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THE IDENTITY OF SO-CALLED *PARAMPHISTOMUM CERVI*
AND *P. EXPLANATUM*, TWO COMMON SPECIES
OF RUMINANT TREMATODES IN SOUTH AFRICA.

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The identification of the species is based on the system devised by Näsmark (1937) involving an examination of the acetabulum, genital atrium and pharynx, as seen in median sagittal sections.

The species previously known as *Paramphistomum cervi* Zeder, 1790, was found to be *Paramphistomum microbothrium* Fiscoeder, 1901; whilst the species previously known as *Paramphistomum explanatum* (Creplin, 1847) Fiscoeder, 1904 was identified as *Calicophoron calicophorum* (Fiscoeder, 1901) Näsmark, 1937.

MATERIALS AND METHODS.

The material was collected exclusively from cattle slaughtered at the Pretoria abattoir; consequently it was impossible to ascertain the exact locality in South Africa from which the cattle had come.

The material was killed and fixed in a mixture of corrosive sublimate and acetic acid after vigorously shaking before and after the addition of the fixative. Serial sections, 15 μ thick, were cut in the median sagittal plane.

Näsmark's system is considered satisfactory in differentiating between the species, according to the type of genital atrium present, as this is quite distinctive in the two described species.

By comparing a series of sections of *Gigantocotyle explanatum* (Creplin, 1847) Näsmark, 1937, from the bile duct of cattle, Madras, it was at once evident that this species is not represented amongst the South African material. Some Australian material from cattle at the author's disposal was examined but as this type did not fit in with the description given by Durie (1951) for *Calicophoron calicophorum* from Australian cattle and as it differs from the South African *Calicophoron* species, it may probably be the same as the undetermined species mentioned by Durie.

PARAMPHISTOMUM MICROBOTHRIUM

Fiscoeder, 1901.

(Plates 1, 2 and 3.)

Synonyms.—The same as given by Näsmark (1937) also the South African species described up to the present as *Paramphistomum cervi* Zeder, 1790.

Host.—*Bos taurus* — rumen.

Distribution.—South Africa.

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Length 8.32 mm. (7.3–9.6 mm.); breadth 3.2 mm. (2.8–3.9 mm.); dorso-ventral 2.77 mm. (1.7–3.6 mm.); dorsal line curved, ventral line slightly concave. Acetabulum (plate 2) conforms to Näsmark's *Paramphistomum* type, opening postero-ventrally, its mean diameter 2.0 mm. (1.9–2.1 mm.), the ratio of its diameter to body length being 1:4.6 (1:4.0–1:5.6). In this species, as described by Näsmark (1937), the dorsal exterior 1 circular muscle layer is compressed exactly in the median sagittal plane into a compact mass of fibres which Näsmark terms the sphincter. The length of this mass is about 0.19 mm. As the presence of this mass is an important point of difference between the South African *P. microbothrium* and *Calicophoron calicophorum*, much more importance should be attached to this point. According to Näsmark the counting of the units of muscle fibres should be done in the median sagittal plane; in reality these muscle units in *P. microbothrium* cannot be counted because they have been transformed into the so-called sphincter of Näsmark. Countings have thus been taken of the dorsal exterior 1 circular in this species by transferring the field of observation either 0.15 mm. to the right or left of the median sagittal section, thus lateral of the mass.



PLATE 1.—*Paramphistomum microbothrium* Fiscoeder, 1901.

The number of muscle units per series of the acetabulum musculature is as follows:— Dorsal exterior 1 circular layer, which becomes the sphincter, 19 (14–24) units; dorsal exterior 2 circular layer 31 (22–38) units; dorsal interior circular layer 47 (42–50) units; ventral interior circular layer 53 (52–58) units and the ventral exterior circular layer 18 (15–22) units. In table I a comparison of the muscle units is given based on the data from the South African *P. microbothrium* and Näsmark's data.

A difference thus exists between the numbers given by Näsmark. The differences between the author's data and Näsmark's concerning the d.e. (1) layer does not appear to be of importance because of the concentration and fusion of the

sphincter into a mass in the median sagittal plane. The differences between the rest of the counts are only slight and as stated by Näsmark p. 310, "an approximate agreement without striking deviation in any series figure, is sufficient to assist in demonstrating a possible identity".

TABLE I.

	d.e. 1.	d.e. 2.	d.i.	v.i.	v.e.	
<i>P. microbothrium</i> (South Africa)	19 (14-24)	31 (22-38)	47 (42-50)	53 (52-58)	18 (15-22)	10 specimens.
<i>P. microbothrium</i> (Näsmark p. 309)	30 (28-31)	28 (22-36)	48 (46-50)	59 (57-62)	25 (24-26)	17 specimens.
<i>P. microbothrium</i> (Näsmark p. 325)	34	25	56	56	21	Unknown.

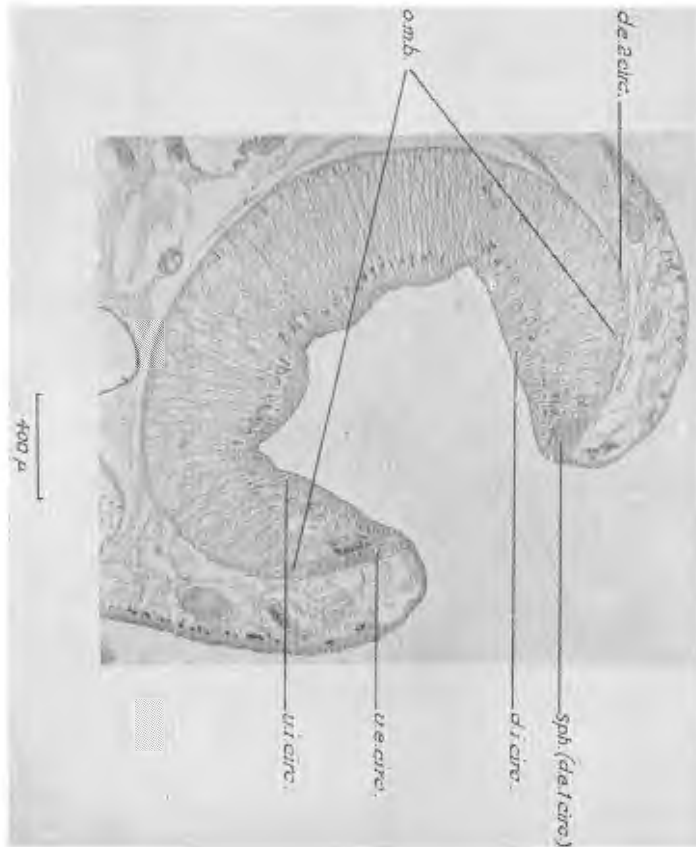


PLATE 2.—A median sagittal section of the acetabulum of *P. microbothrium* Fiscoeder, 1901, showing the d.e.1. circular muscle layer compressed into a compact mass of fibres (termed a sphincter by Näsmark).

A slightly developed oblique-running muscle band is present.

Pharynx conforms to Näsmark's *Paramphistomum* type.

0.778 mm. (0.744–0.86 mm.) in length; ratio of pharynx length to body length 1:11.8 (1:9.9–1:13.8). Interior circular layer of normal size. The interior longitudinal layer more weakly developed than in *Calicophoron calicophorum*, with indistinct exterior limit. Middle circular layer absent. The radial muscles not strongly developed, extending through the interior longitudinal layer. The exterior circular layer more distinct than in the *Calicophoron* species. The exterior longitudinal layer of normal development. The basally-circular layer more strongly developed than in *Calicophoron*. Posterior, anterior and lip sphincters absent.

Oesophagus 0.613 mm. (0.486–0.8 mm.) in length; without oesophageal sphincter.

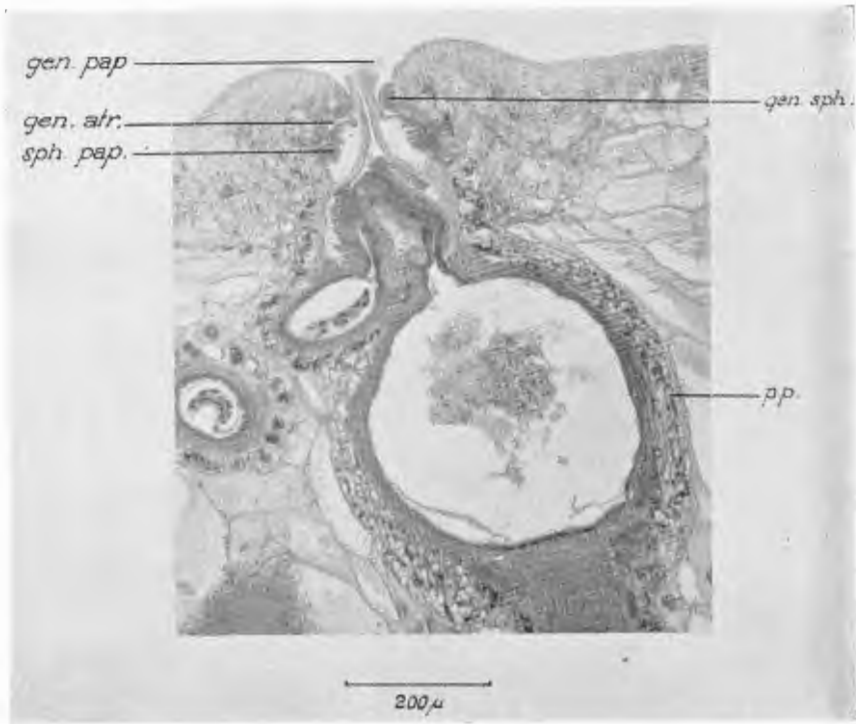


PLATE 3.—A sagittal section of *P. microbothrium* showing the genital atrium.

Genital atrium with genital sphincter and sphincter papillae, conforms to Näsmark's *Microbothrium* type (plate 3). On comparing the genital sphincter with that of the *Calicophoron* type, it is developed to the same degree in both, being well delimited from the surrounding tissue. The sphincter papillae are more compact than those of the *Calicophoron* type. The most prominent point of difference between the two types of genital atria, is that in the *Microbothrium* type, the genital atrium is not eversible as is the case in the *Calicophoron* type. In the eleven series of *Paramphistomum microbothrium*, the genital sphincter was

never found to differ in position in relation to the surface of the worm; always being situated in a slight depression of the surface. The genital papilla may be either retracted behind or slightly protruding beyond the genital sphincter. A very poorly developed ventral atrium might be present or absent.

Testes moderately lobed, round to slightly oval in shape, situated tandem and measuring 1.83 mm. in length and 2.04 mm. in a dorso-ventral direction. Pars prostatica slightly oval, measuring 0.53 mm. (0.407–0.678 mm.) in length and 0.449 mm. (0.373–0.508 mm.) in breadth; ratio between breadth and length being 1:1.2 (1:1.1–1:1.3).

DISCUSSION.

Fischoeder (1903) maintained that there are three characteristic relationships between the excretory bladder, excretory pore and Laurer's canal, which can be used to divide the genus *Paramphistomum* into three groups. Maplestone (1923) page 130, states that "one point was found to be of value in regard to the relations of the opening of Laurer's canal and the excretory pore, and that is, that in species in which Laurer's canal is described as opening behind the excretory pore this is invariably the case, although the actual distance at which one pore lies behind the other varies a good deal". In the ten South African specimens of *P. microbothrium* examined it was found that in six a crossing between the excretory canal and Laurer's canal (i.e. Laurer's canal opens behind the excretory pore) was present. In the other four specimens there was no crossing (i.e. Laurer's canal opens in front of the excretory pore). Further, Laurer's canal was found to open either to the right or left of the excretory pore or the opening of Laurer's canal might be on a level transversely or 0.10–0.90 mm. posterior or 0.30–1.4 mm. anterior to the excretory pore. These findings seem to indicate that no value for classification can be placed on the position of the openings of these two canals.

CALICOPHORON CALICOPHORUM (Fischoeder, 1901) Näsmark, 1937.

(Plates 4, 5, 6, 7, 8 and 9).

Synonyms:—The same as given by Näsmark (1937) p. 493; also all the South African material which had previously been diagnosed as *Paramphistomum explanatum* Creplin, 1847, except such specimens which Näsmark identified as *Calicophoron ijimai* Fukui, 1922, present amongst the South African material examined by Fischoeder.

Host:—*Bos taurus* — rumen.

Distribution:—South Africa.

Length 11.4 mm. (10.0–12.4 mm.); breadth 6.4 mm. (6.0–7.1 mm.); dorso-ventral measurement 6.0 mm. (5.5–6.7 mm.); dorsal line curved, ventral line concave with a predominating acetabular portion. Acetabulum (plates 5 and 6) except for a single discrepancy, conforms to Näsmark's *Calicophoron* type; opening postero-ventrally with a fringe around the aperture, mean diameter 3.1 mm. (2.1–3.5 mm.), the ratio of its diameter to body length being 1:3 (1:2.5–1:4). According to Näsmark there is no division of the dorsal exterior circular muscle layer into two parts in the *Calicophoron* type of acetabulum, the d.e. 2 circular layer being absent. In the South African material it was found that amongst 14 sectioned specimens, ten specimens had a weakly developed d.e. 2 circular layer present (plate 5) and four specimens were without it (plate 6). In the instances when the d.e. 2 circular layer is present it is irregularly spaced

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with empty spaces between the muscle units and not regularly arranged as the d.e. 2 circular of the *Paramphistomum* type of acetabulum. Durie (1951) also did not observe a d.e. 2 circular layer in the Australian material; possibly this layer is confined to the South African material only. The obliquely-running longitudinally branched muscle band separating the d.e. circular and v.e. circular from the acetabular tissue, is present.

The number of muscle units per series of the acetabular musculature is as follows:— Dorsal exterior 1 circular 22 (13–28) units; dorsal exterior 2 circular (i.e. for the ten out of the 14 specimens which had this layer present) 12 (6–16) units, in the other four specimens this layer absent; dorsal internal 54 (43–68) units; ventral internal 64 (51–73) units and the ventral external 19 (15–28) units. Näsmark did not give the number of muscle units for *Calicophoron calicophorum* but when the South African material is compared with Durie's it is at once apparent that in this material there is a greater number of muscle units present in the dorsal internal and the ventral internal. The lateral circular layer, as proposed by Durie (1951), is present.



PLATE 4.—*Calicophoron calicophorum* (Fischoeder, 1901), Näsmark, 1937.

Pharynx conforms to Näsmark's *Calicophoron* type, 1·117 mm. (0·775–1·271 mm.) in length; ratio of pharynx length to body length 1:8·4 (1:7·2–1:12·1). The interior circular muscle layer consists of small units. The interior longitudinal layer is indistinct and consists of loose fibres. The middle circular layer is absent. In agreement with the description given by Durie (1951), it is found that the exterior circular layer is indistinct. The basally-circular layer is weakly developed. Posterior sphincter, anterior sphincter and lip sphincter are absent.

Oesophagus 1·011 mm. (0·769–1·153 mm.) in length.

Genital atrium conforms to Näsmark's *Calicophoron* type (plates 7, 8 and 9). As stated previously, in the case of *C. calicophorum* it is found that the genital papilla, genital atrium, sphincter papillae and genital sphincter as a complex is eversible (plates 7 and 8). When all the afore-mentioned structures are everted the genital atrium is situated on top of a conspicuous ventral papilla. When the ventral papilla is retracted, it vanishes as a structure, the genital atrium with its accompanying structures being separated from the surface of the worm by a canal (plate 9). The components of the genital atrium complex, either when everted or retracted, retain the exact relationship between each other when compared with the condition found in the *Microbothrium* type of genital atrium (plate 3). A small circular ridge (plate 7) around the genital pore is easily observed

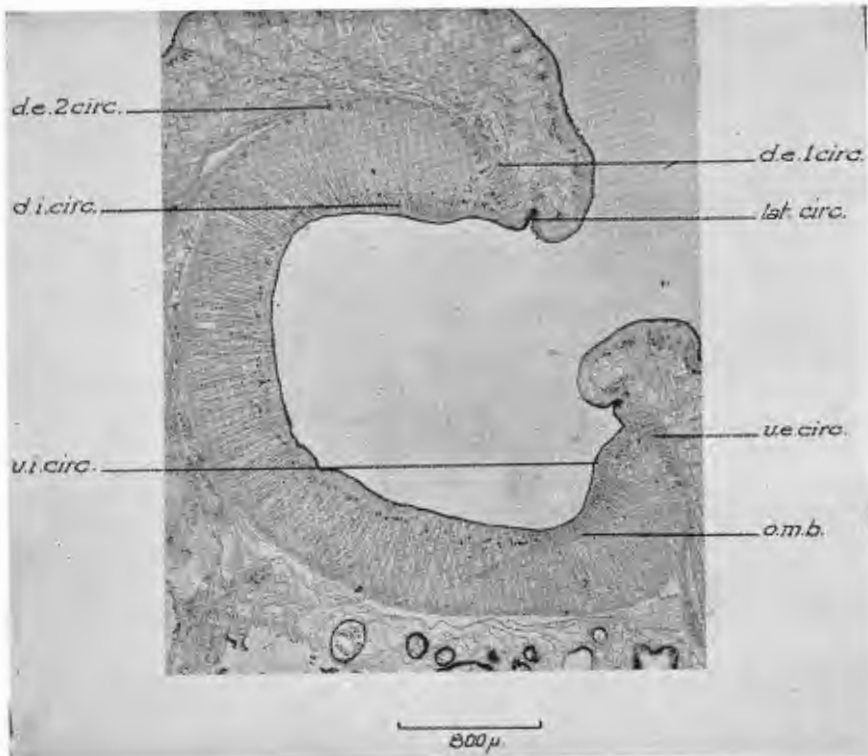


PLATE 5.—A median sagittal section of the acetabulum of *Calicophoron calicophorum* (Fischer, 1901) Näsmark, 1937, showing the weakly developed d.e.2. circular muscle layer.

in the whole specimens. The sphincter papillae are closely packed in comparison with that of the *Microbothrium* type. The genital sphincter is of the same size in both types but the radial musculature of the genital atrium is better developed in the *Calicophoron* type.

Testes deeply lobed, shape round, situated diagonally either vertical or horizontal, overlapping each other, measuring about 2.3 mm. in length and 2.5 mm. dorso-ventrally. Pars prostatica elyptic in shape, measuring 1.013 mm. (0.457–1.333 mm.) in length and 0.52 mm. (0.186–0.775 mm.) in breadth; ratio between breadth and length 1:2 (1:1.3–1:3.6).

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PLATE 6.—A median sagittal section of the acetabulum of *C. calicophorum* without the d.c. 2 circ. muscle layer.

DISCUSSION.

In the South African material described no posterior pharyngeal sphincter was observed and as there is no difference in the development of the interior circular muscle layer of the pharynx in all these specimens, it is probable that the material consists of only one species. It is found that the measurements for the pharynx is 1.117 mm. (0.775–1.271 mm.) and the ratio between the length of the pharynx and body length 1:8.4 (1:7.2–1:12.1). According to Näsmark (1937), collection number 2 of Fiscoeder's material, collected in South Africa and identified as *Paramphistomum calicophorum* by Fiscoeder is in reality the species *Calicophoron ijimai* (Fukui 1922) Näsmark, 1937, his reasons being the

smaller and Ijimai type of pharynx, the measurements of which are 0·95–1·10 mm. in length, giving a length to body length ratio of 1:9·0–1:9·2. These findings are very similar to those found in the material under discussion and would tend to show that these materials are conspecific. The absence of a posterior pharyngeal sphincter (in my material) and its presence in Fiscoeder's material restudied by Näsmark definitely shows that these two materials do not belong to the same species; the material described I identify as *Calicophoron calicophorum* (Fiscoeder, 1901), Näsmark, 1937. This identification is supported by Durie (1951) who identified his Australian material definitely as *Calicophoron calicophorum* (the type material of *Paramphistomum calicophorum* Fiscoeder, 1901 was collected from Queensland). He found that the oesophageal length and its

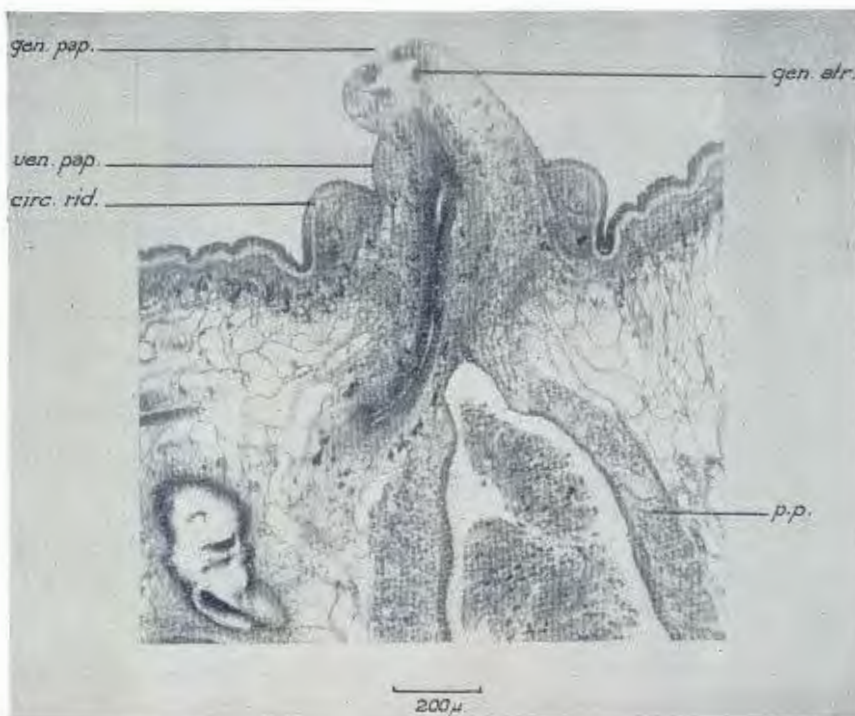


PLATE 7.—A sagittal section of *C. calicophorum* showing the genital atrium everted.

length to body length ratio extend over the whole series of measurements given by Näsmark for *Calicophoron calicophorum* and *Calicophoron ijimai*, but a sphincter was absent. This fits in with the author's observations. The most prominent differentiating character between *Calicophoron ijimai* and *Calicophoron calicophorum* appears to be the presence or absence of an oesophageal sphincter. In the sections studied no specimen was found showing any indication of such a sphincter; the presence and distribution of *Calicophoron ijimai* in South Africa can only be confirmed after the examination of material originating from different parts of the Union.

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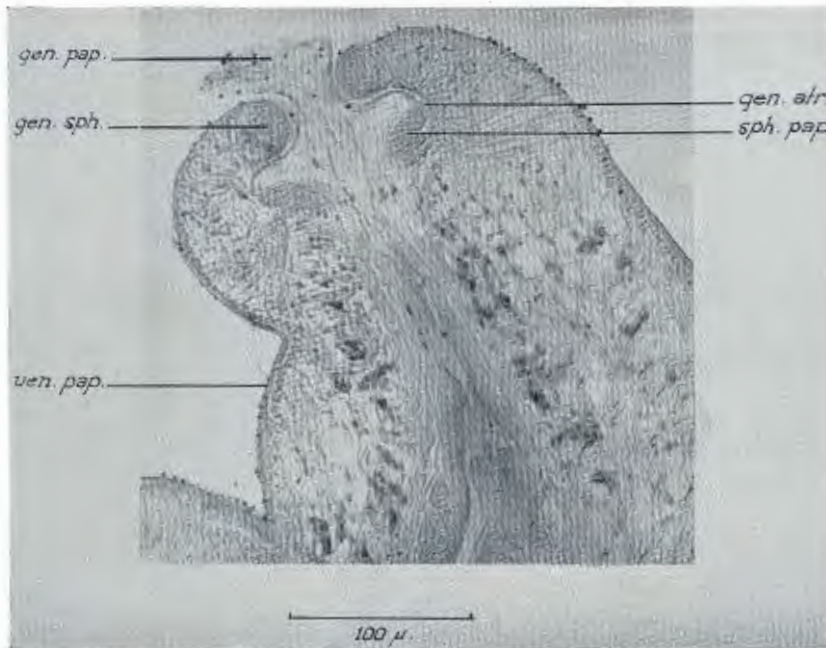


PLATE 8.—The same section as plate 7, slightly enlarged, to show the structures in more detail.

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ABBREVIATIONS.

can.=canal separating the retracted genital papilla from the surface of the worm.
circ. rid.=circular ridge.

d.e.1. circ.=dorsal exterior 1 circular muscle layer.

d.e.2. circ.=dorsal exterior 2 circular muscle layer.

d.i. circ.=dorsal interior circular muscle layer.

gen. atr.=genital atrium.

gen. pap.=genital papilla.

gen. sph.=genital sphincter.

lat. circ.=lateral circular layer (Durie 1951).

o.m.b.=oblique running muscle band.

p.p.=pars prostatica.

sph. (d.e.1. circ.)=sphincter (dorsal exterior 1 circular muscle layer).

sph. pap.=sphincter papillae.

v.e. circ.=ventral exterior circular muscle layer.

ven. pap.=ventral papilla.

v.i. circ.=ventral interior circular muscle layer.



PLATE 9.—A sagittal section of *C. calicophorum* showing the genital atrium retracted.