*.....	Mara, Northern Transvaal
	Setaria congolensis.....	Northern Moçambique
	**Setaria castroi* sp. n.....	Northern Moçambique
	**Macracanthorhynchus hirudinaceus*....	Northern Moçambique

* New host records.

Oesophagostomum aethiopicum Duthy, 1947

The original description of this species is based on two males and three females collected, presumably, from an East African warthog. The material studied by the writer consists of 25 males and 23 females collected from a bushpig from Mara, Northern Transvaal. This species is unique for warthog nodular worms in that it possesses an external leaf-crown consisting of elements considerably in excess of the usual six or eight, and in that an internal leaf-crown is present, which is absent in all the other oesophagostomes from warthogs. Because of this uniqueness, and since this is the only instance of an oesophagostome being reported from the bushpig, the question arises as to which, the bushpig or the warthog, is to be considered the normal host. This species was not present among the hundreds of specimens examined by the writer from more than 30 warthogs originating from Northern Moçambique southwards to the Umfolosi Game Reserve in Natal. The writer is, therefore, inclined to regard the bushpig as the normal host, and the infection in the warthog accidental or the host record to be incorrect. As the habitats and feeding habits of these two hosts are quite different, one would not expect them to harbour the same species of parasites.

To Miss Duthy's description I wish to add the following observations: The males reach a length of 12 mm, the females 14 mm. The cylindrical mouth capsule in optical section has an irregular outline with two anterior and two posterior projections (Fig. 1). The anterior inner projection forms a circular ledge in the buccal capsule; the leaf-crown elements originate from the edge of this ledge. There are 25 to 28 external leaf elements and double this number of internal elements. The latter appear in opticial section as two refringent lines at the corners of the base of each external leaf element while in an *en face* view (Fig. 2) it is seen that they are tongue-shaped and about a fifth of the length of the external elements. The anterior end of the oesophagus is enlarged and three small triangular teeth project into the small oesophageal funnel, one from the anterior end of each longitudinal oesophageal segment.

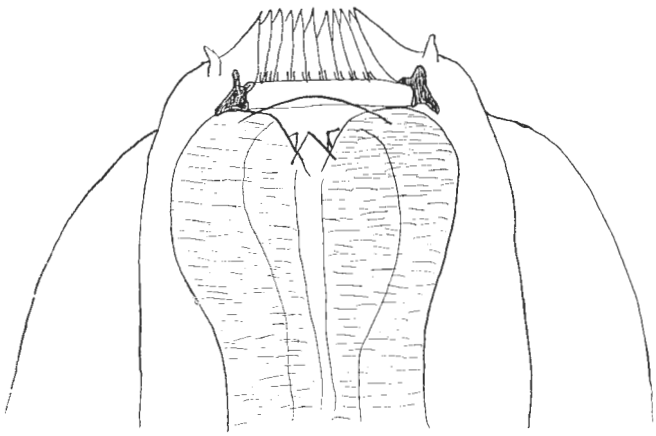

FIG. 1.—*Oesophagostomum aethiopicum.* Anterior end, showing optical section of buccal capsule and teeth in oesophageal funnel

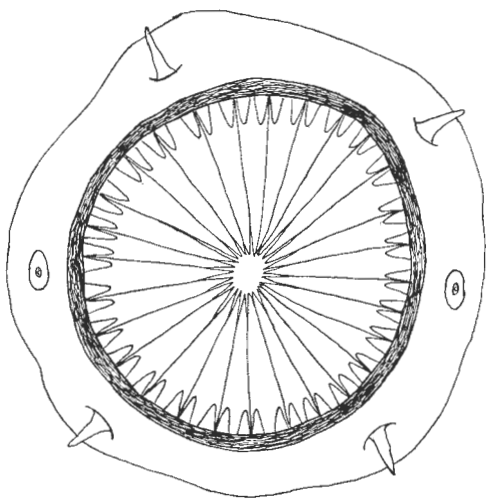

FIG. 2.—*Oesophagostomum aethiopicum. En face* view showing elements of internal and external leaf-crown

FIG. 3.—*Oesophagostomum aethiopicum.* Posterior end of female

The shape of the female tail is represented in Fig. 3.

The principal measurements in Miss Duthy's and the present specimens are:

Measurements in mm of specimens from Warthog and Bushpig

	Miss Duthy (Warthog)	Ortlepp (Bushpig).
Length:	mm	mm
Male	8–9	11–12
Female	9·4–11·8	12–14
Breadth:		
Male	0·52–0·64	0·5–0·56
Female	0·77–0·82	0·63–0·72
Buccal capsule	0·068–0·084 wide and 0·008 deep	0·065–0·07 × 0·01–0·013
Cervical groove from front end	0·168–0·224	0·210–0·226
Cervical papillae from front end	0·373	0·430, 0·420, 0·480 & 0·410
Oesophagus	0·579–0·747	0·56–0·66 & 0·67–0·69
Spicules length	1·307	1·28–1·33
Gubernac. length	0·168	0·11–0·12
Ext. leaf elements	26	25–28
Length female tail	0·243–0·317	0·3–0·39
Distance anus to vulva	0·3–0·44	0·45–0·61
Length vagina	0·149–0·187	0·130–0·14
Eggs	?	0·061–0·064 × 0·037–0·042

Oesophagostomum santos-diasi sp. nov.

This new species is represented by many specimens found amongst numerous worms in two collections reported to be from both the stomach and the large intestine of warthogs from Maracongolha, Portuguese East Africa. Examples of five other species of oesophagostomes were also present, viz. *O. eurycephalum*, *O. mwanzae*, *O. oldi*, *O. simpsoni* and *O. yorkei*. As the two collections comprised the same species in about the same proportions, the writer thinks that both were collected from the normal habitat of these worms, viz. the large intestine. It would be very unusual for adult oesophagostomes to inhabit the stomach.

The worms have a greyish white colour, the males being from 10 to 12 mm long, and 0·25 to 0·275 mm thick. Mature females containing eggs are from 13 to 15 mm long, with a maximum thickness of from 0·25 to 0·33 mm. Immediately in front of the female tail the body suddenly narrows to a thickness of about 0·13 mm.

The head end is somewhat rounded and carries four prominent subdorsal and subventral papillae, each papilla being terminated by an oval and relatively long node. The two lateral papillae are also prominent but are somewhat dome-shaped. The cervical swelling is not very marked and the cervical groove is only weakly indicated (Fig. 4). The groove is situated about 0·23 to 0·25 mm from the anterior end, and the excretory pore is situated in its midventral line. The cervical papillae are peg-like and may be somewhat asymmetrically placed, about 0·025 to 0·03 mm behind the cervical groove. The nerve ring is lodged about midway between the levels of the excretory pore and cervical papillae. The buccal capsule is oval and in optical section its wall is similar to that of *O. mwanzae*, having a somewhat straight

inner margin and a cone-shaped outer border (Fig. 5). Its average thickness is about 0·005 mm. In the females the dorso-ventral diameter of the buccal capsule is 0·06 to 0·065 mm, its lateral diameter 0·03 to 0·032, and its depth 0·017 to 0·02 mm. In the males these measurements are 0·05 to 0·053 mm, 0·03 mm and 0·015 to 0·016 mm respectively. The mouth is surrounded by six somewhat triangular, external leaf-crown elements originating from the base of the buccal capsule and extending very slightly beyond the level of the mouth opening.

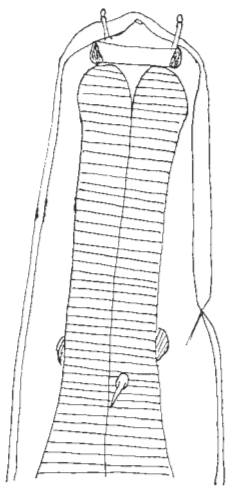

FIG. 4.—*Oesophagostomum santos-diasi*, sp. n. Lateral view of anterior end

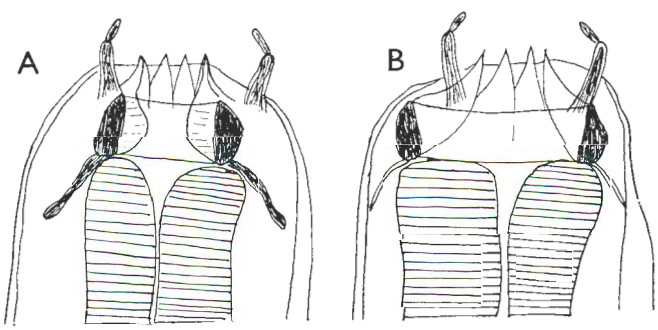

FIG. 5.—*Oesophagostomum santos-diasi*, sp. n. A, dorsal and B, lateral views of head showing optical section of oval buccal capsule

The oesophagus has the normal club-shaped appearance and is from 0·46 to 0·49 mm long in the females, and 0·42 to 0·44 mm long in the males.

The tail of the female is sharply bent dorsalwards and is from 0·08 to 0·09 mm long (Fig. 6). It is somewhat foot-shaped, the anus being situated at about the centre of the foot and the vulva just anterior of the heel. The vagina is simple and relatively long, from 0·95 to 1·06 mm; it passes straight forwards to join the somewhat obliquely placed ovejectors. The eggs measuring 0·068 to 0·07 mm long by 0·035 to 0·057 mm thick are thin-shelled, oval and morulated in the vagina.

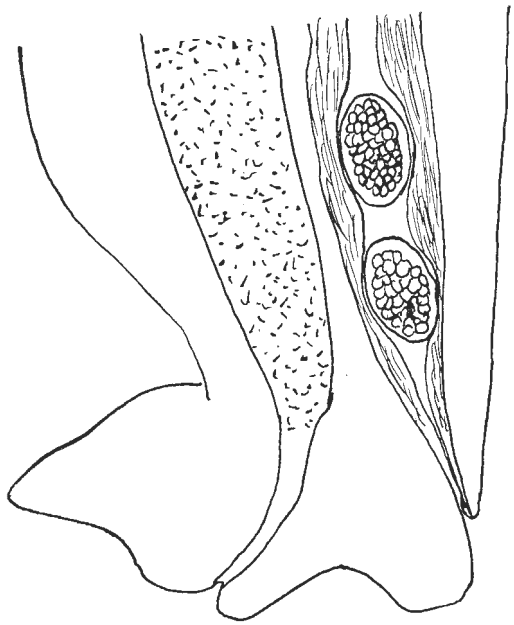

FIG. 6.—*Oesophagostomum santos-diasi*, sp. n Posterior end of female

The male bursa (Fig. 7) shows no special characteristics; there are two well developed lateral lobes, the dorsal lobe is clearly marked. The spicules are long, equal, slender and pointed and each carries a transversely striated ala along its inner margin; their length varies from 2·4 to 2·67 mm, with a maximum proximal thickness of 0·02 to 0·025 mm. A well chitinized gubernaculum 0·08 to 0·085 mm long is present; its shape in lateral view is given in the figure.

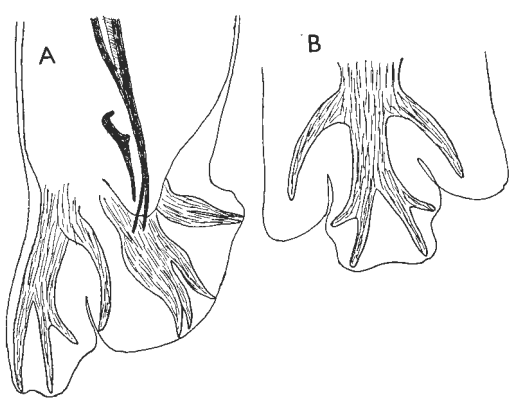

FIG. 7.—*Oesophagostomum santos-diasi*, sp. n. A, lateral view of bursa and B, dorsal view of dorsal ray

Affinities

The dorsally bent tail and the oval buccal capsule ally this species with *O. mwanzae*, *O. roubaudi* and *O. moçambiquei* sp. nov. It differs from the two first-named in being smaller, in that its vagina is much longer and its spicules also are longer. In addition it differs from *O. mwanzae* in that its oesophagus carries no valves. It differs from *O. moçambiquei* sp. nov. in the shape of its buccal capsule as seen in optical section, in that the leaf-crown elements originate from the base of the capsule, in its smaller size and its longer vagina.

Specific diagnosis

Oesophagostominae up to 12 mm long for the males, and up to 15 mm for the females. Buccal capsule oval with six external leaf elements arising from its base. Female tail bent dorsalwards. Vagina about 1·0 mm long. Spicules equal, about 2·5 mm long. Parasites of large intestine of warthogs.

Host: Phacochoerus aethiopicus (warthog)
Location: Large intestine
Locality: Portuguese East Africa
Type: In Onderstepoort collection

This species is named in honour of Dr. J. Travassos Santos Dias in appreciation for placing the specimens at the writer's disposal.

Oesophagostomum moçambiquei sp. nov.

In the material from Portuguese East Africa from three hosts there are nine females referred to this species. These females are from 17 to 20 mm long with a maximum body thickness of 0·35 to 0·42 mm. The mouth collar is flattened and only slightly set off from the rest of the body; its transverse diameter is 0·09 to 0·11 mm. The four submedian papillae are prominent and stand out as distinct horns anterior to the mouth collar; their tips are slightly knobbed. The amphids are only slightly raised above the collar surface. The cervical swelling, varying in length from 0·22 to 0·27 mm, shows only a slight inflation; posteriorly it is demarcated by the cervical groove, which is well defined along the ventral surface but disappears in the subdorsal lateral areas. No lateral alae are present. The lateral cervical papillae are long and spikelike, symmetrically placed behind the cervical groove and from 0·3 to 0·33 mm from the anterior end. The cylindrical buccal capsule has an internal diameter of 0·044 to 0·048 mm and a depth of 0·014 to 0·016 mm; in optical sections its wall, about 0·008 mm thick, has a slight outer and an inner constriction at the junction of its posterior and middel thirds (Fig. 8). The six broad external leaf-crown elements originate from the internal constriction and extend obliquely inwards and forwards through the mouth opening. An internal leaf-crown is absent. The slightly club-shaped oesophagus is 0·42 to 0·5 mm long; its anterior thickness varies from 0·055 to 0·07 mm, and at the middel of the posterior thickening it varies from 0·085 to 0·116 mm. The excretory pore is situated in the cervical groove and the nerve ring encircles the oesophagus just behind this level. The posterior end of the female is sharply bent dorsalwards; a marked constriction of the body just anterior of this bend is present, giving this portion the shape of a human foot (Fig. 9). The vaginal and anal openings are situated in almost a horizontal line along the sole of the foot, the vulva at the heel and the anus at the instep. The vagina extends

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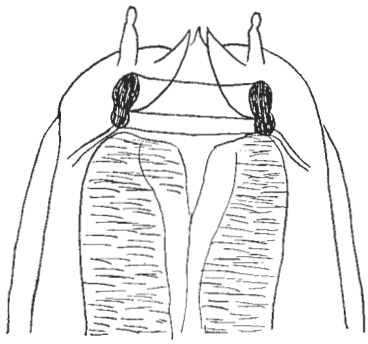

FIG. 8.—*Oesophagostomum moçambiquei*, sp. n. Lateral view of head showing optical section of buccal capsule

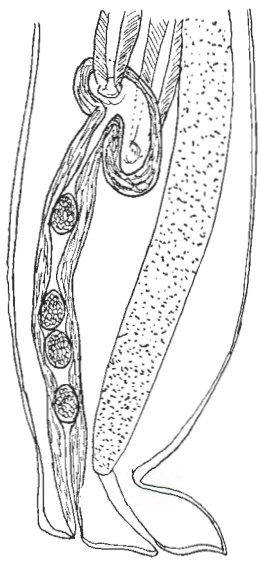

FIG. 9.—*Oesophagostomum moçambiquei*, sp. n. Posterior end of female

straight forwards from the vulva and has a length of 0·65 to 0·75 mm; the ovejectors are slightly obliquely placed in the body. The distance from the vulva to the anus is 0·13 to 0·15 mm, and from the anus to the tail tip 0·1 to 0·13 mm. The thickness of the body at the constriction just anterior of the " foot " is from 0·15 to 0·18 mm. The eggs are oval, thin-shelled and morulated *in utero*; they are from 0·08 to 0·09 mm long and 0·047 to 0·048 mm thick.*

* Since the above account was written a collection of round worms from a warthog was placed at the writer's disposal, the warthog was from the central area of the Kruger National Park and the parasites were collected by Dr. J. W. van Niekerk, Veterinarian for the Park; the writer wishes to thank Dr. van Niekerk for these specimens and for the trouble taken in collecting them.

The collection contains 53 males and females of *Murshidia hamata*, two females of *Oesophagostomum simpsoni*, one female of *Oesophagostomum mwanzae* and 10 males and 28 females of *Oesophagostomum santos-diasi* sp. nov. These males are from 12·5 to 15 mm long by 0·25 to 0·30 mm thick. The oesophagus varies in length from 0·38 to 0·45 mm, and the buccal capsule has an internal diameter 0·038 to 0·042 mm with a depth of 0·015 to 0·016 mm. The cervical groove is situated 0·19 to 0·25 mm from the anterior end. The bursa is of normal shape, consisting of two ample lateral lobes and a distinct dorsal lobe. In most of the worms the common trunk of the lateral rays carries a knob-like protuberance on its dorsal border, about half-way up its length. The two equal spicules vary in length from 2·13 to 2·4 mm. The anterior half of the gubernaculum has a dorsal curvature and its anterior tip may be bent either towards the dorsal or ventral surface; its entire length varies from 0·07 to 0·085 mm.

Affinities

Only four other species of oesophagostomes with a dorsally bent tail are known from warthogs; of these *O. oldi* has a cylindrical buccal capsule and the other three species, viz. *O. mwanzae*, *O. roubaudi* and *O. santos-diasi* sp. nov., have an oval buccal capsule. *O. oldi* differs from *O. maçambiquei* in that its buccal capsule has parallel walls in optical section. The external leafcrown originates from the base of the buccal capsule. The vagina of *O. oldi* is much longer, reaching to over 1 mm. *O. moçambiquei* differs from the other three species with respect to the cylindrical mouth capsule, its shape in optical section and the origin of the external leafcrown-elements.

Specific diagnosis

Oesophagostominae: Male unknown. Female up to 20 mm long, posterior end bent sharply dorsalwards. External leaf-crown of six elements arising from constriction at junction of posterior middle thirds of cylindrical buccal capsule. Oesophagus slightly club-shaped. Straight vagina up to 0·75 mm long. Parasitic in large intestine of warthogs.

Host: Phacochoerus aethiopicus (warthog)

Location: Large intestine

Locality: Portuguese East Africa

Type: In Onderstepoort collection

Oesophagostomum mpwapwae Duthy, 1948.

Miss Duthy described the species from two males and one female. In the material from Portuguese East Africa there are nine males and two females which are referred to this species. The identification is based on the cylindrical mouth capsule surmounted by six leaf-crown elements, the anterior end of the oesophagus not being thickened, the presence of long spicules varying from 3·1 to 3·8 mm, and long vagina, 2·13 and 2·4 mm. Miss Duthy found the length of the spicules to be 3·75 to 3·8 mm, and of the vagina 2·091 mm. The only striking differences between Miss Duthy's and the present specimens lie in (1) the shape of female tail (in the writer's specimens the tail is bent slightly dorsalwards and the vulva does not open on a protuberance) (Fig. 11); (2) the details of the dorsal rays of the male bursa (in the writer's specimens the second small branch on each of the main branches of the dorsal ray is present as thin branchlets in two specimens, is represented by small knobs in four specimens, and is absent in the remaining three males.)

These differences are in the writer's opinion outweighed by the similarities of the other organs, especially the lengths of the spicules and vagina.

In Fig. 10 (A–I) the shape and relative size of the oesophagus of each of the species studied by the writer are represented.

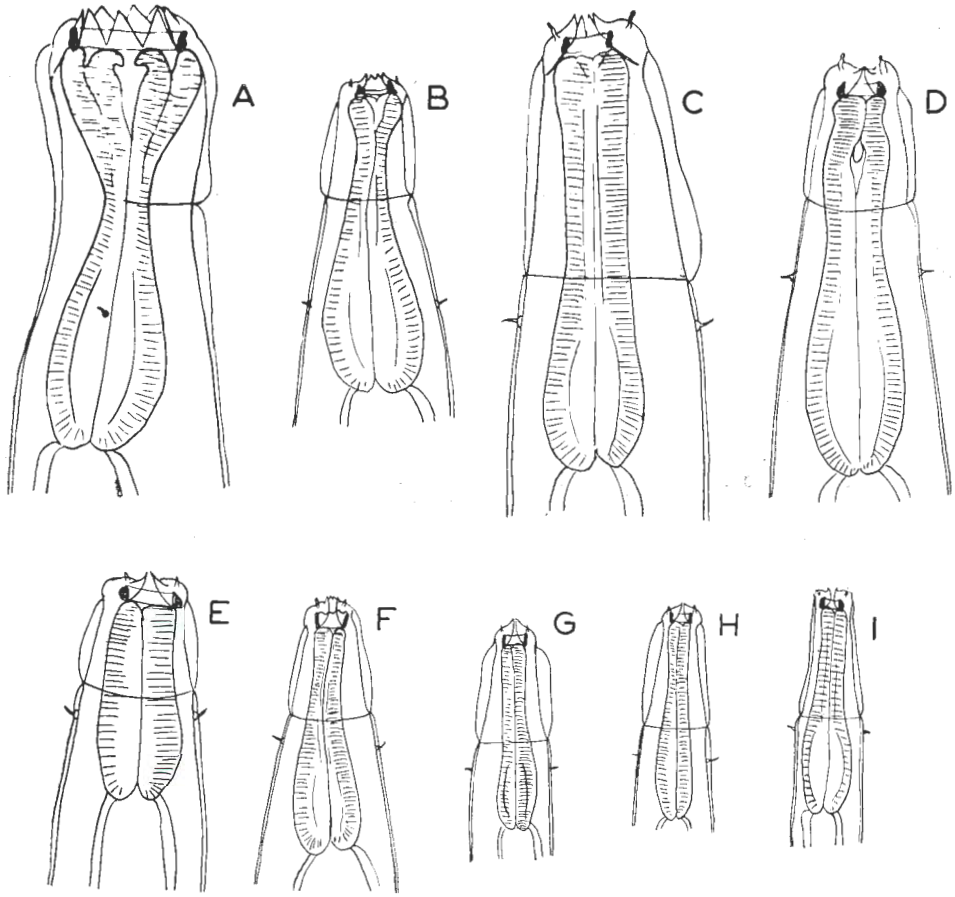

FIG. 10.—Oesophaguses of species of *Oesophagostomum* to same scale showing their shapes in optical sections. A = *O. eurycephalum*. B = *O. aethiopicum*. C = *O. moçambiquei*, sp. n. D = *O mwanzae*. E = *O. simpsoni*. F = *O. yorkei*. G = *O. oldi*. H = *O. mpwapwae*. I = *O. santos-diasi*, sp. n.

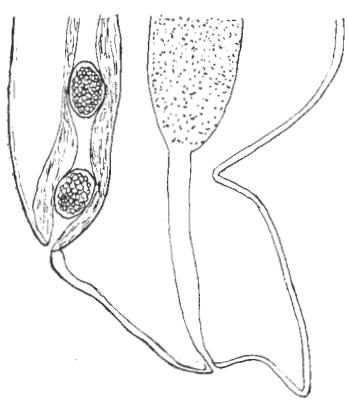

FIG. 11.—*Oesophagostomum mpwapwae*. Posterior end of female

TABLE 1.—*Table giving principal characteristics of oesophagostomes from warthogs and bushpigs; all measurements in mm*

Oesophagostome	Maximum length		Mouth capsule	External leaf crown	Oesophagus	Tail ♀	Vagina	Anus-Vagina	Spicule
O. aethiopicum Duthy, 1948.....	12	14	Cylindrical	25–28	Thickened...	Straight..	0·13–0·19	0·3–0·44	1·28–1·33
O. eurycephalum Goodey, 1924..	15	17	Cylindrical	8	Thickened...	Straight..	0·21–0·26	0·3	1·3–1·7
O. goodeyi Daubney, 1926.....	—	18	Oval.....	6	Club-shaped..	Straight..	0·6	0·15	—
O. moçambiquei sp. nov.....	—	20	Cylindrical	6	Club-shaped	Bent	0·65–0·75	0·13–0·15	—
O. mpwapwae Duthy, 1948.....	12·7	14·5	Cylindrical	6	Club-shaped	Straight	2·1	0·11	3·1–3·8
O. mwanzae Daubney, 1924.....	19	24	Oval	6	Club-shaped 3 valves	Bent	0·35–0·5	Short 0·2	1·87–2·2
O. oldi Goodey, 1924.....	13	18	Cylindrical	6	Club-shaped	Bent	1·3–1·7	0·2	2·4–2·6
O. roubaudi Daubney, 1926.....	17	22·5	Oval	6	Club-shaped	Bent	0·17–0·26	0·28–0·34	1·27–1·3
O. santos-diasi sp. nov.....	12	15	Oval	6	Club-shaped	Bent	0·7–1·0	0·09–0·1	2·4–2·7
O. simpsoni Goodey, 1924.....	15	21	Oval	8	Short and thick not club-shaped	Straight	0·1–0·15	0·36–0·53	1·2–1·3
O. yorkei Thornton, 1924.....	10	15·3	Cylindrical or slightly oval	8	Club-shaped	Straight	0·19–0·25	0·18	1·1–1·3

Key to Oesophagostomum *spp. from Warthog and Bushpig*

Females

1. Tail bent dorsalwards 2
   Tail straight 6
2. Mouth capsule cylindrical 3
   Mouth capsule oval 4
3. Vagina over 2.0 mm long ..... **O. mpwapwae** (cf. Ortlepp)
   Vagina 1·3 to 1·6 mm long ..... **O. oldi**
   Vagina not more than 0·75 mm long ..... **O. moçambiquei** sp. n.
4. Vagina about 1·0 mm long ..... **O. santos-diasi** sp. n.
   Vagina not more than 0·5 mm long 5
5. Vagina not longer than 0·26 mm, no valves in oesophagus ..... **O. roubaudi**
   Vagina longer than 0·26 mm, 3 valves in oesophagus ..... **O. mwanzae**
6. Anterior end of oesophagus thickened 7
   Anterior end of oesophagus not thickened 8
7. External leaf-crown 25 elements; vagina 0·15–0·19 mm long .... **O. aethiopicum**
   External leaf-crown 8 elements; vagina up to 0·26 mm long .... **O. eurycephalum**
8. External leaf-crown 6 elements; vagina about 2·0 mm long. Buccal capsule cylindrical ..... **O. mpwapwae** (cf. Duthy)
   External leaf-crown 6 or 8 elements; vagina less than 1·0 mm long 9
9. Oesophagus short and thick, not club-shaped; vagina 0·1–0·15 mm long. Buccal capsule oval ..... **O. simpsoni**
   Oesophagus longer, thinner and club-shaped 10
10. Buccal capsule cylindrical with wavy anterior border; 8 external leaf-crown elements; vagina 0·19 to 0·25 mm long ..... **O. yorkei**
    Buccal capsule oval; 6 external leaf-crown elements; vagina 0·63 mm long ..... **O. goodeyi**

Males

1. Anterior end of oesophagus thickened 2
   Anterior end of oesophagus not thickened 3
2. External leaf-crown elements 25 or more; internal leaf-crown present; spicules 1·28–1·3 mm long ..... **O. aethiopicum**
   External leaf-crown elements 8; no internal leaf-crown present; spicules 1·3 to 1·7 mm long ..... **O. eurycephalum**
3. Spicules 3·1–3·8 mm long; buccal capsule cylindrical ..... **O. mpwapwae**
   Spicules less than 3.0 mm long 4
   Spicule lengths unknown ..... **O. goodeyi** and **O. moçambiquei** sp. n.
4. Spicules less than 1·5 mm long 5
   Spicules more than 1·5 mm long 7
5. External leaf-crown 6 elements; spicules 1·27 to 1·32 mm long; buccal capsule oval ..... **O. roubaudi**
   External leaf-crown 8 elements 6
6. Oesophagus elongate and club-shaped; spicules 1·1–1·3 mm long; buccal capsule cylindrical with wavy anterior rim ..... **O. yorkei**
   Oesophagus short and thick, hot club-shaped; spicules 1·3 mm long; buccal capsule oval ..... **O. simpsoni**
7. Buccal capsule cylindrical; spicules 2·4 to 2·6 mm long ..... **O. oldi**
   Buccal capsule oval 8
8. Oesophageal valves present; spicules 1·87 to 2·15 mm long ..... **O. mwanzae**
   Oesophageal valves absent; spicules 2·4 to 2·67 mm long .. **O. santos-diasi** sp. n.

Discussion

Railliet & Henry (1913) divided the *Oesophagostomum* from ruminants into two new subgenera and gave the following definitions:

(*a*) *Hysteracrum* n. sg. similar to the type (i.e. *O. dentatum*) except that the cervical papillae are situated behind the oesophagus. It contains the species *O. venulosum* and *O. asperum.*

(*b*) *Proteracrum* n. sg. differs from the type in that the cephalic vesicle is only slightly or not inflated, two well developed lateral alae are present along the body and the 3rd and 4th larval stages produce nodules in the intestine. It includes *O. columbianum* and *O. radiatum.*

Ihle (1922) created another subgenus, *Conoweberia*, to accommodate those nodular worms which are provided with an oesophageal funnel carrying three teeth. It contains the primate species *O. apiostomum* and *O. brumpti.*

Goodey (1924b) after a careful morphological study of the four species from ruminants named above, severely criticises the splitting of this genus. He puts forward valid arguments against such a procedure and concludes that there is very little justification for the creation of these subgenera. He says: " Such a process of breaking-up is not, however, necessary nor, in the writer's opinion, desirable. We have in the genus *Oesophagostomum* a neat and compact array of species which resemble the type species of the genus on broad lines, as for example, in possessing a mouth collar with circum-oral papillae, mouth with, or, in one case, without external leaf-crown, a cephalic vesicle generally inflated, but sometimes not, as in *O. columbianum*, delimited posteriorly by the cervical groove, the spicules and gubernaculum similar in structure and appearance, genital cone built on the same general plan throughout all the species and ovejector apparatus also similar in all the species. On these grounds, therefore, there is every reason for the maintenance of the genus intact, and it may also be advanced as an argument against disintegration that nothing is gained by such a process in that the genus is so self-contained and has such well marked characters that there is no possibility of confusing its members with those of other nearly-related genera ".

The writer is in full agreement with these remarks. Thornton (1924) and Daubney (1926) are also of the same opinion. York & Maplestone (1926) apparantly concur. Travassos & Vogelsang (1932), however, consider that the dismemberment of this genus is justified; they accept the four subgenera *Oesophagostomum*, type *O. dentatum: Hysteracrum*, type *O. venulosum: Proteracrum*, type *O. columbianum* and *Conoweberia*, type *O. apiostomum*, and in addition create two more, viz. *Bosicola*, type *O. radiatum* and *Ihleia*, type *O. stephanostomum.*

They give the following key for differentiating these subgenera:—

1. Cervical papillae behind the oesophagus..... **Hysteracrum**
   Cervical papillae in front of end of oesophagus..... 2
2. Lateral alae well developed..... 3
   Lateral alae rudimentary..... 4
3. Mouth with two leaf-crowns, oesophageal funnel absent..... **Proteracrum**
   Mouth without external leaf-crowns; oesophageal funnel present, cephalic swelling with median constriction..... **Bosicola**

4. External leaf-crown generally of 10 elements, rarely with 12 to 14, or fewer elements..... 5
   External leaf-crown of more than 30 elements, oesophageal funnel present with 6 ribs at base of funnel.....**Ihleia**
   External leaf-crown of 8 elements, oesophageal funnel with 3 external ribs.....**O. eurycephalum**
   External leaf-crown of 30 elements.....**O. maplestoni**
5. Cervical papillae opposite thickest portion of oesophagus, oesophageal funnel not dilated.....**Oesophagostomum**
   Cervical papillae opposite nerve ring, oesophageal funnel goblet (Amphora) shaped.....**Conoweberia**

In his publication on Oesophagostomes Le Roux (1940) accepts Travassos & Vogelsang's dismemberment and further adds two more subgenera, viz. *Hudsonia* for *O. multifoliatum* Daubney & Hudson, 1932, *O. walkeri* Mönnig, 1932, *O. africana*, Mönnig, 1932 and *O. corcoei* n. sp.; and *Pukuia* for *O. lechwei* n. sp. and in addition a new genus *Daubneyia* is created for the Oesophagostomes from warthogs. From the text and accompanying key it would appear that in both of his two subgenera the cervical inflation is poorly developed, that of *Hudsonia* being better developed ventrally and laterally than dorsally, and in *Pukuia* the internal leaf-crown elements are long and stout and the worms are relatively small. The chief characteristics of his genus *Daubneyia* are:— absence of anterior cuticular inflation, external leaf-crown of six or eight elements, mouth collar depressed dorsally and ventrally, cervical papillae long and slender, buccal capsule thick-walled and not wholly situated in mouth collar, female tail relatively short, bluntly pointed and may be tilted dorsally and a bursa with distinct lobes and stout rays.

The writer considers that the reasons given for his subgenera and genus are insufficient for their acceptance. The degree of development of the cervical inflation is purely relative, the nature of the internal leaf-crown elements is a characteristic which is not easily determined and their structure, as given in Le Roux's observations, requires confirmation. The reasons for the creation of the genus *Daubneyia* are even more unsatisfactory. From the hundreds of specimens examined by the writer it is evident that there are greater differences between the different species of worms from warthogs than there are between the genera *Daubneyia* and *Oesophagostomum* (*sensu* Le Roux). To take but one characteristic, viz. the oesophagus: in *O. mwanzae* it differs radically from that of all the other species in its structure and in the presence of three oesophageal valves; in *O. eurycephalum* its anterior end is very much enlarged with a complicated internal structure; in *O. simpsoni* it is relatively short and thick and not club-shaped as in *O. oldi* and *O. yorkei*. It is agreed, however, that the oesophagostomes from warthogs constitute a neat group within the genus *Oesophagostomum* in that they all have a small number (six to eight) of external leaf-crown elements and in that an internal leaf-crown is absent. The exception is *O. aethiopicum* in which both leaf-crowns are present in considerably greater numbers than in the other species. There is, however, some doubt that the warthog is its normal host. It was not present in the numerous specimens from several warthogs examined by the writer, but was present in the material from the single bushpig. The writer is inclined to the view that the bushpig is the normal host and that the original record was based on a confusion of hosts.

Globocephalus versteri sp. nov.

The bushpig from which the specimens of *Oesophagostomum aethiopicum* were obtained, also carried a heavy infection of *Ascarops strongylina*, *Physocephalus sexalatus* and *Globocephalus* worms. Examination showed that these latter differ from the other adequately described species from swine, viz. *G. urosubulatus* (Alessandrini, 1909), *G. connorfilii* Lane, 1922, *G. samoense* Lane, 1922 and *G. amucronatus*

(Smit & Notasoedero, 1926). Molin's (1861) description of the type species, *G. longemucronatus*, also from swine, is so incomplete that it cannot be used for comparative purposes. The meagre data given by Molin can be applied to any one of the above species.

The straight to curved and somewhat robust worms have a reddish colour. The males vary in length from 7·0 to 8·0 mm with a maximum thickness of 0·35 to 0·4 mm. The females are from 8·6 to 9·2 mm long and 0·4 to 0·53 mm thick. The cuticle is much thickened, varying from 0·04 to 0·05 mm; it is very coarsely annulated, the annuli being 0·009 to 0·01 mm apart. The anterior end is bluntly rounded and is slightly tilted dorsalwards (Fig. 12). The mouth is circular, with a smooth internal edge; it lies in the centre of a clear collar-like area which is generally slightly raised above the anterior end of the head. The buccal capsule is somewhat globular in lateral view and funnel-shaped when viewed from the dorsal aspect (Fig. 13); in the males it has an antero-posterior depth of 0·16 to 0·18 mm and a dorso-ventral breadth of 0·105 to 0·12 mm; these measurements for the females are 0·18 to 0·22 mm by 0·14 to 0·16 mm respectively. Two prominent, triangular ventral buccal lancets are present near the base of the capsule. The dorsal oesophageal gutter is prominent and extends forwards as far as the collar-like area surrounding the mouth. The oesophagus is slightly club-shaped and varies in length from 0·67 to 0·76 mm for the males and 0·75 to 0·86 mm for the females. The nerve ring encircles the oesophagus anterior of the level of the excretory pore; it is situated 0·45 to 0·48 mm from the anterior end in the males and 0·53 to 0·6 mm in the females. The excretory pore is found about 0·15 to 0·2 mm further back in both sexes. The cervical papillae are stout, prominent and symmetrically placed, about 0·1 mm behind the level of the excretory pore. The male bursa is in general similar to those of the other members of the genus (Fig. 14). The dorsal lobe is only slightly developed and not distinctly set off from the lateral lobes. The externo-dorsal rays originate about half-way up the dorsal ray, which is about 0·35 mm long; its posterior quarter splits into two branches, each of which divides into two and the minor branchlet is again split. Each primary branch thus has a tridigitate termination. The spicules are relatively long, equal and slender and measure from 0·8 to nearly 0·9 mm in length; their distal endings are generally bent dorsalwards. A trough-like gubernaculum is present.

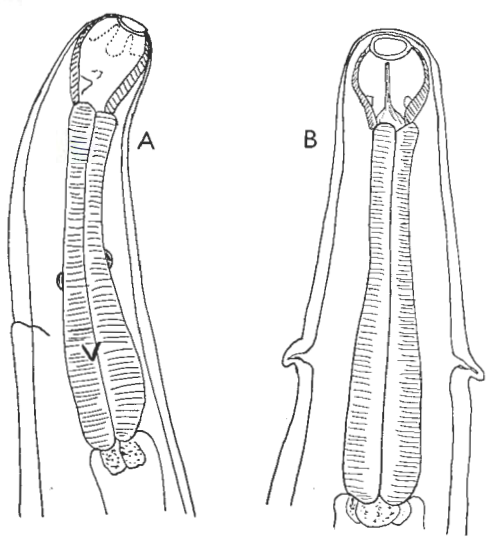

FIG. 12.—*Globocephalus versteri*, sp. n. A, lateral and B, dorsal views of anterior extremity

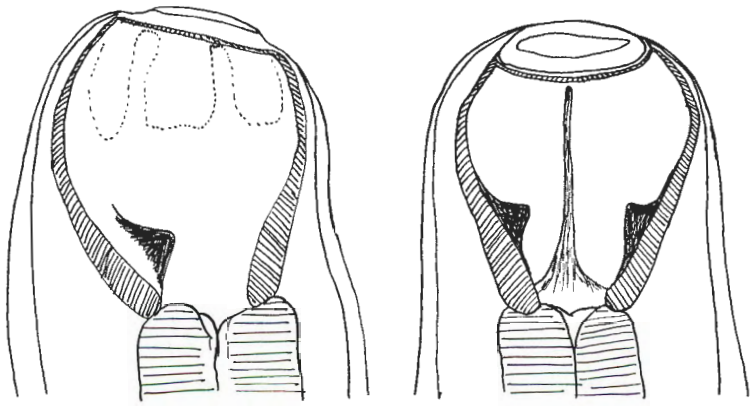

FIG. 13.—*Globocephalus versteri*, sp. n. Enlarged views of head; A, lateral and B, dorsal view

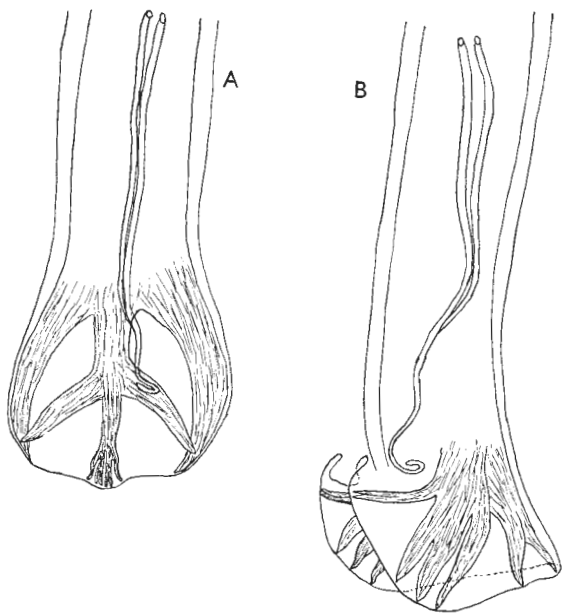

FIG. 14.—*Globocephalus versteri* sp. n. Posterior extremity of male; A. dorsal and B, lateral views of bursa

The vulva is placed in the posterior half of the body, about 5·6 to 5·85 mm from the anterior end and 3·15 to 3·32 mm from the tail tip, i.e. its position divides the body in the proportion 1·7–1·8:1; in other words its position is just anterior to the junction of the 2nd and 3rd body thirds. The distance between it and the anus is from 2·93 to 3·05 mm. The vagina is short, transverse and joins the two opposed ovejectors, each of which is about 0·25 mm long. The eggs measuring about 0·05 by 0·03 mm are oval and morulated *in utero*. The body suddenly narrows behind the anus to form a conical tail with a pointed tip (Fig. 15). No mucron is present, the substance of the tail passing backwards to its tip. The total tail length varies from 0·21 to 0·27 mm.

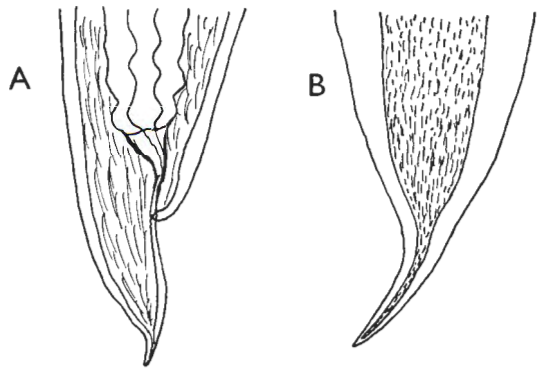

FIG. 15.—*Globocephalus versteri*, sp. n. Female tail; A, lateral and B, dorsal views

Affinities

The shape of the buccal capsule, its triangular lancets and the length of its spicules closely ally this species with *G. amucronatus* Smit & Notosoedro, 1926 and *G. urosubulatus* of Maplestone, 1930. In *G. amucronatus*, however, the body does not exceed 7 mm for the females, the female tail is much shorter (0·132 to 0·166 mm). The vulva is situated much further back, its position dividing the body in the ratio of about 3:1. The spicules are shorter (0·7 mm). A characteristic to which the authors pay particular stress is the shape of the lateral bursal rays. They describe and figure a large common stem for these rays, which is directed almost directly backwards and not laterally, as in other species of this genus. Also the three lateral rays are shorter than the common stem and are directed almost vertically downwards and forwards, thus forming practically a right angle with the common stem. Maplestone's specimens agree with those of the writer as far as the spicular lengths are concerned, but can readily be differentiated by their very much smaller dimensions.

Specific Diagnosis

Strongylidae: Males up to 8 mm, and females up to 9 mm long. Buccal capsule somewhat globular in lateral, and infundibular in dorsal view. Buccal lancets prominent and triangular, situated near base of capsule. Spicules slender, 0·8 to nearly 0·9 mm long. Vulva just anterior to junction of 2nd and 3rd body thirds. Tail conical, 0·21 to 0·27 mm long, terminating in a sharp point. Eggs oval and embryonated *in utero*.

Host: Potamochoerus porcus (Linn.) Bushpig
Location: Small intestine
Locality: Mara, Northern Transvaal
Types: In Onderstepoort collection

This species is named in honour of Miss Anna Verster who kindly placed these helminths at the writer's disposal for study.

Discussion

In his description of *Crassisoma urosubulatus* Alessandrini (1909) quotes Molin's (1861) description of the type species, *G. longemucronatus* and gives a reproduction of his diagrammatic figure of the anterior extremity. The chief characteristics given in Molin's description are:— the globular capsule is directed forwards and

carries no sub-ventral lancets. The male is 7 mm long and 0·2 mm thick, the bursa is slightly trilobed with a tridigitate dorsal ray, and two spicules are present. The female is 8 mm long and 0·3 mm thick, the vulva is in the posterior body portion, the tail is conical and is terminated by a long mucronate tip. These characteristics are so general that they can be applied to any of the later described species assigned to the genus *Globocephalus*. Cameron (1924) justly states that the figures should not be strictly interpreted. Unfortunately Alessandrini, after the detailed study of his specimens from Italian pigs, compared his findings literally with those obtained by Molin. He concluded that his specimens represented a different genus and species since, among other differences, they differed from Molin's specimens in that the buccal capsule was oval, directed dorsalwards and carried ventral lancets, the oesophagus had a different shape and the female tail gradually tapered to a fine point. These differences also apply to all the species of *Globocephalus*, so that it is not possible to identify his species definitely from Molin's inadequate description. Yamaguti (1935) identified worms from Kyoto, Japan, as *G. longemucronatus*. He did not state, however, on what grounds he based his identification. Possibly his decision was influenced by the fact that in his specimens the ventral lancets are rudimentary and inconspicuous and thus could easily escape observation. His Figure 16 shows no buccal lancets and the buccal capsule is directed practically straight forwards, a condition also mentioned by Molin. By themselves these two characteristics are not sufficient for the determination of any species of the genus *Globocephalus*, since the size and conspicuousness of the buccal lancets and the degree of dorsal tilting by the buccal capsule are seen to vary quite considerably when a number of specimens are compared. Yorke & Maplestone (1926) figure what they took to be *G. longemucronatus:* here the buccal capsule is distinctly tilted dorsalwards and ventral lancets are figured in the buccal capsule. Later, Maplestone (1930) expressed the opinion that these figures are referable to *G. connorfilii* Lane, 1922. Specimens from British Guiana, West Africa and New Guinea studied by Cameron (1924) were identified as *G. urosubulatus*. The length of the spicules was found to be 0·55 mm, which is in close agreement with Alessandrini's measurement of 0·59 mm. The spicular lengths given by Yamaguti for his *G. longemucronatus* from Japan are 0·69 to 0·72 mm and by Maplestone for his *G. urosubulatus* from India are 0·852 and 0·931 mm; these are considerably greater than those given by Alessandrini in his original description of *G. urosubulatus*. This means that Yamaguti's and Maplestone's specimens cannot be co-specific with Alessandrini's specimens. To which species are they then to be assigned? If Yamaguti's specimens are to be considered representative of the true *G. longemucronatus*, *G. urosubulatus* of Maplestone may possibly belong to this species. Some years ago Dr. Maplestone kindly donated to this Institute a number of specimens of his type A (*G. urosubulatus*) and type B (*G. connorfilii*) worms. An examination of these specimens reveals that it is not possible to make a determination of the exact length of the spicules of his type A worms, because of their wavy course in the body. By allowing for these waves it is estimated that they are at least 0·8 mm long and possibly longer than 0·9 mm. His type B specimens have straighter spicules and are from 0·4 to 0·48 mm long. For his two types Maplestone gave the spicular length as 0·852 to 0·931 mm for type A and 0·455 to 0·594 mm for type B, i.e. his measurements are in close agreement with those of the writer. His two types represent two distinct species: type B, because of its shorter spicules being related to, but not co-specific with, *G. urosubulatus*. His type A and probably also *G. longemucronatus* of Yamaguti, are considered to be specifically distinct from *G. urosubulatus*, the longer spicules relating it to *G. versteri* sp. nov. and to *G. amucronatus*.

When the spicular lengths of all the species from Suidae are compared it is seen that those of *G. urosubulatus*, *G. connorfilii* and *G. samoensis* are less than 0·6 mm and those of *G. amucronatus*, *G. versteri*, *G. urosubulatus* of Maplestone and *G. longemucronatus* of Yamaguti exceed 0·7 mm. Molin unfortunately does not give the spicular length for his *G. longemucronatus* so that the type species of the genus may resort in any of the above two groups. Maplestone identified his type A specimens as *G. urosubulatus*, but the length of the spicules, as given by Maplestone, is 0·85 to 0·93 mm (which the writer can confirm after his examination of Maplestone's type A specimens at this Institute). This shows that these specimens cannot be co-specific with *G. urosubulatus* for which Alessandrini gives the length as 0·59 mm. The spicular measurements of Maplestone's type A specimens are in close agreement with those of *G. versteri* sp. nov. Since, however, his specimens are very much smaller than those of the writer, Maplestone's type A is here considered as representing an unnamed species. For this the writer proposes the name of *G. maplestonei* sp. nov. in recognition of Dr. P. A. Maplestone's valuable contributions to systematic helminthology. The characters of the species will be those so adequately described and figured by Maplestone (1930). With regard to Yamaguti's *G. longemucronatus* the writer is still in doubt as to its identity. As Molin's description is so incomplete there is no ground for Yamaguti's assumption that he had representatives of Molin's species at his disposal. The spicular lengths of his material are given as 0·69 to 0·72 mm; these agree very closely with 0·7 mm in *G. amucronatus*. These two sets of specimens are from the Far East, one each from Japan and Java, so that their possible identity is not excluded.

Maplestone's type B specimens, identified by him as *G. connorfilii*, represent a species allied to *G. urosubulatus* Alessandrini. They agree in their spicular lengths for which Alessandrini gives 0·59 mm, Lane 0·54 mm (in his 1922 publication the length is given as 0·275 mm) and Maplestone 0·455 to 0·594 mm (the writer finds the lengths to vary from 0·45 to 0·48 mm in Maplestone's type B material). Lane's and Maplestone's specimens, however, differ from Alessandrini's in that the buccal capsule is less globular and more infundibular and the buccal lancets are very poorly developed, being represented by mere ridges. In some of Maplestone's type B specimens examined by the writer these lancets were apparently absent. The writer considers that these differences are of sufficient importance to justify the separation of Alessandrini's specimens from those of Lane and Maplestone. This veiw is contrary to that of Cameron (1924) who, after an examination of Lane's type material of *G. connorfilii*, concluded that Lane's species was the same as *G. urosubulatus*. His figures of *G. urosubulatus* show a distinct globular (dorsal view) and cylindrical (lateral view) buccal capsule with prominent buccal lancets, whereas Lane's figures show the capsule as more elongate and funnel-shaped in both views, with very insignificant lancets. In his text Cameron states that the " buccal capsule is elongated and almost cylindrical " and that the lancets are comparatively large in his British Guiana specimens, smaller in his specimens from West Africa and comparatively small in Lane's types. It is unfortunate that Cameron did not give figures of Lane's type material, (the writer assumes that his figures are based on the British Guiana specimens) since such figures would have shown clearly that differences between these two lots of specimens do exist. These differences are well shown in Maplestone's Figure 37 which the writer confirmed by a close examination of over 20 male specimens from each of Maplestone's type A and type B material in this Institute.

Key to the species of Globocephalus *from Suidae:*

1. Spicules less than 0·6 mm long 2
   Spicules 0·7 mm or longer 4
   Spicular lengths unknown, females up to 8 mm long; other characters not sufficiently described ..... **G. longemucronatus** Molin, 1861.
2. Spicules about 0·4 mm long; lancets large and bicuspid ..... **G. samoensis** Lane, 1922
   Spicules over 0·4 mm long 3
3. Buccal lancets prominent, triangular and situated at base of capsule **G. urosubulatus** Aless., 1909
   Buccal lancets inconspicuous, being merely ridges and removed from base of capsule ..... **G. connorfilii** Lane, 1922
4. Worms large and stout, females 9 mm long or longer ..... **G. versteri** sp. nov.
   Worms smaller and thinner, females not over 7 mm long 5
5. Spicules about 0·7 mm long ..... **G. amucronatus** Smit & Notosoedero, 1926
   Spicules 0·8 mm long and longer ..... **G. maplestoni** sp. nov.

Setaria congolensis Railliet & Henry, 1911.

In the Onderstepoort collection there are four sets of specimens which are referred to the above species. All the specimens were collected from bushpigs, three sets from Portuguese East Africa and one from Northern Rhodesia. The specimens consist of 21 females and 8 males; their sizes vary from 7·5 to 8·3 cm long and about 0·42 mm thick for the males and 11·2 to 15 cm long by 0·75 mm thick for the females. All are provided with the very characteristic tubular and chitinous buccal crown to which Yeh (1959) pays special attention. Such a structure has not been described for any of the other species of the genus, and its presence easily distinguishes it from them. A characteristic which no writer, except Mönnig (1928), emphasizes is the presence of marked lateral shoulders at the anterior end. Sandground (1933) figures such shoulders in his *S. congolensis* from Annam. Yeh (1959) in the generic diagnosis of his genus *Artionema* states that the anterior extremity has lateral shoulders; no mention of such structures is made in his generic diagnosis of *Hyraconema* or of *Setaria*. These shoulders (Fig. 16) are present in all the 29 specimens examined. They are best seen in the specimens from Portuguese East Africa, killed and preserved in formol-acetic-alcohol with no apparent sign of shrinkage. The specimens from Northern Rhodesia, collected directly into 70 per cent alcohol, are considerably distorted; in some the shoulders are well shown, whereas in others they are not clearly evident. The cylindrical buccal crown measures 0·035 to 0·045 mm across and 0·03 to 0·04 mm deep in the males; in the females these dimensions are 0·04 to 0·05 mm and 0·025 to 0·04 mm respectively. The tail of the females is 0·36 to 0·43 mm long, and that of the males 0·19 to 0·2 mm; in both sexes it is loosely coiled and that of the females bears a tuberculated tip in all specimens. The proximal shaft of the left spicules is from 0·2 to 0·225 mm long and 0·025 mm thick; its membranous distal portion varies in length from 0·075 to about 0·1 mm. The right spicule is much shorter and is from 0·12 to 0·135 mm long with a maximum thickness of 0·03 mm. The caudal papillae can be considered to consist typically of four pairs of pre-anals and four pairs of post-anals; in general the members of each pair are not symmetrically arranged and there is considerable variation in the number of papillae on each side. In five males, whose tails could be rolled to show these papillae to advantage, three have four pairs of pre-anals, one has three pairs, and the other has three pairs plus an unpaired papilla. The spacing

TABLE 2.—*Principal dimensions in mm of* Glob

Globocephalus sp.	Author	Max. length ♂	Max. length ♀	Max. thickness ♂	Max. thickness ♀	Length Oesophagus ♂	Length Oesophagus ♀
G. longemucronatus Molin, 1861	Molin, 1861 (from Alessand., 1909)	7	8	0·2	0·3		
	Yamaguti 1935	5·7	6·8	0·37	0·43	0·56–0·63	?
G. urosubulatus Alessandrini, 1909	Alessandrini, 1909	4·4	6·5	0·385	0·507	0·612	0·752
	*Maplestone, 1930	4·69	6·87	0·376	0·475		
	Cameron, 1924	5·5	6·0				
	*Ortlepp, 1963 (Mapl. A)	4·5	4·5	0·23	0·26		
G. connorfilii Lane, 1922	Lane, 1923	5·5	6·0	0·35	0·33	0·625	
	Maplestone, 1930	4·99	6·52	0·336	0·455		
	Ortlepp, 1963 (Mapl. B)	3·3	4·5	0·2	0·22		
G. samoensis Lane, 1922	Lane, 1923	5·5	5·6	0·3	0·33	0·75	
	Maplestone, 1930	5·72	6·72				
	Yamaguti, 1935	6·24	6·44	0·37	0·5	0·62 –0·67;	0·62–0·71
	Cameron, 1924						
G. amucronatus Smit & Notosoedero, 1926	Smit & Ihle, 1929	5	7	0·325	0·41	0·496–0·53;	0·58–0·67
G. versteri, sp. nov.	Ortlep, 1963	8	9·2	0·38	0·53	0·67–0·76;	0·75–0·86

* These specimens are considered by the author as not cos

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ɔcephalus *spp. of swine as given by different observers*

Lancets	Max. buccal capsule ♂	♀	Tail of female	Distance vulva to anus	Spicules	Vulva divides body into relation of
Very inconspicuous	0·16 ×0·126;	0·196 ×0·15	0·16–0·2		0·69–0·72	Ca 1·7:1
Triangular, near base	0·175 ×0·122;	0·245 ×0·175	0·227	2·37	0·59	1·5:1
Comp. large (Br. Guiana.)	0·168 ×0·108;	0·2 ×0·14	0·12–0·196		0·852–0·931	
			0·2	2·3	0·55	Ca 1·4:1
	0·140 ×0·075;	0·12 ×0·09	0·11–0·12	1·1 –1·2	0·8–0·9	Ca 1·8:1
Longitudinal ridges	0·17	×0·085	0·18	1·82	0·54	Ca 2 :1
Longitudinal ridges	0·168 ×0·092;	0·212 ×0·108	0·128–0·212		0·455–0·594	
Longitudinal ridges	0·09 ×0·05;	0·12× 0·065	0·106–0·113	1·12–1·3	0·4–0·48	Ca 2 :1
Large and bicuspid	0·14	×0·11	0·1	1·9	0·4–0·41	Ca 1·7:1
			0·084–0·124		0·376–0·495	
Large and bicuspid	diam.	diam.	0·075–0·1		0·4 0·48	Ca 1·9:1
Well developed	170	220				
			0·1		0·4	Ca 2 :1
Well developed, triangular	0·155 ×0·119;	0·18× 0·152	0·132–0·166		0·74	Ca 3 :1
Well developed, triangular, near base.	0·185	0·22×	0·212–0·2626	2·93–3·05	0·83–0·85	Ca 1·8:1

ɜpecific with *G. urosubulatus* and have been renamed as *G. maplestoni* sp. nov.

of the papillae is very irregular, the most posterior being either immediately in front of the cloaca or located further forwards; generally they occupy a lateral position, but in some their position is more ventral. This irregularity in number and position is more marked in the post-anal papillae; in two there are four papillae on each side, in the other three the numbers are 4 & 5, 4 & 6, and 5 & 6 respectively.

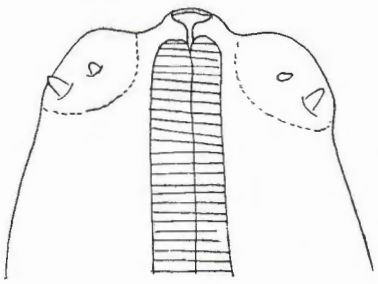

FIG. 16.—*Setaria congolensis*. Dorsal view of head showing lateral shoulders of body.

Discussion

Bernard & Bauche (1911) described an unnamed Filaria from pigs (Annam, China) of which about 5 per cent were infected. In this parasite the head is described as continuous with, and not set off, from the body. The males are 10 to 11 cm long and the females 20 to 21 cm. The proximal shaft of the left spicule is 0·125 mm long and 0·025 mm thick and its membranous distal portion, i.e. the blade, 0·07 mm long; right spicule 0·14 mm long and 0·052 mm thick. The vulva is 0·6 mm from the anterior end and the tail about 0·3 mm long. This parasite was named *Setaria bernardi* by Railliet & Henry (1911) who described the characters distinguishing it from *S. congolensis* as " less dimensions plus considérables du corps, la bouche plus grande, la vulve à garniture plus large et plus saillante, la disposition des papilles caudales du mâle, enfin les dimensions des spicules ". Smit (1918) describes female worms from pigs (Netherlands India) as *Filaria labiato-papillosa* var. *suis*. These have an average length of 16·5 cm. His figure of the head shows that it has a thickening round the head and carries a buccal crown of four relatively large projections (? submedian papillae). The female tail is terminated by a crown of nine small papillae. In a later publication (1920), at the suggestion of Prof. Ihle, he identifies it as probably co-specific with *S. bernardi*. He had by then also obtained a few males which are 7·5 to 10·0 cm long. The spicules appear to be broken. There are three pairs of post-anal and five pairs of pre-anal papillae. The four large buccal projections are probably comparable to the structures which Bernard and Bauche describe as " quatre spicules, chitineuses, papilliformes, sub-mediens " surrounding the mouth. These French authors mention that there are eight pairs of caudal papillae, four pre- and four post-anal in their unnamed specimens of *S. bernardi*. Great emphasis should, however, not be placed on these differences, as appreciable variations occur in the number and position of these papillae in filariid worms.

Mönnig (1928) with considerable reserve identified worms from a pig from Portuguese East Africa as probably belonging to *S. bernardi*. He emphasizes that his worms are considerably smaller (males 8 cm, females 13·8 cm) and that they are provided with a very conspicuous shoulder-like prominence on either side of the head, each prominence carrying a lateral and two submedian papillae. The female tail (0·4 mm long) has a tuberculated end; the male tail carries four pairs of pre- and

nine post-anal papillae, irregularly arranged. The right spicule is thick and 0·137 mm long, while the shaft of the left spicule is 0·212 mm long and its membranous portion 0·141 mm long. Unfortunately because of maceration Mönnig's specimens are lost, but from his data and figures the writer is satisfied that his specimens belonged to *S. congolensis*. Yeh is also of this opinion.

Sandground (1933) describes and figures male worms from *Sus cristatus*, Annam, which he identified as *S. congolensis*. He states that the peribuccal ring is prolonged anteriorly to form two tooth-like projections, and in his Figure 31 such projections are clearly shown. Such structures are not present in *S. congolensis* and the writer agrees with Chatterji (1939) and Yeh (1959) that these specimens should be referred to the species *S. bernardi* as redescribed by Chatterji.

Measurements in mm of S. congolensis *by Mönnig, Yeh and the writer*

	Mönnig (1928)	Yeh (1959)	Ortlepp (1963)
Dimensions—			
Male	80 × 0·55	76 × 0·54	83 × 0·60
Female	138 × 0·76	122 × 0·96	150 × 0·75
Length Oesophagus—			
Male	—	12·5	10·9
Female	8·66	12·9	12·3
Length Tail—			
Male	0·192	0·17	0·185
Female	0·404	0·56	0·43
Male caudal papillae—			
Pre-anal	4 pairs	3 prs. + 1 pap.	3–4 pairs
Post-anal	9 pap.	7 pairs	4 prs. + 1 or 2 pap.
Length—			
L. spicule: shaft	0·212	0·213	0·2–0·255
L. spicule: membrane	0·14	—	Ca 0·1
R. spicule	0·137	0·140	0·12–0·135

Setaria castroi* sp. nov.

Among the consignment of worms from Portuguese East Africa are four tubes of female filariid worms, three with worms from the body cavity of warthogs and one with a single worm from a bushpig. These worms, while showing features similar to those of *S. congolensis*, differ from them in three characteristics, viz. size, structure of the buccal crown and female tail. Because of these differences they are described as a new species.

The four females from warthogs are 9·0 to 12·0 cm long with a maximum thickness of 0·6 to 0·7 mm, the single female from the bushpig is 12·4 cm long. Each head has two conspicuous shoulders as in *S. congolensis*, each shoulder carrying a lateral papilla, and two more anteriorly placed submedian papillae. The lateral thickness of the body across the shoulders is 0·14 to 0·15 mm while the dorsoventral thickness is 0·1 mm or less. The buccal crown is not tubular and cylindrical as in *S. congolensis*, but its base is flattened and oblong, the lateral diameter being less than the dorso-ventral. Laterally on each side the base carries a quadrangular projection directed forwards with its anterior corners bent outwards as small horns

* Named in honour of Dr. Luis A. da Costra è Castro who was responsible for the collection of the material from Northern Moçambique.

(Fig. 17). When viewed from the lateral aspect these projections have the appearance of two pillars resting on the buccal crown. The dorso-ventral diameter of the crown varies from 0·04 to 0·052 mm whereas the lateral diameter varies from 0·035 to 0·042 mm. The small cervical papillae are symmetrically placed, 0·3 to 0·43 mm from the anterior end. The oesophagus is long and consists of two parts, an anterior muscular portion 0·6 to 0·65 mm long by about 0·05 mm thick, and a glandular posterior portion 8·7 to 10·3 mm long with a maximum posterior thickness of 0·16 mm. The nerve ring encircles the muscular portion at about 0·2 mm from the front end. The posterior end of the body is loosely coiled. The tail (Fig. 18) is 0·33 to 0·35 mm long; its termination is either smooth and bluntly rounded or it may carry a small conical projection about 0·015 mm long without any tubercles.

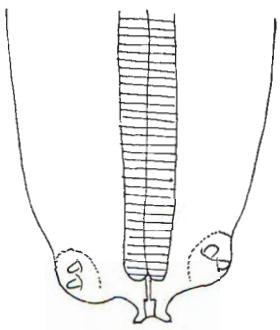

FIG. 17.—*Setaria castroi*, sp. n. Dorsal view of head.

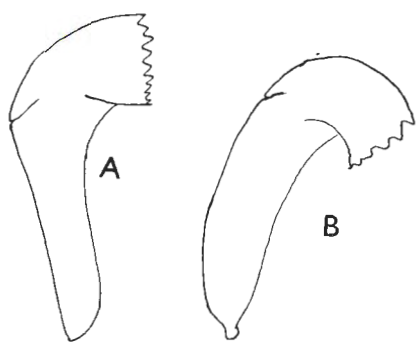

FIG. 18.—*Setaria castroi*, sp. n. Lateral views of two female tails.

Affinities

This species, which is the first record of a *Setaria* from warthogs, is closely related to *S. congolensis*. It may, however, be distinguished from this species by its smaller size, the structure of its buccal crown, and the absence of tubercles on the end of the female tail.

Specific diagnosis

Only female known. Up to 12·4 cm in length. Head provided with conspicuous shoulders each bearing a lateral and two submedian papillae. Base of buccal crown flattened and oblong, lateral diameter less than dorso-ventral; base provided with lateral quadrangular projections directed forwards with anterior corners bent outwards. Tail either smooth and bluntly rounded or provided with a small conical projection without tubercles.

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Type host: Phacochoerus aethiopicus (Warthog)
Additional host: Potamochoerus porcus (Bushpig)
Location: Body cavity
Locality: Portuguese East Africa
Type: In Onderstepoort collection

Discussion

Yeh (1959) in his revision of the genus *Setaria* proposed that its members be placed into three genera, viz. *Hyraconema* g. nov. with type and only species *S. loveridgei* Sandground, 1928, from Hyracoidea, *Setaria* Viborg, 1795, with type and only species *S. equina* (Abildgaard, 1789) from Perissodactyla and *Artionema* g. nov., type *A. africana* sp. nov. to include all the species from Artiodactyla. From the generic diagnosis given by Yeh it appears that *Setaria* is distinguished from the other two genera mainly by the presence of four submedian, spike-like processes on the head. The main differences between *Hyraconema* and *Artionema* are the longer left spicule without a sclerotized membrane in the former. The members of the genus *Setaria* (*sensu* Railliet & Henry, 1911) are all characterized by the presence of a chitinous peribuccal crown surrounding the mouth. This crown is generally provided with simple or bifid lateral tooth-like extensions. All inhabit the body cavity. In addition the caudal end is loosely coiled, the female tail is generally terminated by a smooth or tuberculated knob; the spicules are built on the same plan and consist of a proximal handle or shaft portion and a distal portion consisting of a weakly sclerotized membrane except in *S. loveridgei*. In the male the ventral surface anterior of the caudal papillae carries transverse ridges.

The characteristics utilized by Yeh for splitting the well-defined genus *Setaria* appear to the writer to be too slender to warrant this procedure. His splitting does not simplify the classification of these helminths in that two of his genera each embrace only a single species, each of which is well defined and easily separated from the other species. Consequently his two genera *Hyraconema* & *Artionema* are not acceptable, and his two species *Artionema africana* and *A. hartwicki* are herewith transferred to the genus *Setaria*.

Summary

Helminths from warthogs and bushpigs in the Onderstepoort collection have been studied. All the species of *Oesophagostomum* described from warthogs were represented, except *O. goodeyi* and *O. roubaudi*. In addition two unknown species were discovered and these are described under the names *O. santos-diasi* and *O. moçambiquei*. Additional information on *O. aethiopicum* and *O. mpwapwae* is given, and a key for the identification of all the warthog oesophagostomes is drawn up. The validity of the different genera and sub-genera of *Oesophagostomum* is discussed. A new species of *Globocephalus*, viz. *G. versteri* is described from the bushpig. The status of the different species of this genus is critically examined and a key is given for the identification of the species considered valid. The species referred to *G. urosubulatus* by Maplestone (his type A specimens) is considered to be a new species and is named *G. maplestoni*. Filariid worms from these hosts are discussed and a new species, *Setaria castroi*, is described from the warthog and bushpig. The genera *Hyraconema* and *Artionema* are eliminated as synonyms of *Setaria*.

References

ALESSANDRINI, G., 1909. Su di un raro parassita dell intestino del Maiale. *Arch. Parasitol.* 13, 458–476.

BAYLIS, H. A., 1929. A Manual of Helminthology, Medical and Veterinary. London: Bailliere, Tindall and Cox.

BERNARD, P. M. & BAUCHE, J., 1911. Sur un filaire peritonéale du Porc. *Bull. Soc. Pathol. Exot.* 4, 482–485.

CAMERON T. W. M., 1924. On the Nematode genus *Globocephalus* Molin, 1861. *J. Helminth.* 2, 65–76.

CHATTERJI, R. C., 1939. Report on two unrecorded Nematode parasites from domesticated animals of India or Burma. *Ind. J. Vet. Sci.* 9, 323–332.

DAUBNEY, R., 1923. A note on two species of the genus *Murshidia* (Nematode Strongyloidea) parasitic in the Warthog. *Ann. Mag. Nat. Hist.* Ser. 9, 11, 256–263.

DAUBNEY, R., 1926. Description of a new Nematode–*Oesophagostomum mwanzae* from the Warthog. *Ann. Mag. Nat. Hist.* Ser. 9, 13, 542–546.

DAUBNEY R. & HUDSON, J. R., 1932. *Oesophagostomum multifoliatum* n. sp., an undescribed Nematode from sheep and goats. *Parasitol.* 24, 265–267.

DE FREITAS, J. F. T. & LENT, H., 1936. Estudo sobre o genero *Globocephalus* Molin, 1861. (Nematodes, Strongyloidea). *Mem. Inst. Osw. Cruz.* 31, 69–79.

DUTHY, BARBARA, L., 1947. Three new Nematodes of the genus *Oesophagostomum* from the East African Warthog, *Phacochoerus aethiopicus*. *Ann. Mag. Nat. Hist.* Ser. 11, 14, 280–288.

GOODEY, T., 1924*a*. The Anatomy of *Oesophagostomum dentatum* (Rud.), a nematode parasite of the pig, with observations on the structure and biology of the free-living larvae. *J. Helminth.* 2, 1–14.

GOODEY, T., 1924*b*. Oesophagostomes of goats, sheep and cattle. *J. Helminth.* 2, 97–110.

GOODEY, T., 1924*c*. Some new members of the genus *Oesophagostomum* from the roan antelope. and the warthog. *J. Helminth.* 2, 135–148.

LANE, C., 1922. A preliminary note on two Strongylata from swine in the Pacific. *Ann. Mag Nat. Hist.* Ser. 9, 9, 683–685.

LANE, C., 1923. Some Strongylata. *Parasitol.* 15, 348–364.

LE ROUX, P. L., 1940. On the division of the genus *Oesophagostomum* Molin 1861, into subgenera and the creation of a new genus for the oesophagostomes of the warthog. *J. Helminth.* 18, 1–20.

MAPLESTONE, P. A., 1930. Nematode Parasites of Pigs in Bengal. *Rec. Ind. Museum* 32, 77–105.

MÖNNIG, H. O., 1928. Check list of the worm parasites of domesticated animals in South Africa. *13th & 14th Rept. Dir. Vet Educ. & Res.* S. Afr. Pt. 2, 801–837.

NEVEU LEMAIRE, M., 1936. Traité d'Helminthologie Medicale & Véterinaire. Paris: Vigot Frères.

RAILLIET, A. & HENRY, A., 1911. Remarques au sujet des deux notes de M. M. Bauche & Bernard. *Bull. Soc. Pathol. Exot.* 4, 485–488.

SCHWARTZ, B. & ALICATA, J. E., 1930 Two new species of nodular worms (*Oesophagostomum*) parasitic in the intestine of domestic swine. *J. Agric. Res.* 40, 517–522.

SMIT, H. J., 1918. Een drietal wormen van het varken. *Nedl. Ind. Bl. Diergeneesk.* 30, 592–600.

SMIT, H. J., 1920. Nog enige aantekeninge omtrent " een drietal wormen van het varken " en " een drietal Strongyliden van den Olifant ". *Nedl. Ind. Bl. Diergeneesk.* 32, 152–153.

SMIT, H. J. & IHLE, J. E. W., 1929. *Globocephalus amucronatus* (Smit & Notosoediro). *Nederl. Blad. Diergeneesk.* 29, 49–54.

THORNTON, H., 1924. A review of the Oesophagostomes in the collection of the Liverpool School of Tropical Medicine. *Ann. Trop. Med. & Parasitol.* 18, 393–408.

TRAVASSOS, L. & VOGELSANG, E., 1932. Pesquizas helminthologicas realisadas em Hamburgo. X. Contribuição ao conhecimento das especies de *Oesophagostomum* dos primates. *Mem. Inst. Osw. Cruz.* 26, 251–328.

TUBANGUI, M. A., 1925. Metazoan parasites of Philippine domesticated animals. *Philip. J. Sci.* 28, 11–35.

YAMAGUTI, S., 1935. Studies on the Helminth Fauna of Japan. Pt. 13. Mammalian Nematode. *Jap. J. Zool.* 6, 434–457.

YAMAGUTI, S., 1961. Systema helminthum. Vol. III (1 & 2). pp.357–358 & 393–397. London & New York: Intersci. Publishers.

YEH, S., 1959. A revision of the Nematode Genus *Setaria* Viborg, 1795, its Host-parasite Relationship, Speciation and Evolution. *J. Helminth.* 33, 1–98.

YORKE, W. & MAPLESTONE, P. A., 1926. The Nematode Parasites of Vertebrates. London: Churchill.