

Parasites of the relict fauna of Ceylon

III. Nematodes from a Rhacophorid frog and reptiles of the hill country

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Summary

Eight nematode species, all of which have been named before, are reported from 6 host species which are endemic to Ceylon and nearly all confined to the upper montane zone (above 5 000 ft.). A *Rhabdias* sp. and *Entomelas* sp. are reported from the lizard *Calotes nigrilabris*; *Kalicephalus brachycephalus* from the colubrid snake *Aspidura trachyprocta*; *Cosmocercoides rickae* from *Calotes nigrilabris*, from the horn-nosed lizard *Ceratophora stoddarti* and from the frog *Rhacophorus microtympanum*; *Strongyluris chamaeleonis* from *Cophotis ceylanica* and *Ceratophora stoddarti*; *Strongyluris calotis* from *Calotes nigrilabris*; *Meteterakis longispiculata* from the hump-nosed lizard *Lyriocephalus scutatus* collected in Kandy (elevation 1 674 ft.); and *Meteterakis baylisi* from *Ceratophora stoddarti*.

Cosmocercoides rickae, *Strongyluris calotis* and *Meteterakis baylisi* are confined to Ceylon. The fact that the nematode *Cosmocercoides rickae* is found in Ceylon in an endemic frog and relict lizards, appears to throw light on the discovery of the acanthocephalan *Acanthocephalus serendibensis* in one of the relict lizards in Ceylon while a closely related species *A. madagascariensis* occurs in a *Rhacophorus* sp. in Madagascar.

Kalicephalus brachycephalus, which occurs in several snakes in the Oriental region, appears to be poorly adapted to the almost relic *Aspidura trachyprocta* in Ceylon.

There appears to be no evidence for regarding *Meteterakis cophotis* as being different from *M. longispiculata*. It is therefore regarded as a synonym of the latter species which was originally reported from a gecko in Java. The case for synonymising these two species is made more plausible when one considers the fact that one of the lyriocephaline host genera, namely *Cophotis*, is represented in Sumatra and Java as well by the species *Cophotis sumatrana*.

Résumé

Parasites de la faune relique de Ceylan. III. Nématodes d'une grenouille Rhacophoridae et de reptiles de la zone montagneuse.

Huit espèces reconnues de nématodes ont été recueillies dans 6 espèces d'hôtes endémiques à Ceylan et presque toutes furent trouvées dans la zone montagneuse (plus de 1 500 m). Une *Rhabdias* sp. et *Entomelas* sp. ont été observées chez le lézard *Calotes nigrilabris*; *Kalicephalus brachycephalus* chez le serpent colubrine *Aspidura trachyprocta*; *Cosmocercoides rickae* chez *Calotes nigrilabris*, chez le lézard « horn-nosed » *Ceratophora stoddarti* et chez la grenouille *Rhacophorus microtympanum*; *Strongyluris chamaleonis* chez *Cophotis ceylanica* et *Ceratophora stoddarti*; *Strongyluris calotis* chez *Calotes nigrilabris*; *Meteterakis longispiculata* chez le lézard « hump-nosed » *Lyriocephalus scutatus* récolté à Kandy (altitude 510 m), et *Meteterakis baylisi* chez *Ceratophora stoddarti*.

Cosmocercoides rickae, *Strongyluris calotis* et *Meteterakis baylisi* ne se trouvent qu'à Ceylan. Le fait que le nématode *Cosmocercoides rickae* se trouve à Ceylan dans une grenouille endémique et des lézards reliques éclaire notre découverte de l'acanthocéphale *Acanthocephalus serendibensis* dans un lézard relique à Ceylan, tandis qu'une espèce proche, *Acanthocephalus madagascariensis*, apparaît dans une *Rhacophorus* sp. à Madagascar.

Kalicephalus brachycephalus, trouvé chez plusieurs serpents de la région orientale, semble peu adapté au serpent *Aspidura trachyprocta*, presque relique, à Ceylan.

Rien ne nous permet de considérer *Meteterakis cophotis* comme étant différent de *Meteterakis longicaudata*. Il est par conséquent un synonyme de la dernière espèce, qui a été trouvée dans des geckoes à Java. Il est vraisemblable que ces deux espèces soient synonymes lorsqu'on considère le fait qu'un des genres lyriocéphalines, à savoir *Cophotis*, est aussi représenté à Sumatra et à Java par l'espèce *Cophotis sumatrana*.

Introduction

« *Speciation in nematode parasites is allopatric and, in general, independent of the speciation or trans-specific evolution of the host.* »

W. G. INGLIS, 1965.

The 8 nematode species dealt with in this paper were collected from 6 host species, which are all endemic to Ceylan and confined mostly to the upper montane zone (above 5000 ft.). Two of the host genera, *Lyriocephalus* and *Ceratophora* are both endemic and relict genera belonging to the lacertilian subfamily Lyriocephalinae, while *Cophotis*, which belongs to the same subfamily, occurs in Sumatra and Java as well. *Aspidura*, a genus of colubrid snakes, is found elsewhere only on the nearby Maldiv Islands and is therefore essentially a Ceylonese genus. The frog genus *Rhacophorus* enjoys a wider distribution in Africa, Madagascar and Asia. Details of the collections are set out in Table I.

Although none of the nematode species recorded here are new, the wealth of material obtained has helped clarify many points regarding the species already described. A certain amount of light is also thrown on possible connections with other

Table I

Parasite	Male	Female	Host	Male	Female	Habitat	Locality of host
Rhabditida : Rhabdiasidae							
1. <i>Rhabdias</i> sp.	—	28	<i>Calotes nigrilabris</i>	4	3	Lungs	Horton Plains 2195 m. (7200 ft.)
2. <i>Entomelas</i> sp.	—	8	»	»	»	»	»
Strongylida : Diaphanocephalidae							
3. <i>Kaliocephalus brachycephalus</i>	2	4	<i>Aspidura trachyprocta</i>	1	1	Small intestine	Horton Plains
Ascariidida : Cosmocercidae							
4. a) <i>Cosmocercoides rickae</i>	1 1 fragment	7	<i>Rhacophorus microtypanium</i>	—	1	Rectum	Horton Plains
b) »	38	42	<i>Ceratophora stoddarti</i>	1	—	»	»
c) »	—	23 immature	»	1	—	Small intestine	»
d) »	2	2	»	1	—	Rectum	Hakgala Gardens 1707 m. (5600 ft.)
e) »	5 Mixed infection with <i>M. baylisi</i> and <i>S. chamaeleonis</i>	12	»	1	—	»	Horton Plains
f) »	20 immature	—	»	—	1	Small intestine	Nuwara Eliya
g) »	1	—	<i>Calotes nigrilabris</i>	1	—	Stomach	Nuwara Eliya Park 1885 m. (6185 ft.)
Ascariidida : Heterakidae							
5. a) <i>Strongyluris chamaeleonis</i>	—	2	<i>Cophotis ceylanica</i>	6	4	Rectum	Nuwara Eliya Park
b) »	5	10 3 immature	»	1	1	Small intestine	Hakgala Gardens
c) »	2	5	<i>Ceratophora stoddarti</i>	3	2	Rectum	Horton Plains

Table I (contd.)

Parasite	Male	Female	Host	Male	Female	Habitat	Locality of host
6. a) <i>Strongyluris calotis</i>	69	42	<i>Calotes nigrilabris</i>	5	4	Rectum	Horton Plains
b) »	—	1 was found along with a solitary <i>Cosmocercoides rickae</i>	»	1	—	Stomach	Nuwara Eliya Park
c) »	9	7	»	2	—	Rectum	Hakgala Gardens
d) »	—	1 with numerous eggs and larvae	»	1	—	Stomach	Horton Plains
7. a) <i>Meteterakis longispiculata</i>	64	91	<i>Lyriocephalus scutatus</i>	—	3	Small intestine	Udawattekele (Kandy) 510 m. (1674 ft.)
b) »	—	52 immature	»	—	»	Small intestine and rectum	»
c) »	120	190	»	1	—	Rectum	»
d) »	—	265 immature	»	»	—	Small intestine	»
8. a) <i>Meteterakis baylisi</i>	94	137	<i>Ceratophora stoddari</i>	10	7	Rectum	Horton Plains
b) »	—	56 immature	»	1	1	Small intestine	»
c) »	16	17; 3 immature	»	—	3	Rectum	Hakgala Gardens
d) »	9	2	»	1	1	»	Nuwara Eliya Park

countries, and possible geographical pathways of infection, as reflected in the parasite distributions. Only 3 out of the 8 parasite species appear so far to be confined to Ceylon, namely *Cosmocercoides rickae*, *Strongyluris calotis* and *Meteterakis baylisi*. Three others are variously distributed in Asia, and two rhabdiasids need to be studied more intensively by experimental infestations before their specific status could be finally determined.

Rhabdias sp.

(fig. 1)

Out of 15 specimens of *Calotes nigrilabris* caught at Horton Plains, the lungs of 7 specimens were found to be infected with rhabdiasid nematodes, and yielded respectively 10, 2, 3, 13, 6, 1 and 1, that is, a total of 36 such nematodes. All the worms proved to be females. A large number of eggs and actively moving larvae were also seen in the collecting medium (0.9 % saline), but no males were found at all.

The parasites were first examined in the fresh condition and then preserved in warm 70 % alcohol. They were then mounted in glycerine, after clearing in lacto-phenol. Staining the nematodes with acid fuschin and clearing in fresh lacto-phenol also gave very good results. A critical study of the parasites showed that they belonged to two distinct genera, namely *Rhabdias* and *Entomelas*.

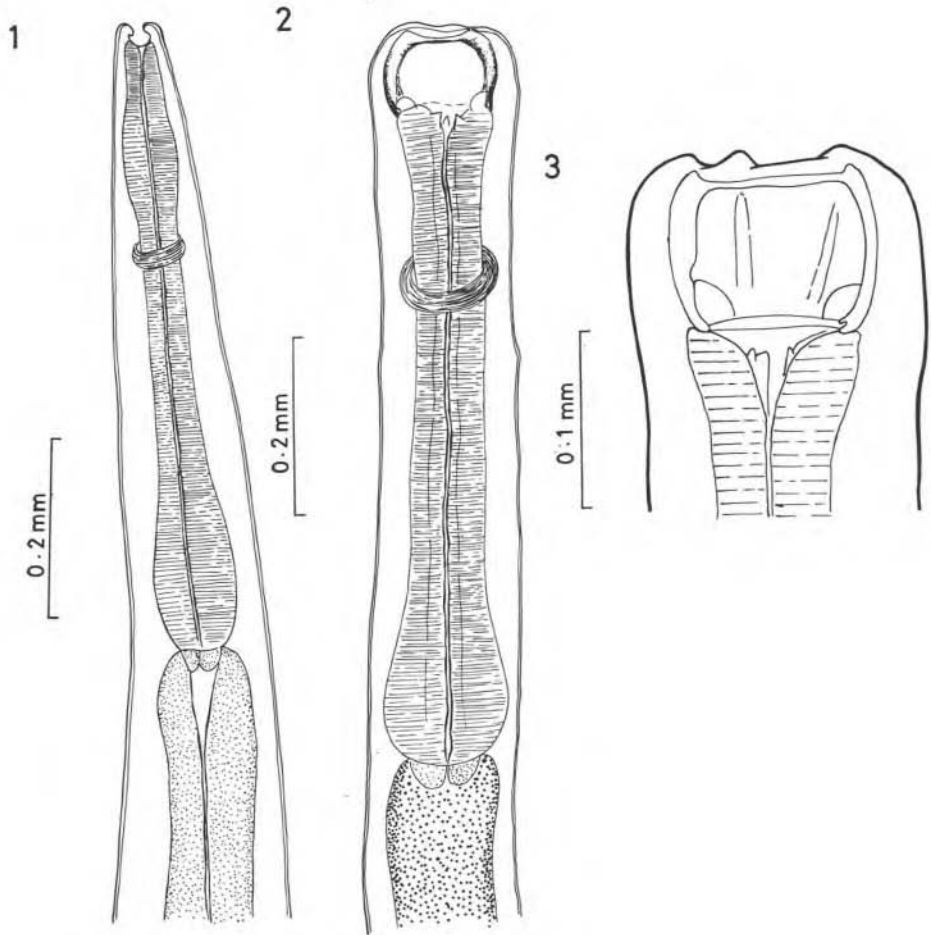
Description :

Twenty-eight specimens of *Rhabdias* sp. were collected in all. They are long, slender and filiform, with bluntly rounded anterior ends and finely pointed posterior ends. The mouth is surrounded by 6 small insignificant lips and is followed by a small cup-shaped buccal capsule. The oesophagus is short and is provided with two swellings separated by a constricted portion surrounded by the nerve ring. The anterior portion is spindle-shaped while the posterior portion is club-shaped. The intestine is simple, without any appendages.

The ovaries are reflexed. The vulva is situated near the middle of the body. The uteri are divergent and end in a receptaculum seminis, shortly after which the oviducts bend sharply back towards the middle of the body. The uteri are packed with eggs, which are thin-shelled and contain fully-formed larvae.

Discussion :

So far 23 species of *Rhabdias* have been described from amphibians and 12 species from reptiles. Out of the 12 reptilian species, 10 are reported from snakes and only 2 from chameleons. The species from chameleons, *R. chamaeleonis* and *R. gemellipara*, are extremely long worms and Travassos in 1930 shifted *R. chamaeleonis* to the genus *Entomelas*, in spite of the fact that it lacks the prominent buccal capsule and the 3 teeth at the base of the buccal capsule so characteristic of the genus. *R.*

FIG. 1. — *Rhabdias* sp.FIG. 2-3. — *Entomelas* sp.

gemellipara, though classified under *Rhabdias*, shows very close affinities to *Entomelas dujardini* and *Entomelas entomelas* in its developmental cycle (Chabaud, Brygoo and Petter, 1961). So it is quite probable that *R. gemellipara* is also a species of *Entomelas* and not a species of *Rhabdias*, in spite of the differences it presents in the size of its buccal capsule and body length.

Thus, the form under discussion from *Calotes nigrilabris* is the only species reported from a lizard. The differences it presents in its body-length and oesophageal length may well be due to a difference of host.

Entomelas sp.

(fig. 2 and 3)

Eight specimens of *Entomelas* sp. were collected along with the *Rhabdias* sp. from the lungs of the same hosts. They were easily distinguished from the *Rhabdias* sp. by their larger size and more prominent buccal capsule. The various body measurements are set out in Table II.

Table II. — Measurements of *Rhabdias* sp. and *Entomelas* sp. (1)

	<i>Rhabdias</i> sp. (6)	<i>Entomelas</i> sp. (8)
Body length	7.052-10.332	14.862-16.520
Body width	0.217-0.299	0.348-0.369
Head diameter	0.049-0.057	0.143-0.147
Buccal capsule diameter	0.020-0.028	0.102-0.114
Oesophagus length	0.675-0.738	0.348-0.369
Eulb dimensions	0.073-0.082	0.164-0.184 by 0.123-0.131
Nerve ring from anterior end	0.184-0.287	0.246-0.266
Vulva from anterior end	4.059-4.120	8.823-10.045
Tail length	0.287-0.328	0.369-0.533
Egg dimensions	0.045-0.102 by 0.028-0.041	0.102-0.123 by 0.045-0.057

(1) All measurements in this table and subsequent tables are in millimetres.

The mouth is surrounded by a cuticular ring. The free margins of the ring are shallowly lobed. Lips are absent. The buccal capsule is large and well developed and is provided at its base with 3 small chitinoid teeth. The teeth, which are bifid in *E. entomelas* and *E. dujardini*, appear to be simple in the present form. The buccal capsule leads to a claviform œsophagus which lacks the characteristic anterior swelling found in the *Rhabdias* sp. It is followed by a simple intestine which is identical in structure with that of the *Rhabdias* form.

The vulva is situated behind the middle of the body. The uteri are opposed. The tail is conical and pointed. The eggs are large, oval, thin-shelled and embryonated.

Discussion :

Only 3 species of *Entomelas* have been described so far from reptiles, namely *E. entomelas* (Dujardin, 1845) (Syn. *Angiostoma macrostomum*), *E. dujardini* (Mau-pas, 1916) (Syn. *Angiostoma entomelas*) and *E. chamaeleonis* (Skrjabin, 1916).

A close comparison of the measurements of *E. entomelas* and *E. dujardini* show that these two species, reported from the same host *Anguis fragilis* in Europe, are synonymous. The present form resembles these species in the structure of its buccal capsule and in the presence of teeth at the base of the buccal capsule, but differs from them in that it is thrice as long.

If *R. gemellipara* is also placed under the genus *Entomelas*, then our form resembles *R. gemellipara* and *E. chamaeleonis* in being a very long worm, but the prominent buccal capsule demarcates it clearly from these species. A conclusive determination of its specific status could be made only after experimentally working out its developmental cycle and life-cycle.

Kalicephalus brachycephalus Maplestone, 1931

(fig. 4-11)

Three specimens of *Kalicephalus* (2 females and 1 male) were collected from the small intestine of a female colubrid snake, *Aspidura trachyprocta*, on July 24, 1969. Three more specimens (2 females and 1 headless male) of the same parasite, from the same habitat, were collected from a male *Aspidura trachyprocta* on November 13, 1969. The hosts on both occasions were caught on Horton Plains. The parasites were fixed in warm 70 % alcohol and preserved in the same fluid.

Description :

The worms are of medium size with a slightly curved anterior end. The greatest width is generally at the level of the buccal capsule (Figs. 4 and 5). The cuticle of the face is inflated, specially at the corners. The head is strongly compressed laterally. The buccal capsule is large and relatively deep (Fig. 4). It could also appear to be foreshortened (Fig. 5) as a result of its two lateral halves bending in strongly. The ventral posterior chitinous piece of the buccal capsule is crescentic and orientated longitudinally. The anterior chitinous ridge is curved somewhat strongly. It is variable in thickness, from narrow to medium. The dorsal gutter is well developed with a beaded internal edge.

The oesophagus varies in length when compared with the depth of the buccal capsule. It is slightly bulbed when it is twice as long as the buccal capsule is deep, and is more stoutly bulbed when the oesophagus is considerably shorter in length.

The nerve ring encircles the oesophagus just anterior to the bulb. The excretory pore is situated posterior to the nerve ring, at the level of the middle of the oesophageal bulb.

Male :

The bursa is well developed (fig. 6). The terminal branching of the dorsal ray is of pattern III (fig. 6 and 7). The ventral rays are long and thin, and distinctly separate distally. They terminate considerably anteriorly, the distal ends being anterior to the end of the genital cone. The lateral rays are symmetrical, with their tips evenly

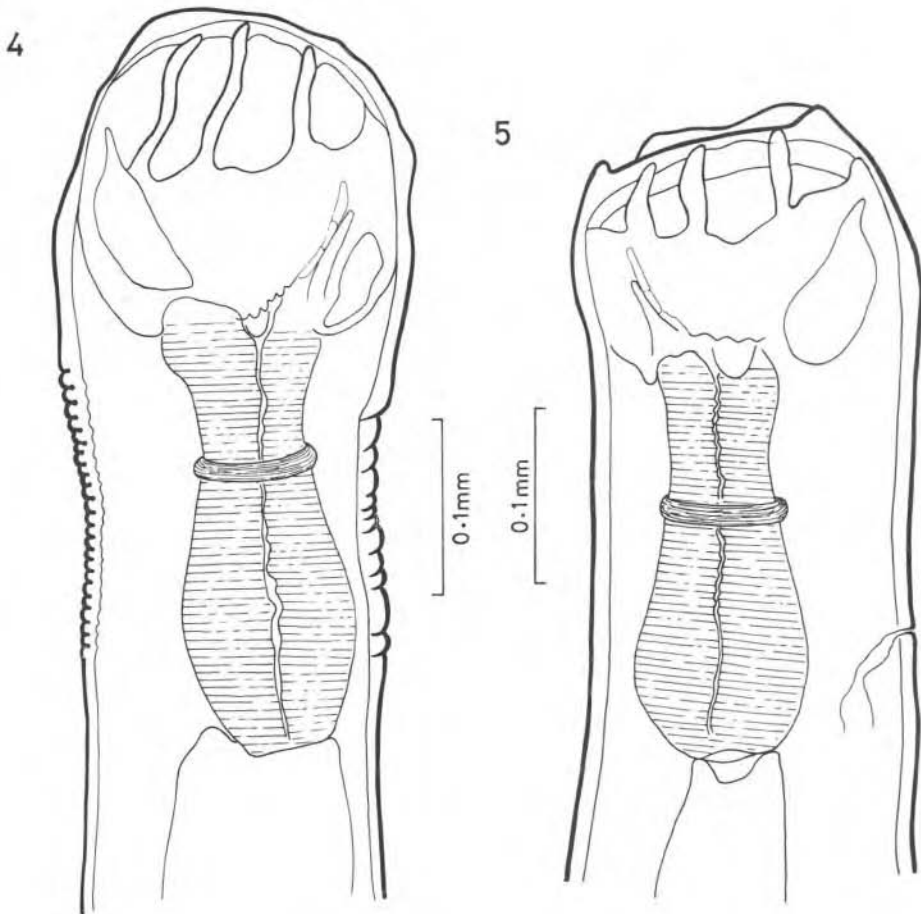


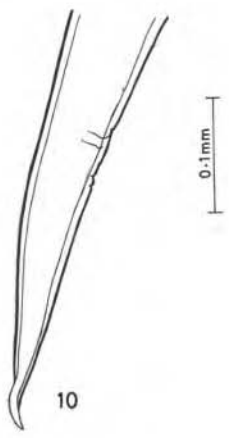
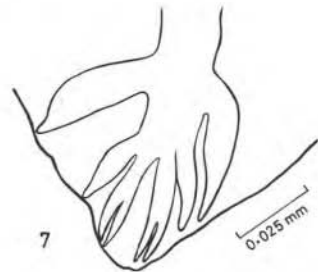
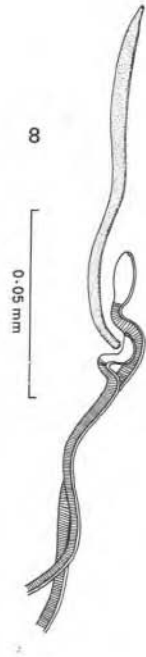
FIG. 4-5. — *Kalicephalus brachycephalus*.

spaced and the rays diverging uniformly. The externo-lateral ray is shorter than the other laterals.

The spicules are equal, simple, short and alate, with spatulate tips (fig. 8). A simple, well developed gubernaculum (fig. 8) and a telamon are present. The genital cone is prominent.

Female :

The vulva varies from a slightly raised structure to a prominent structure. The worm is amphidelphic, with the uteri opposed from ovejectors. The ovejectors are short and distinctly separated from the uteri by prominent muscular constrictions



(fig. 9). The tail of the female is elongate (fig. 10 and 11) and its tip is either bluntly pointed or has a small prominence, when viewed laterally. The eggs are large.

Discussion :

So far about 33 species and subspecies of *Kalicephalus* are recognised. They have been reported from the alimentary tract of various snakes and lizards, but none from the colubrid snake *Aspidura trachyprocta*. This is the first report of this parasite from this host, which is found in the hill country of Ceylon and also in the Maldive Islands.

Table III. — Measurements of *Kalicephalus brachycephalus*

	Male (1)	Female (4)
Body length	4.28	4.612-5.145
Body width	0.184	0.176-0.221
Head diameter	0.143	0.147-0.205
Buccal capsule depth	0.102	0.123-0.184
Œsophagus length	0.229	0.213-0.246
Bulb diameter	0.090	0.082-0.094
Nerve ring from anterior end	0.184	0.205-0.266
Excretory pore from anterior end	—	0.300
Spicule length	0.319-0.320	—
Vulva from anterior end	—	2.99-3.15
Tail length	—	0.246-0.311
Egg dimensions	—	0.0410-0.0697 by 0.0246-0.0328

The worms from *Aspidura trachyprocta* show features that point to their belonging to one of four species, namely *Kalicephalus colubri*, *K. truncatus*, *K. viperae* and *K. brachycephalus*. *K. colubri* has however an anteriorly tapering body with a relatively narrow head, and a dorsal ray showing terminal branching of pattern IV, very occasionally pattern III (*vide* Schad, 1962). All subspecies of *K. viperae* have narrow heads. Their spicules have markedly shouldered spatulate tips and the terminal branching of the dorsal ray is of pattern IV. *K. truncatus*, like the present form, is a very small worm with almost the same measurements for most of the structures. It too has a relatively large head with a deep buccal capsule, and the terminal branching of the dorsal ray is of pattern III or IV. But it differs from the present species in having ventral rays which are fused except at the tips, and spicules with markedly shouldered spatulate tips.

The length of the œsophagus in all three species, namely *K. colubri*, *K. truncatus* and *K. viperae*, is double or more than double the depth of the buccal capsule, whereas in the present species the œsophagus is mostly less than double the depth of the buccal capsule.

The present species comes closest to *K. brachycephalus*, with which it agrees in the following features :

1. The greatest width of the worm is generally at the level of the buccal capsule ;
2. The face is tilted ;
3. The facial cuticle is inflated especially at the corners ;
4. The anterior chitinoid ridge is curved, sometimes strongly ;
5. The ventral posterior chitinoid piece is crescentic and longitudinally orientated ;
6. The buccal capsule is relatively deep. The body-length by buccal-capsule-depth index is closer to that of *K. brachycephalus* than to those of the other species (Table IV) ;
7. The œsophagus-length by buccal-capsule-depth index is very close to that of *K. brachycephalus* (Table IV) ;
8. The spicules are alate with narrow spatulate tips.

The present form, however, differs from *K. brachycephalus* in its much smaller size and in the pattern of the terminal branching of the dorsal ray. But these may both be host-determined variations, the small size of the worms being perhaps an indication of poor adaptation to *Aspidura*. The location in the host, namely the small intestine, may be another indication of poor adaptation, since worms of the Rectiphilous group, to which *K. brachycephalus* belongs, properly infest the rectum. According to Schad (1971, personal communication) these worms are quite habitat specific, for, whenever Schad did his own autopsies on freshly killed hosts, he never found kalicephs at ectopic sites. The worms in the present collection too were obtained directly from freshly killed hosts, whose alimentary canals were examined for their entire lengths. There is also no indication that these worms are particularly young adults, which could have later finally established themselves in the rectum. In spite of these differences and the fact that the host *Aspidura trachyprocta* is found in Ceylon only above an elevation of 5 000 ft., it would be best to regard the present worms as belonging to *K. brachycephalus*, a species which is of Oriental distribution and has probably already been found in Ceylon in *Typhlops braminus* (*vide* Schad, 1962).

Cosmocercoides rickae Ogden, 1966

Ninety-seven specimens of the above species were collected from the rectum of two male specimens of the horn-nosed lizard, *Ceratophora stoddarti*, in July 1969, at Horton Plains. Twenty-three immature worms were also recovered from the small intestine of one of them.

Table IV

	No. of worms measured	Body-length/buccal-capsule-depth index	Mean	Standard Deviation	Oesophagus length/buccal-capsule-depth index	Mean	Standard Deviation
<i>K. brachycephalus</i> (from <i>Aspidura trachyprocta</i>)	5	26-42	36.014	6.099	1.3-2.2	1.754	0.290
<i>K. brachycephalus</i> (from other hosts)	19/18	21-37	29.440	3.855	1.3-2.2	1.758	0.199
<i>K. colubri</i>	12	37.6-93.5	64.590	17.440	2.0-2.6	2.220	0.141
<i>K. truncatus</i>	4	35-38	35.445	6.099	1.9-2.1	2.002	0.110
<i>K. viperæ chungkingensis</i>	16	45-78	61.860	8.669	2.3-2.7	2.458	0.099
<i>K. viperæ</i> subsp. Schad, 1962 (from Madagascar)	4	62-74.5	67.522	4.742	2.3-2.6	2.480	0.127

All figures, except those for *K. brachycephalus* from *Aspidura trachyprocta*, were computed from data given by Schad (1962).

Table V. — Details of collections of *Cosmoceroides rickae* Ogden, 1966

Host	Sex of host	Locality and date of collection	Habitat of worms	No. and sex of worms	
				Male	Female
<i>Ceratophora stoddarti</i> Gray, 1835	Male	Hakgala Gardens July 19, 1969	Rectum	2	2
»	Male	Horton Plains July 21, 1969	Rectum	38	42
»	Male	Horton Plains July 21, 1969	Small intestine		23 immature
»	Female	Nuwara Eliya March 23, 1970	Rectum	5	12
»	Female	Nuwara Eliya March 23, 1970	Small intestine		20 immature
<i>Calotes nigrilabris</i> Peters, 1860	Male	Nuwara Eliya July 22, 1969	Stomach	1	
<i>Rhacophorus microtympaanum</i> Günther, 1858	Female	Horton Plains July 19, 1969	Rectum	2	7

Table VI. — Comparative chart of *Cosmocerooides rickae* Ogden, 1966 from different hosts

	From <i>Ceratophora tennenti</i> (vide Ogden 1966)		From <i>Ceratophora stoddartii</i>		From <i>Calotes nigrilabris</i>		From <i>Rhacophorus microtypanum</i>	
	Male (1)	Female (6)	Male (10)	Female (12)	Male (1)	Female (7)	Male (2)	Female (7)
Body length	3.07	3.56-4.94	2.13-4.77	3.28-4.79	2.808	4.07	4.07	4.14-5.08
Body width	0.41	0.36-0.47	0.205-0.451	0.266-0.350	0.192	0.389-0.430	0.389-0.430	0.274-0.533
Head diameter	0.035	0.037-0.043	0.028-0.041	0.028-0.041	0.036	0.041	0.041	0.047-0.057
Oesophagus length	0.65	0.68-0.84	0.574-0.779	0.697-0.922	0.533	0.779	0.779	0.656-0.820
Bulb diameter	—	—	0.102-0.143	0.123-0.151	0.123	0.123-0.164	0.123-0.164	0.131-0.188
Nerve ring from anterior end	0.34	0.24-0.30	0.246-0.348	0.282-0.287	0.246	—	—	—
Excretory pore from anterior end	0.42	0.28-0.35	0.31-0.492	0.369-0.492	0.348	—	—	—
Spicule length	0.168	—	0.143-0.225	—	0.246	0.246-0.278	0.246-0.278	—
Gubernaculum length	0.121	—	0.098-0.123	—	0.123	0.094-0.143	0.094-0.143	—
No. of caudal papillae (rosette-form type)	18	—	18	—	18	18	18	—
Vulva from anterior end	—	1.94-2.63	—	—	—	—	—	2.39-2.87
Tail length	0.161	0.158-0.243	0.123-0.237	0.217-0.240	0.155	0.143-0.155	0.143-0.155	0.164
Egg dimensions	—	0.076-0.090	—	0.041-0.082	—	—	—	0.051-0.082
		by		by				by
		0.044-0.055		0.028-0.102				0.028-0.041

Four specimens of the same nematode species were collected from a male *Ceratophora stoddarti* in the Hakgala Gardens in the same month, and twenty immature worms were obtained from the small intestine of a female horn-nosed lizard at Nuwara Eliya in March 1970. A solitary male nematode was recovered from the stomach of a male *Calotes nigrilabris* at Nuwara Eliya. This may well have been an accidental infection.

Nine specimens of *Cosmocercoides* were also collected in July 1969 at Horton Plains from the rectum of a female *Rhacophorus microtypanum*.

Relevant details regarding the above collections are set out in Table V.

The worms correspond in all their features to the species *Cosmocercoides rickae* Ogden, 1966. The various measurements are set out in Table VI.

This species was originally reported from the rectum of *Ceratophora tennenti* in Gammaduwa, Ceylon, by Ogden (1966). It was the first record of worms of the genus *Cosmocercoides* from a reptile. All other species of this genus have so far been reported only from the alimentary tract of amphibia.

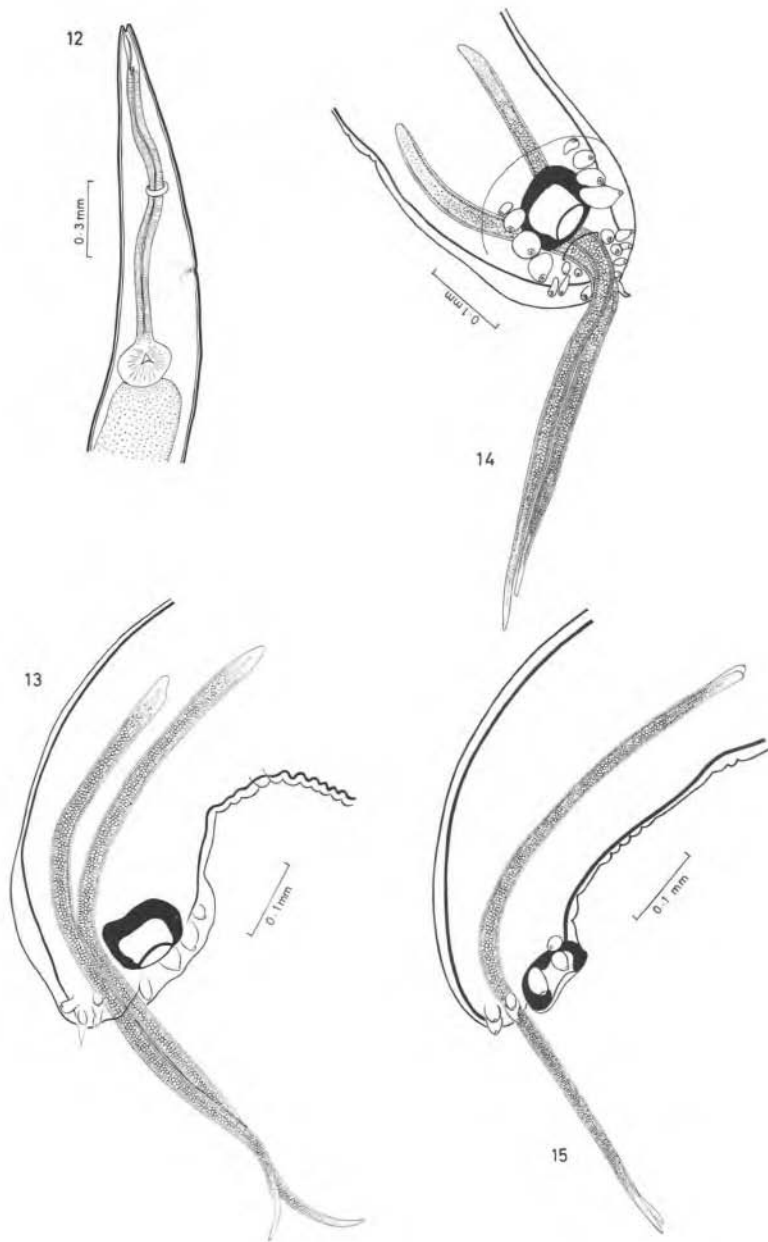
It is very interesting to note the occurrence of this species in both an endemic amphibian and an endemic reptile in the same location and same locality in Ceylon. While rhacophorids have a wide distribution, in Africa, Madagascar and the Oriental region, agamid lizards of the subfamily Lyriocephalinae to which *Ceratophora* spp. belong are a group confined to Ceylon, with the exception of *Cophotis*, which is found also in Sumatra and Java. Very probably *Ceratophora* spp. obtained their *Cosmocercoides* from rhacophorid frogs. This co-existence of *Cosmocercoides rickae* in an endemic amphibian and a relict reptile would also throw light on the probable route of infection of the echinorhynchid acanthocephalan, *Acanthocephalus serendibensis* Crusz and Mills, 1970, from *Ceratophora stoddarti* in Ceylon. The closely allied species *Acanthocephalus madagascariensis* Golvan, 1965, came from a *Rhacophorus* sp. on Mt. d'Ambre in Madagascar. It will be interesting indeed if *Acanthocephalus serendibensis* is found to infest rhacophorids as well, in Ceylon.

Strongyluris chamaeleonis Baylis and Daubney, 1922

(fig. 12-15)

Seventeen specimens of the above parasite were collected from *Cophotis ceylanica* and 7 specimens from *Ceratophora stoddarti*. The infection in *Cophotis ceylanica* occurred in the small intestine and rectum, while in *Ceratophora stoddarti* the parasite was collected from the rectum along with *Cosmocercoides rickae* and *Meteterakis baylisi*.

Details of all these collections are set out in Table VII (a).



Description :

The worms collected from *Cophotis ceylanica* are long and slender and in a highly coiled state while those from *Ceratophora stoddarti* are slender and straight but in a poor state of preservation. Body papillae are absent in all the specimens examined.

The mouth is surrounded by 3 well developed lips. The cuticular flange and the two shoulders present in *S. calotis* are absent in this form. The pharynx and œsophagus are well developed (fig. 12). A ventral kink is present in the lumen of the pharynx. The nerve ring is situated in the anterior half of the œsophageal region. The œsophagus enlarges into a bulb at its posterior extremity. The intestine is simple. The excretory pore is situated just behind the nerve ring.

Male :

The tail of the male is typical, with a pre-anal sucker having a chitinous ring, and with 10 papillae and 2 spicules (fig. 14). There are 4 pairs of pre-anal papillae and 6 pairs of post-anal papillae. The pre-anal papillae increase in size from before backwards, while the post-anal papillae are all much smaller in size.

The spicule lengths fall into all categories — equal, subequal and unequal. The spicules are longer and more slender than those of *S. calotis* and they are strongly tessellated throughout their lengths (fig. 13 and 14).

Female :

The female tail tapers regularly and has a terminal spike. The vulva opens behind the middle of the body. Eggs are oval with smooth shells, and they vary greatly in size.

A detailed chart of the measurements is given in Table VIII. As the forms from *Ceratophora stoddarti* (fig. 15) were not in a good state of preservation, the measurements of these worms are not given.

Discussion :

The worms described here belong to the species *Strongyluris chamaeleonis*, although they were collected from agamid lizards from the same geographical localities in Ceylon as *Calotes nigrilabris* which harbours *S. calotis*. *S. chamaeleonis* differs markedly from *S. calotis* in the shape and size of the spicules, size of sucker, arrangement of the papillae and the shape of the tail.

Strongyluris calotis Baylis and Daubney, 1923

(fig. 16-18)

A large number of specimens of *Strongyluris calotis* were collected from the rectum of *Calotes nigrilabris* that were brought from Horton Plains, Hakgala Gardens

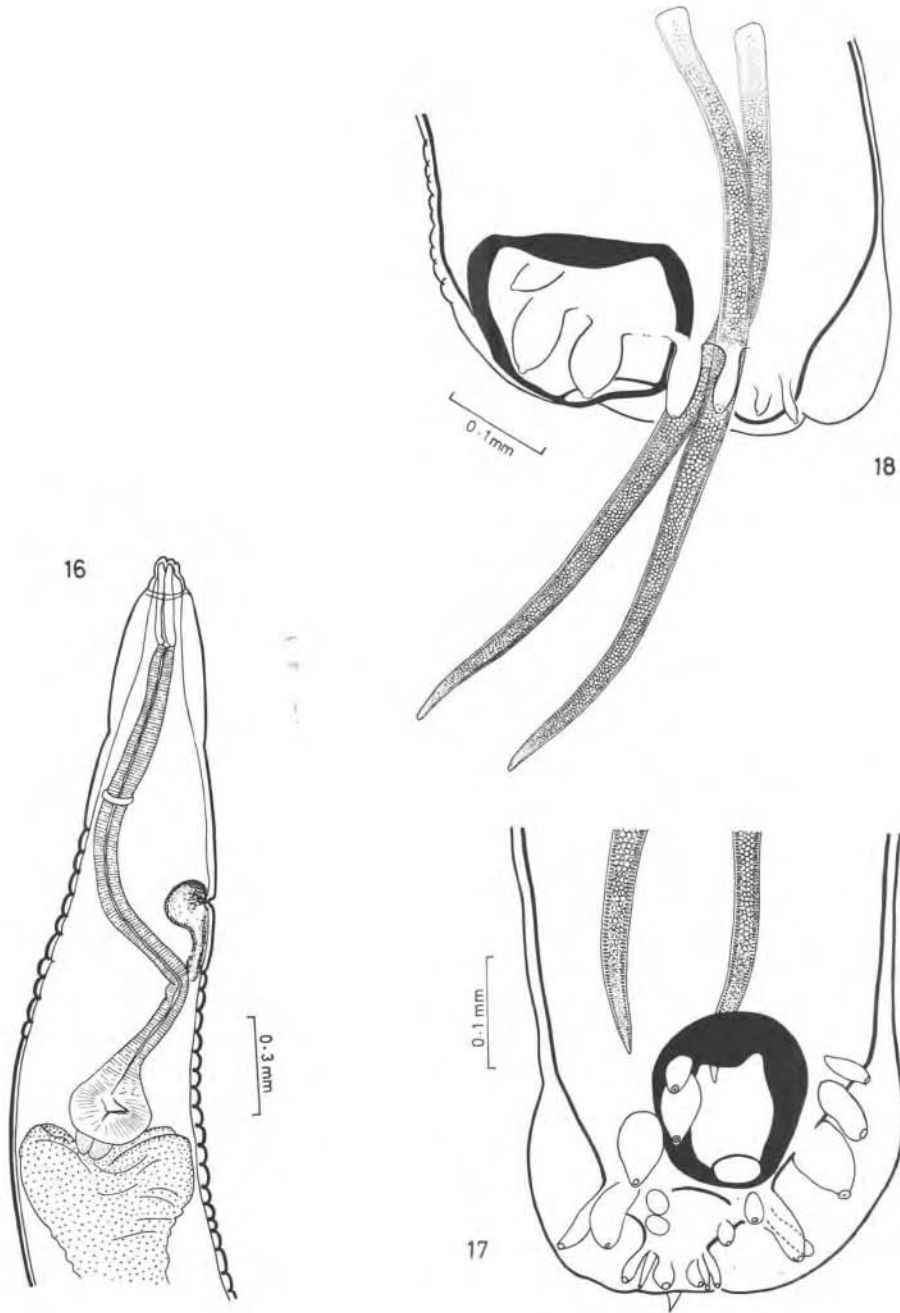


Table VII (a)

Host	Sex of host	Locality of host	Habitat of parasite	Parasite	No. and sex of parasites	
					Male	Female
1. <i>Cophotis ceylanica</i>	Male	Horton Plains	—	—	—	—
2. »	Female	Nuwara Eliya Park	—	—	—	—
3. »	Male	»	—	—	—	—
4. »	Male	»	—	—	—	—
5. »	Female	»	—	—	—	—
6. »	Female	»	Rectum	<i>Strongyluris chamaeleonis</i>	—	1
7. »	Male	»	—	—	—	—
8. »	Male	»	Rectum	<i>S. chamaeleonis</i>	—	1
9. »	Male	»	—	—	—	—
10. »	Male	»	—	—	—	—
11. »	Female	»	—	—	—	—
12. »	Female	Hakgala Gardens	Small intestine	<i>S. chamaeleonis</i>	5	10, 3 immat.
13. »	Young male	»	—	—	—	—
14. <i>Ceratophora stoddarti</i>	Male	Horton Plains	—	—	—	—
15. »	Female	»	—	—	—	—
16. »	Female	»	—	—	—	—
17. »	Male	»	—	—	—	—
18. »	Male	»	Rectum	<i>S. chamaeleonis</i> Mixed infection with <i>Cosmocerooides riccae</i> and <i>Metetrakis baylisi</i>	2	5
19. »	Young male	Hakgala Gardens	—	—	—	—
20. »	Male	»	—	—	—	—

Table VII (a) (contd.)

Host	Sex of host	Locality of host	Habitat of parasite	Parasite	No. and sex of parasites	
					Male	Female
21. <i>Ceratophora stoddarti</i>	Female	Hakgala Gardens	—	—	—	—
22. »	Female	»	—	—	—	—
23. »	Female	»	—	—	—	—
24. »	Female	»	—	—	—	—
25. »	Male	Nuwara Eliya Park	—	—	—	—
26. »	Female	Nuwara Eliya	—	—	—	—

Table VII (b)

1. <i>Calotes nigrilabris</i>	Female	Horton Plains	Rectum	<i>Strongyluris calotis</i>	21	14
2. »	Male	Hakgala Gardens	»	»	5	2
3. »	Male	»	»	»	4	5
4. »	Male	Horton Plains	»	»	8	3
5. »	Male	»	»	»	5	4
6. »	Female	»	»	»	6	3
7. »	Female	»	»	»	8	2
8. »	Male	»	»	»	6	5
9. »	Male	»	Stomach	»	—	1
					numerous eggs and larvae.	
10. »	Male	»	Rectum	»	—	2
11. »	Female	»	»	»	15	9
12. »	Young male	»	—	—	—	—
13. »	Male	Nuwara Eliya Park	—	—	—	—
14. »	Female	»	—	—	—	—
15. »	Male	»	Stomach	<i>S. calotis</i> along with 1 <i>Cosmocercoides rickae</i>	—	1

and Nuwara Eliya Park, in July 1969. On one occasion, a solitary female specimen of the same parasite was collected from the stomach, along with larvae and eggs. On another occasion a mature female was collected from the stomach, along with a solitary male specimen of *Cosmocercoides rickae*. These infections in the stomach could have been accidental. All the collections however were made from freshly dissected hosts.

Details of all these collections are set out in Table VII (b).

Description :

The worms from *Calotes nigrilabris* are long and broad, with pointed posterior ends in the female and abruptly truncated posterior ends in the male.

The mouth is surrounded by 3 lips, each having a flange-like marginal extension of the cuticle. The cuticle is finely striated. Body papillae are absent. The neck is wider than the head, forming a « shoulder » behind the base of the lips (fig. 16). A second « shoulder » is formed a little further back by the commencement of a cuticular inflation which covers part of the pharyngeal and œsophageal regions. The pharynx is separated from the œsophagus by a constriction and a ventral kink in the lumen. The nerve ring is situated in the anterior half of the œsophageal region. The œsophagus enlarges into a bulb at its posterior extremity. The intestine is simple but it widens at its anterior end to meet the œsophagus. The excretory pore is situated behind the nerve ring and opens into an enlarged vesicle.

Male :

The tail of the male is typical, with a pre-anal sucker having a chitinous ring, and with 10 papillae and 2 spicules (fig. 17). There are 3 pairs of pre-anal papillae and 7 pairs of post-anal papillae, but in some males the arrangement is 4 pre-anal and 6 post-anal. The anteriormost pair of papillae are slender and small. The succeeding 3 pairs are very much larger, while the rest are small and either short and rounded or long and slender. The terminal end of each papilla has a prominent thickening. The spicules are strongly tessellated throughout their length (fig. 18). They are short and stout and equal in length.

Female :

The female tail tapers regularly and has a terminal spike. The vulva opens behind the middle of the body. Eggs are oval with smooth shells and vary greatly in size.

Discussion :

The worms described above, from *Calotes nigrilabris*, resemble in all respects *Strongyluris calotis* collected from the same host species by Baylis and Daubney in 1923. For purposes of comparison and for the completeness of the comparative data, detailed measurements of the male and female worms are given in Table VIII.

Table VIII. — Comparative data on *Strongyluris* spp.

	<i>S. chamaeleonis</i> (from <i>Chamaeleon</i> <i>vulgaris</i> , India) Baylis and Daubney, 1922		<i>S. chamaeleonis</i> (from <i>Cophotis ceylanica</i> , Ceylon)		<i>S. calotis</i> (from <i>Calotes</i> <i>nigrilabris</i> , Ceylon) Baylis and Daubney, 1923		<i>S. calotis</i> (from <i>Calotes</i> <i>nigrilabris</i> , Ceylon)	
	Male	Female	Male (5)	Female (12)	Male	Female	Male (5)	Female (10)
Body length	6.3	8.4-8.75	4.92-7.07	6.62-9.96	8.9-11.1	11.0-13.65	7.29-8.44	8.58-11.0
Body width	0.5-0.7	0.5-0.7	0.328-0.369	0.512-0.656	0.4-0.5	0.55-0.75	0.49-0.57	0.54-0.79
Head diameter . .	0.06	0.06	0.053	0.061-0.073	0.06-0.08	—	0.049-0.061	0.061-0.082
Pharynx length .	—	—	—	—	0.26-0.30	—	—	—
Œsophagus length	1.1	1.45	1.23-1.47	1.64-1.84	1.75-2.25	—	1.66-1.84	1.76-2.02
Bulb diameter . .	0.20	0.20-0.25	0.217-0.225	0.266-0.287	0.28-0.35	—	0.246-0.287	0.24-0.30
Nerve ring from anterior end . . .	—	—	0.6-0.64	—	—	—	0.6-0.62	0.6-0.62
Excretory pore from anterior end	—	—	0.90-0.92	0.90-0.92	—	—	0.75-0.78	0.75-0.78
Bursa width . . .	—	—	0.164-0.225	—	—	—	0.287-0.300	—
Spicule length . .	1.1	—	0.758-0.922	—	0.75-0.80	—	0.615-0.802	—
Sucker diameter .	0.09	—	0.082-0.102	—	0.14-0.17	—	0.102-0.143	—
Caudal papillae arrangement	3 pre-anal + 6 post-anal	—	4 pre-anal + 6 post-anal	—	3 pre-anal + 7 post-anal	—	3 pre-anal + 7 post-anal	—
Vulva from poste- rior end	—	3.3	—	2.96-3.23	—	4.7-5.65	—	4.7-4.98
Tail length	—	0.3	—	0.184-0.205	—	0.2-0.25	—	—
Egg dimensions .	—	0.0875 by 0.0550	—	0.0574-0.0820 by 0.0369-0.0410	—	0.0875-0.0975 by 0.0500-0.0525	—	0.0820-0.0860 by 0.0328-0.0491

Meteterakis longispiculata (Baylis, 1929)

(fig. 19 and 20)

Three female hump-nosed lizards, *Lyriocephalus scutatus*, were collected from Udawattekele (Kandy) on September 28, 1969, and one male on July 12, 1971. Each lizard was found to be infected with a species of *Meteterakis*. The parasites were collected from both small intestine and rectum. Table IX sets out the number of parasites collected from each host.

Table IX

Host (<i>Lyriocephalus scutatus</i>)	Total number of worms collected	Male worms	Female worms	Immature female worms
1. Female	159	51 (small intestine)	76 (s.i.)	32 (s.i.)
2. Female	20	—	—	20 (rectum)
3. Female	28	13 (s.i.)	15 (s.i.)	—
4. Male	575	120 (r)	190 (r)	265 (s.i.)

Description :

The worms are short and stout with a distinct ventrally curved tail in the male. The anterior end has the typical structure of a heterakid, with three distinct lips and a cuticular flange projecting anterior to the mass of the lip. Each lip is provided with a pharyngeal tooth and an amphid.

The mouth leads into a distinct pharynx which is followed by a long, narrow muscular œsophagus ending in a pear-shaped posterior bulb. The post-œsophageal bulb is entirely muscular and is valvulated. The nerve ring encircles the narrow part of the œsophagus anterior to the excretory pore. This pore lies on the ventral surface and opens into a characteristic, large, lobulate excretory vesicle, which displaces dorsally the posterior section of the œsophagus (fig. 19).

The intestine is swollen at its anterior end, where it meets the œsophagus, and at this point it is wider than the post-œsophageal bulb.

Male :

The tail is curved ventrally, and has narrow caudal alae, each supported by 3 large fleshy papillae (fig. 20). The sucker is relatively small and there are 8 pairs of small sessile papillae anterior to it, and 3 pairs at the posterior end of the tail. The tail ends in a sharply pointed terminal spike.

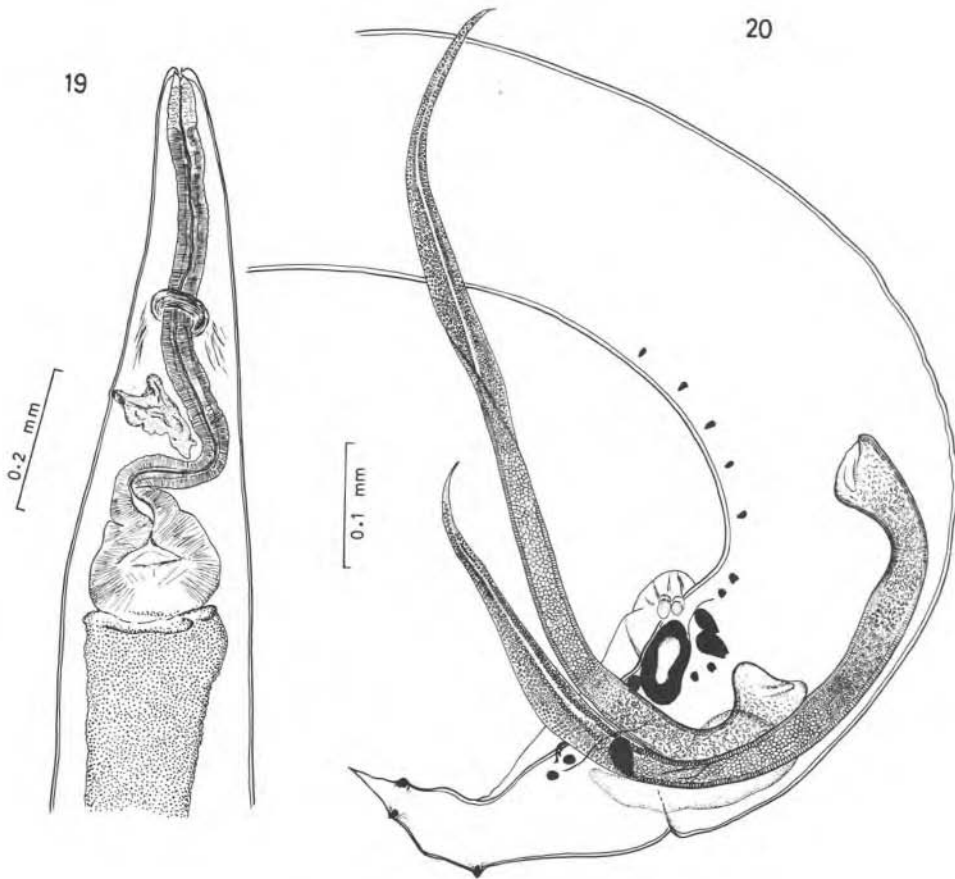


FIG. 19-20. — *Meteterakis longispiculata*.

The spicules are large, equal and similar in form and structure, with the anterior end strongly curved ventrally. They are tessellated for their entire length. The gubernaculum is very prominent.

Female :

The vulva opens on the ventral surface, about the middle of the body, and is covered by a prominent flap developed from the anterior lip. The eggs are oval and thin-shelled. The tail is long and pointed.

The various measurements of both male and female worms are set out in Table X.

Discussion :

Baylis and Daubney (1923) recorded a few immature specimens of a nematode from the duodenum of (?) *Lyriocephalus scutatus*, which nematode they identified as

Table X. — Measurements of *Meteterakis longispiculata*

	Male (12)	Female (11)
Body length	3.485-5.710	3.997-6.20
Body width	0.163-0.266	0.246-0.348
Head diameter	0.041-0.061	0.053-0.061
Pharynx length	0.049-0.061	0.053-0.061
Œsophagus length	0.502-0.902	0.635-1.004
Bulb dimensions	0.121-0.164	0.164-0.205
	by	by
	0.131-0.164	0.151-0.196
Nerve ring from anterior end	0.278-0.307	0.246-0.328
Excretory pore from anterior end ..	0.410-0.512	0.369-0.574
Sucker diameter	0.041-0.061	—
Distance from sucker to cloaca ...	0.041-0.061	—
Spicule length	0.553-0.799	—
Vulva from anterior end	—	1.414-2.50
Tail length	0.205-0.287	0.287-0.490
Egg dimensions	—	0.0410-0.0779
		by
		0.0240-0.0430

a *Spinicauda* sp. They were unable to determine the species. According to Inglis (1958) « it is very probable that these actually represent a *Meteterakis* sp. probably *M. cophotis* of which *L. scutatus* is a known host ».

Baylis (1935) subsequently described *Spinicauda cophotis* from both *Cophotis ceylanica* and *Lyriocephalus scutatus* taken at Gammaduwa, Ceylon. He noted that the specimens from *C. ceylanica* were slightly larger than those from *L. scutatus*. Inglis (1958) put this species, *S. cophotis*, into the genus *Meteterakis*.

The form described here differs markedly from *M. cophotis* in body and egg-measurements, being about half the size of *M. cophotis* in these respects, although the host, *Lyriocephalus scutatus*, is a very much larger lizard than *Cophotis ceylanica*.

An important datum that appears to be lacking in previous accounts is the total number of worms found to infest each host specimen. If this had been recorded one could have looked for some correlation between the number of worms and their size.

The fact that Baylis (1935) found *M. cophotis* in both *Cophotis ceylanica* and *Lyriocephalus scutatus*, in the same locality, is strong evidence that the present forms too are of the same species, despite differences in body measurements, which may be a function of population size or due to hostal influences.

The absence of the cap-like structure at the tip of the spicules, in the present form, clearly differentiates it from *M. baylisi*. However, in the size and structure of its spicules it comes close to *M. longispiculata*, which differs from *M. cophotis* essen-

tially in having strongly tessellated alae, which in *M. cophotis* were found to be poorly cuticularised (Inglis, 1958). The spicules of *M. longispiculata* and *M. cophotis* are stated by Inglis to be in all other respects identical, while the difference in the alae « is most probably due only to variation within one species ». Like Baylis, Inglis preferred to treat *M. cophotis* as distinct from *M. longispiculata* until more material was available for study. The present material should help considerably in settling this question. *M. cophotis*, *M. longispiculata* and the present form have hardly any differences except those of body-measurements and egg size to warrant their recognition as three separate species (*vide* Table XI). They are therefore considered to be conspecific, all belonging to the species *Meteterakis longispiculata* (Baylis, 1929).

It is interesting to note that *Meteterakis longispiculata* was described from the intestine of *Gecko gecko* in Samarang, Java. In all probability this nematode species originated early and had a wide distribution, and is now represented in Ceylon and the Malaysian region in the Geckoninae and Lyriocephalinae, the latter being essentially a relict subfamily of agamid lizards confined almost entirely to Ceylon, but represented also in Sumatra and Java by the species *Cophotis sumatrana*.

Meteterakis baylisi Inglis, 1958

Twelve male and 12 female horn-nosed lizards (*Ceratophora stoddarti*) collected on the Horton Plains and in Nuwara Eliya and Hakgala in July 1968 and July 1969, yielded a total of 334 specimens of *Meteterakis baylisi*, comprising 119 males and 156 females from the host's rectum and 59 immature females from the small intestine. The worms correspond in all respects with the species described by Inglis (1958). Hence no detailed measurements or figures are provided here.

M. baylisi is a well established species, which appears to be confined to Ceylon in relict mountain lizards.

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Table XI. — Comparative data on *Meteterakis* spp.

	<i>Meteterakis baylisi</i> (vide: Inglis, 1958)		<i>Meteterakis cophotis</i> (vide: Inglis, 1958)		<i>Meteterakis longispiculata</i> (vide: Inglis, 1958)		<i>Meteterakis longispiculata</i> (Present study)	
	Male (4)	Female (5)	Male (7)	Female (8)	Male (3)	Female (3)	Male (12)	Female (11)
Body length	3.0-3.7	3.6-4.2	6.4-8.0	7.3-9.0	7.0-7.5	7.5-7.8	3.48-5.71	3.99-6.20
Body width	0.21-0.28	0.24-0.31	0.35-0.37	0.24-0.37	0.28-0.35	0.30-0.39	0.163-0.267	0.246-0.348
Spicule length . . .	0.42-0.45	—	0.64-0.81	—	0.63-0.68	—	0.553-0.799	—
Nature of spicule	Tessellated throughout, excluding alae. Caplike structure at tip of spicules.	—	Tessellated throughout, excluding alae.	—	Strongly tessellated throughout, including alae.	—	Strongly tessellated throughout, including alae.	—
Vulva from anterior end	—	1.7-2.2	—	3.0-4.3	—	3.0-3.5	—	1.41-2.50
Egg dimensions	—	0.0580-0.0640 by 0.0370-0.0420	—	0.0580-0.0760 by 0.0420-0.0480	—	0.0730-0.0840 by 0.0440-0.0480	—	0.0410-0.0779 by 0.0240-0.0430
								One female, reported by Baylis (1929), has eggs as large as 0.1125 by 0.1155

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