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Proceedings of the Helminthological Society of Washington

VOLUME 32 JULY 1965 NUMBER 2

A New Nematode, *Pharyngodon boulengerula*, from the Caecilian *Boulengerula uluguruensis*[1]

JOHN E. UBELAKER[2]

A study of the helminths of caecilians from different parts of the world resulted in the collection of a number of trematodes and nematodes, most of which were previously described from caecilians and other hosts. In addition to the nematodes previously described, specimens of an undescribed species of *Pharyngodon* Diesing, 1861, were obtained from the caecilian *Boulengerula uluguruensis*, collected in Tanganyika.

The genus *Pharyngodon* was established by Diesing with *P. spinicauda* (Dujardin, 1845) (syn. *Ascaris acanthura* Diesing, 1851) as the type from the intestine of a lizard, *Lacerta muralis* taken on St. Malo. Presently, the genus contains 41 species—six from amphibians and 35 from reptiles.

METHODS

The nematodes were prepared for study using the method outlined by Cable (1963). The parasites were studied with phase-contrast microscopes. All measurements are taken from ten specimens selected as being mature, and are expressed in millimeters. In each case the mean is followed by the range in parentheses.

Pharyngodon boulengerula n. sp. (Figs. 1, 2)

SPECIFIC DIAGNOSIS: With the characters of the genus, male unknown; female 1.80 (1.39–1.98) long by 0.33 (0.26–0.37) wide; anterior end with distinct annulations which increase in width posteriorly until indistinct, all annulations divided into incomplete secondary annuli; six lateral alae present, extending from anterior end, along length of body, terminating posteriorly at level of anus; mouth surrounded by three lips; buccal cavity absent; esophagus 0.28 (0.27–0.29) terminating in posterior bulb 0.118 (0.11–0.12) wide by 0.09 (0.09–0.09) long, projecting into intestine; intestine cylindrical throughout length; anus 0.44 (0.37–0.51) from anterior end; tail tapered to subulate process 0.34 (0.31–0.37) in length; ten papillae present along subulate process; vulva in posterior part of body 0.85 (0.78–1.02) from anterior end, and 1.00 (0.85–1.09) from posterior end slightly extensable; nerve ring not visible; excretory pore 0.28 (0.20–0.36) from anterior end; uterine eggs fusiform 0.127 (0.126–0.129) long by 0.07 (0.07–0.07) wide, unsegmented and lacking oval plugs.

HOST: *Boulengerula uluguruensis*.

SITE OF INFECTION: Upper small intestine.

TYPE LOCALITY: Vituri, Uluguru Mountains, Tanganyika.

TYPE SPECIMEN: Deposited in U.S. National Museum Helminthological collection, Catalogue number 60042.

COMPARISONS: *Pharyngodon boulengerula* differs from all other species in the genus *Pharyngodon* by possessing six lateral alae while other species have either none, two, or four alae surrounding the body. Furthermore, the worms described here are smaller than any known species in the genus.

P. papillocauda Hannum, 1952, parasitic in the whip-tailed lizard, *Cnemidophorus gulae* from Arizona, is the only other member of the genus in which the female possesses papillae on the tail. *P. boulengerula* differs from *P. papillocauda* not only in being smaller and

[1] Adapted from a thesis done under the supervision of Professor William H. Coil and presented to the Graduate school of The University of Kansas in partial fulfillment of the requirement of the degree of Master of Science.

The author is indebted to Professor Emeritus Edward H. Taylor, Department of Zoology, The University of Kansas, for providing the caecilians for study.

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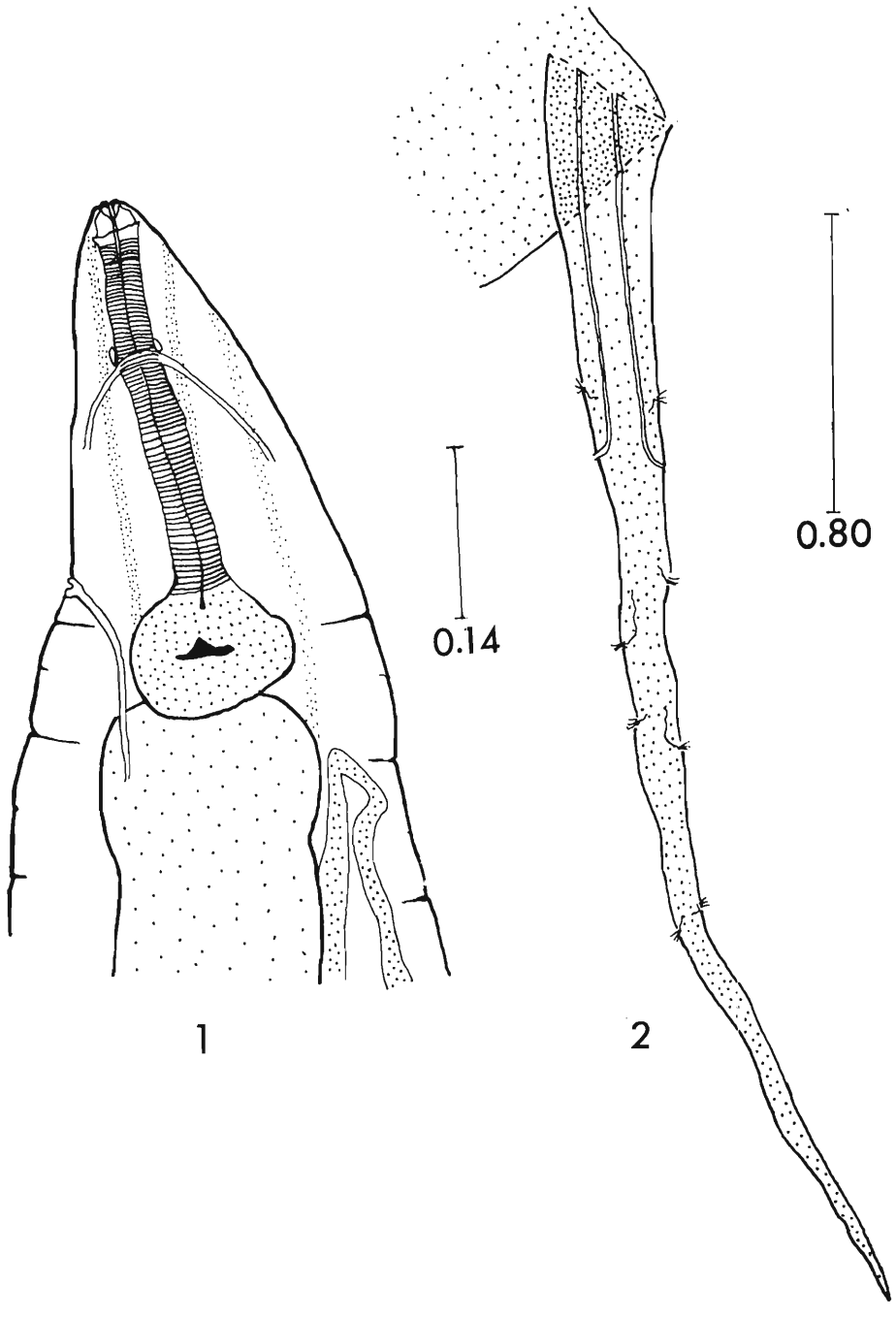

Fig. 1. *Pharyngodon boulengerula* n. sp. Anterior region of female, lateral view.

Fig. 2. *Pharyngodon boulengerula* n. sp. Filiform portion of tail, dorsal view.

possessing the additional alae but also in possessing an elongate filiform tail.

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Stictodora lariformicola n. sp. (Trematoda : Heterophyidae) from Floridian Piscivorous Birds

FRANKLIN SOGANDARES-BERNAL AND DAN WELLS WALTON[1]

Cable, Conner, and Balling (1960) reported, pictured, and partially described an unidentified species of *Stictodora* from a royal tern, *Thalasseus maximus* (Bod.), from Puerto Rico. Their material was contracted and the uterus was filled with eggs which obscured certain internal structures, making a specific identification impossible.

We have collected a new species of *Stictodora*, which seems identical with that reported as *Strictodora* sp. by Cable *et al.* (1960), from Floridian *Larus argentatus* Pont., *L. atricilla* Linn., *L. delawarensis* Ord., and *T. maximus* (Bod.). This new species is named and described below. All measurements are in millimeters.

Stictodora lariformicola n. sp. (Figs. 1, 2)

HOSTS: *Larus argentatus* Pontoppidan (herring gull); *L. atricilla Linn.* (laughing gull); *L. delawarensis* Ordmann (ring-billed gull), type host; and *Thalasseus maximus* (Boddaert) (royal tern).

LOCATION: Rectum of all hosts.

LOCALITY: St. Petersburg, Florida.

HOLOTYPE: U.S.N.M. Helm. Coll. No. 61094.

DIAGNOSIS (based upon four specimens from *L. delawarensis*): *Stictodora.* Body elongate, linguiform, 0.991 to 1.381 long by 0.538 to 0.637 wide. Forebody 0.422 to 0.673 long. Cuticle completely spined. Cuticular spines large and close-set in anterior two-thirds of body, becoming smaller and thinly distributed in posterior one-third of body. "Eyespots" present in anterior one-sixth of body. Oral sucker subterminal, with median longitudinal aperture; 0.166 to 0.218 long by 0.154 to 0.192 wide. Prepharynx about one-fifth the length of oral sucker. Pharynx elongate or roundish in shape, 0.051 to 0.090 long by 0.038 to 0.064 wide. Esophagus from almost absent to about one-half the length of pharynx. Ceca two, extending laterally from esophagus, one on each side of body, abruptly bending towards posterior end of body, winding a tortuous course to end blindly in about posterior one-third of body. Ventrogenital pore slightly dextral to midline of body about at equator. Ventrogenital sac densely surrounded by glandular cells, containing mesial and posteriorly directed acetabulum and sinistrolateral gonotyl. Acetabulum with protrusible lobes which may extend through ventrogenital pore; lateralmost ventral borders of acetabular lobes lamelliform. Gonotyl muscular, variable in shape, usually doughnut-shaped, bearing trident armature of which terminal three tips end as spines. Genital atrium short, muscular, partially surrounded by prostate gland cells at its distal tip perforating ventrogenital sac on mid-sinistral side lateral to gonotyl. Testes two, immediately postequatorial, usually side by side, sometimes slightly oblique, oval in shape with smooth edges; right testis 0.148 to 0.205 long by 0.128 to 0.179 wide; left testis 0.141 to 0.166 long by 0.128 to 0.166 wide. External seminal vesicle sacculate, anterior or dorsal to ventrogenital sac, extending transversely from midline of body to enter genital atrium *via* what appears to be a prostatic vesicle which is not clearly observable due to gland cells surrounding it. Ovary usually mesial and equatorial, sometimes

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We would like to express our appreciation to Professor R. M. Cable, Purdue University, for confirmation of our interpretation of the terminal genitalia of our material.

displaced to left of midline of body, sometimes partially overlapping posterior tip of ventrogenital sac dorsally, oval or roundish in shape, 0.090 to 0.115 long by 0.098 to 0.115 wide. Seminal receptacle between ovary and dextral testis, saccular in shape. Vitellaria follicular, restricted to posttesticular space, sometimes overlapping posterior border of testes in contracted specimens. Vitelline reservoir intertesticular. Uterus filling posttesticular space, extending anteriorly into forebody to fill intercecal space, partially overlapping ceca, ending in genital atrium. Uterine eggs operculate, 0.022 to 0.028 long by 0.011 to 0.014 wide. Excretory vesicle not clearly observed, seems to extend to posterior border of testes.

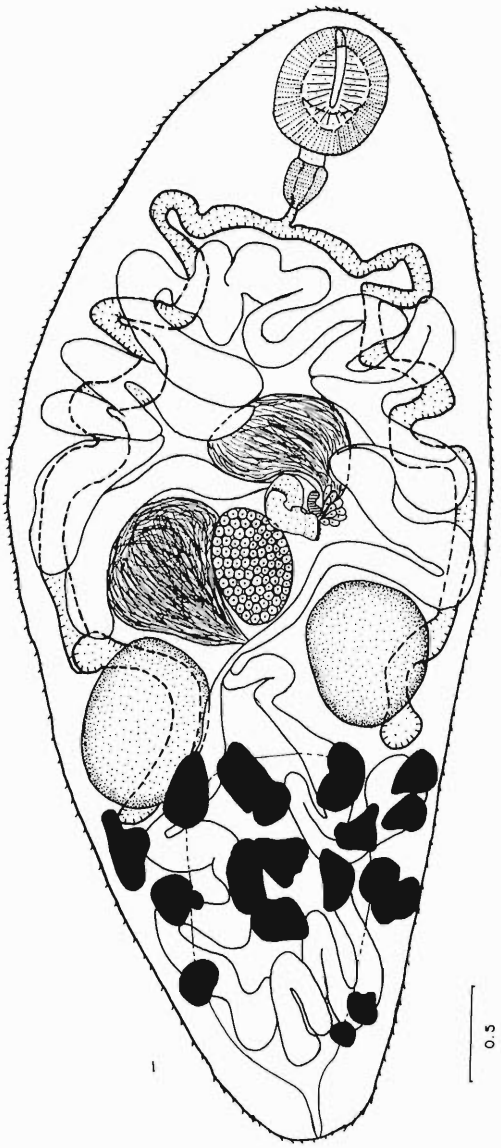

Fig. 1. *Stictodora lariformicola* from *Larus delawarensis*. Ventral view. The projected scale has its value indicated in millimeters.

DISCUSSION: The name *lariformicola* is to indicate that this species lives in lariform birds.

Yamaguti (1958) has listed the species in the genus *Stictodora*. To his list must be added S. (S.) *caballeroi* Martin, 1955, and S. (*P.*) *martini* Sogandares, 1959. Cable *et al.* (1960) have, following Martin (1950) and Witenberg (1953), suggested that *Acanthotrema acanthotrema* Travassos, 1928, should also be included in the genus *Stictodora*. For the present time we shall follow Martin (1950) and the others cited above in accepting the name *Stictodora acanthotrema* (Travassos, 1928) Martin, 1950. However, we recognize that there are several species groups in *Stictodora*, based on acetabular and gonotylar structure, which may well be regarded as subgenera or genera. Our concept of this genus of trematodes will doubtless need to be revised in the future. We have not attempted such a revision here since many of the species descriptions are

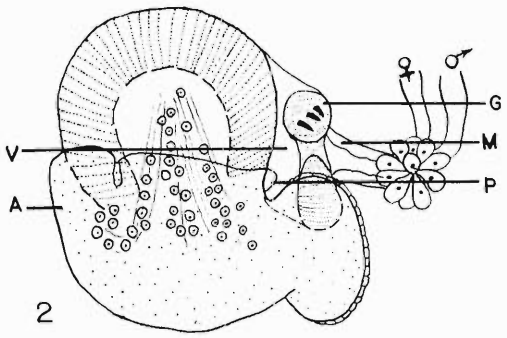

Fig. 2. *Stictodora lariformicola* from *Larus delawarensis*. Composite sketch of terminal genitalia with acetabulum protruded. A is acetabulum, G is gonotyl, M is genital atrium, V is ventrogenital sac, and P is ventrogenital pore.

Table 1. Measurements of *Stictodora lariformicola* from different hosts.

Structures	Hosts				Total ranges (16 specimens)
	L. argentatus (1 specimen)	*L. atricilla* (3 specimens)	*L. delawarensis* (4 specimens)	*Thalasseus maximus* (8 specimens)	
Body length	1.345	0.956–1.133	0.991–1.381	0.850–1.239	0.850–1.345
width	0.531	0.460–0.566	0.538–0.637	0.390–0.460	0.390–0.637
Forebody length	0.614	0.410–0.550	0.422–0.637	0.390–0.460	0.390–0.637
Oral Sucker length	0.218	0.205–0.230	0.166–0.218	0.154–0.179	0.154–0.230
width	0.128	0.166–0.205	0.154–0.192	0.128–0.154	0.128–0.205
Pharynx length	0.077	0.064–0.090	0.051–0.090	0.051–0.090	0.051–0.090
width	0.064	0.064–0.090	0.038–0.064	0.051–0.090	0.038–0.090
Rt. testis length	0.192	0.128–0.154	0.148–0.205	0.102–0.179	0.102–0.192
width	0.179	0.128–0.154	0.128–0.179	0.102–0.192	0.102–0.192
Lft. testis length	0.192	0.102–0.166	0.141–0.166	0.089–0.154	0.089–0.192
width	0.153	0.115–0.166	0.128–0.166	0.077–0.154	0.077–0.166
Ovary length	0.102	0.064–0.090	0.090–0.115	0.064–0.090	0.064–0.115
width	0.115	0.090–0.090	0.098–0.115	0.051–0.090	0.051–0.115
Egg length	0.022–0.028	0.022–0.028	0.022–0.028	0.022–0.028	0.022–0.028
width	0.011–0.014	0.011–0.014*	0.011–0.014	0.011–0.014	0.011–0.014

* One grossly misshapen egg measured 0.028 long by 0.020 wide.

inadequate and specimens are not presently available for study. *Stictodora lariformicola* seems to differ from other known species of the genus primarily by possessing an acetabulum which is bilobed when protruded.

To avoid possible taxonomic problems in the future, if a parasite is found in more than one host, it is usually wise to base the original description on material from one host species. Accordingly, the description of *S. lariformicola* is based upon material from the type host only. Table 1 presents comparative measurements of specimens identified as *S. lariformicola* from different hosts in Florida.

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Anguina agropyronifloris n. sp., Infecting Florets of *Agropyron smithii*

DON C. NORTON[1]

Nematodes of the genus *Anguina* are, as far as is known, obligate parasites which produce galls in the foliage and inflorescences of many plants. Of the species which form seed galls, two are well known in the United States. These are *Aguina agrostis* (Steinbuch, 1799) Filipjev, 1936 and *A. tritici* (Steinbuch, 1799) Filipjev, 1936.

Steinbuch (1799) first described the nematodes occurring in the inflorescences of *Agrostis capillaris* L., *Phalaris phleoides vivipara* (= *Phleum Böhmeri*), and *Triticum aestivum* L. as *Vibrio agrostis*, *V. phalaridis*, and *V. tritici*, respectively. Opinions differed for well over a century as to whether or not these were one or two distinct species. It was not until the work of Goodey (1930) that the distinctiveness of *Tylenchus agrostis* (= *Anguina agrostis*) and *T. tritici* (= *A. tritici*) became clearer. Goodey (1930) questioned the validity of *Tylenchus phalaridis* and later (1932) made it a synonym of what is now called *A. agrostis*. Many workers, including Byars (1920), Byars, Johnson, and Leukel (1919), Courtney and Howell (1952), Henslow (1841), Leukel (1924), Marcinowski (1910), Roffredi (1776), and Steinbuch (1799) looked for what we now know as *A. agrostis* or *A. tritici* on plants other than *Agrostis* and *Triticum*, but they made no mention that any species of *Agropyron* was included in their observations or tests. Bessey (1905) found nematodes in seed galls on *Agropyron* but reported no attempts to transfer the nematodes to other plants.

Seed galls caused by unknown species of *Anguina* have been reported as occurring on *Agropyron* by Bessey (1905), Morrison (1957) on *A. scabrum* Beauv., and Norton and Everson (1963) on *A. smithii* Rydb. Molliard (1904) described leaf galls caused by nematodes on *Agropyron repens* (L.) Beauv. and nematode galls have also been reported on *A. trachycaulum* (Link) Malte (U.S. Dept. Agr., 1960). Kirjanova (1955) reported that *Paranguina agropyri* Kirjanova, 1955 caused the enlargements at the base of the stem of *A. repens*.

Nematode seed galls on western wheatgrass (*Agropyron smithii*) have been observed by seed analysts at the Iowa State University Seed Laboratory for at least 15 years. The galls are usually reddish brown, elongated, and about twice as long and half as wide as healthy seed (Norton and Everson, 1963). Morphological and biological studies have indicated that this nematode from western wheatgrass is different from other forms in *Anguina* and is described herein as a new species of the genus.

Anguina agropyronifloris n. sp.

MEASUREMENTS: FEMALES (15): Length 3.52 mm (2.66–4.15); a = 26 (22–31); b = 20 (15–24); c = 41 (28–47); $V = {}^{85}91.8^{3.2}$ ($^{82\text{-}88}89.9\text{–}93.0^{2.9\text{-}3.6}$); stylet 10 μ (10–11). MALES (7): Length 1.78 mm (1.68–1.94); a = 23.0 (18.3–29.1); b = 9.3 (8.2–10.1); c = 22.2 (20.0–24.1); T = 77.4 (75.1–80.6); stylet 10 μ (10–11).

HOLOTYPE (male): Length 1.68 mm; a = 23.0; b = 9.1; c = 21.5; T = 78.6; stylet 10 μ.

ALLOTYPE (female): Length 3.61 mm; a = 23.2; b = 23.4; c = 34.7; $V = {}^{83}91.4^{2.9}$; stylet 10 μ.

DESCRIPTION: FEMALE: Fig. 1C, D, E. Body obese, typically in spiral coil. Fine transverse striae usually visible only on neck. Deirids and phasmids not observed. Lip region set off bearing two annules. Spear small with well-developed knobs. Dorsal esophogeal gland orifice 1–2 μ behind base of stylet. Median esophageal bulb tapering more posteriorly than anteriorly. Valvular apparatus located slightly anterior to median region of bulb. Isthmus often swollen with nerve ring at base of isthmus. Posterior to the nerve ring is an organ, usually pyriform in shape and presumably used for storage or esophageal secretions (Thorne, 1949). Basal esophageal lobes irregular but with the anterior ends usually partially enveloping the storage organ. Excretory pore usually near or posterior to base of storage organ but always posterior to nerve ring. Ovary prodelphic and reflexed once or twice. Oocytes in multiple rows arranged about a rachis (Fig. 1D). Cap cell at terminus of gonad (Fig.

[1] Department of Botany and Plant Pathology, Iowa State University, Ames. Journal Paper No. J-5044, of the Iowa Agricultural and Home Economics Experiment Station, Ames; Project No. 1337. Appreciation is expressed to Dr. A. M. Golden for his helpful assistance during this investigation.

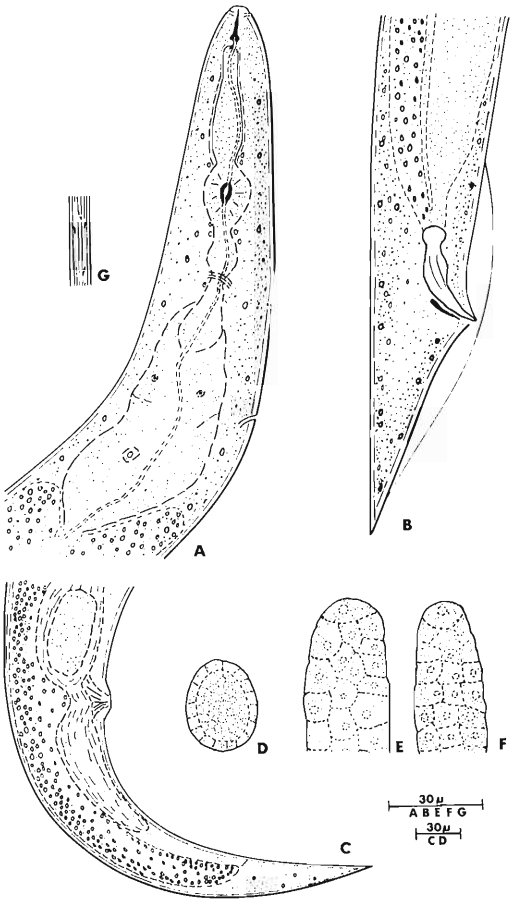

Fig. 1. *Anguina agropyronifloris* n. sp. A—Anterior end of male, B—Posterior end of male, C—Posterior end of female, D—Cross section of ovary, E—Terminal end of ovary, F—Terminal end of testis, G—Lateral field.

1E). Spermatheca present but often obscure in mature preserved specimens. Several eggs may be in the oviduct at one time. Eggs 66–70 $\mu \times$ 30–32 μ. Posterior uterine branch present. MALE: Fig. 1A, B, F, G. Similar to female. Lateral fields indistinct, consisting of many minute incisures, variable in number but eight to ten seen with these sometimes merging (Fig. 1G). Testes with one flexure, the spermatocytes arranged about a rachis. Spicules arcuate, broad, 33–36 μ long. Gubernaculum trough-shape appearing larger at the anterior end, 12–14 μ long. Bursae enveloping tail or nearly so.

DIAGNOSIS: *Anguina agropyronifloris* appears to be most closely related to *A. agrostis* and *A. tritici*, with some characters intermediate between the two. *Anguina* with eight to ten lateral lines, usually with a well-defined storage organ in adults. Distinguished from *A. tritici* by the generally less massive and more pyriform storage organ and by the less robust spicules (Fig. 2). It is distinguished from *A. agrostis* by the larger spicules, by the trough-shaped gubernaculum with the more expanded anterior portion instead of a linear gubernaculum, and by the presence of eight to ten lines in the lateral field as compared with six in *A. agrostis*. It is distinguished from *A. microlaenae* (Fawcett, 1938) Steiner, 1940, by the presence of the storage organ, by a distinct median esophageal bulb as compared with an indistinct one in *A. microlaenae*.

An expanded isthmus has also been reported in *A. amsinkia* (Steiner and Scott, 1935) Thorne, 1961 (Thorne, 1961), and *A. millefolii* (Löw, 1874) Filipjev, 1936 by Thorne in 1961. In addition to an expanded isthmus, *A. agropyronifloris* and *A. tritici* have a distinct larger storage organ posterior to the nerve ring, according to Thorne (1961). *A. agropyronifloris* also differs from *A. amsinkia*, *A. balsamophila* (Thorne, 1926) Filipjev, 1936, and *A. millefolii* by the stouter spicules and gubernaculum.

To the writer's knowledge, *Anguina agrostis* has never been reported to possess a storage organ. In recent work, Mulvey (1963) did not depict one in *A. agrostis* collected in Canada. Examination of *A. agrostis* specimens from Oregon, housed in the Nematology Collection, Beltsville, Maryland, revealed a well-defined storage organ, which is best seen in the better preserved material. This organ is similar to that in *A. agropyronifloris* both in shape and in that it is partially enclosed by the anterior portion of the basal esophageal bulb.

HOLOTYPE (male): Obtained by inoculation of *Agropyron smithii*, in the greenhouse, with juveniles received in western wheatgrass galls from either Phillips or Valley counties, Montana in 1962. Slide T54t, United States Department of Agriculture Nematode Collection, Beltsville, Maryland.

ALLOTYPE (female): From same inflorescence as holotype. Slide T-55t, United States Department of Agriculture Nematode Collection, Beltsville, Maryland.

PARATYPES (6 males and 14 females): From same inflorescence as holotype. Slides T-289p–T-307p, United States Department of Agriculture Nematode Collection, Beltsville, Maryland.

TYPE HABIT, HOST, AND LOCALITY: Floret galls in inflorescence of *Agropyron smithii*; obtained by inoculation, in the greenhouse with juveniles received in seed galls from *A. smithii* from either Phillips or Valley counties, Montana.

As is well known, many species of *Anguina* are difficult to preserve. Because of better preservation and the value of the spicules and gubernaculum as diagnostic characters, a male was made holotype.

Since nematodes in mature seed galls, as found in seed lots, are mostly juveniles, with sometimes eggs or occasionally a degenerate adult, all adults used in the present study were obtained by inoculation. This was done in the greenhouse by planting seed in infested soil or by placing juveniles next to seed germinated 1 day in sterilized soil. Infection was not always obtained, but invariably where successful, the infected florets headed about 2 months after inoculation of the germinated seed, while the noninoculated controls never headed, even after being kept in the greenhouse for periods up to a year. This indicates that in some way *A. agropyronifloris* causes an initiation of the inflorescence.

It was also apparent that the number of adults in a floret varied considerably. There were either two to four adults in each floret, or there were over 40. In the most successful infections, two to four adults were found in each floret. In these cases, one or two adults of each sex were found in every infected floret. Every floret in an inflorescence was not infected, however. Using the 35 adults obtained from the inflorescence from which the type material was taken, the average number per sex per infected floret was 1.6 females: 1.4 males. There were no more than two individuals of each sex in any floret in the type material. In cases where many adults developed in a floret, a maximum of 73 females and eight males were found in any infected floret.

The comparative dimensions of adults where two to four or many adults were in a floret are presented in Table 1. Where many adults were in a floret, the females were shorter, the esophagus and tails were comparatively longer, and the vulva was further forward than on specimens where two to four adults were in a floret. There was little difference in the "a" value between the two groups of nematodes. Fewer observations were made on the males where many adults occurred in a floret, but those observed were shorter and had comparatively longer tails (smaller "c") than those in florets containing two to four adults.

The possibility that there might be two species of nematodes involved was considered. Since the differences of body size are probably determined by the amount of food available to

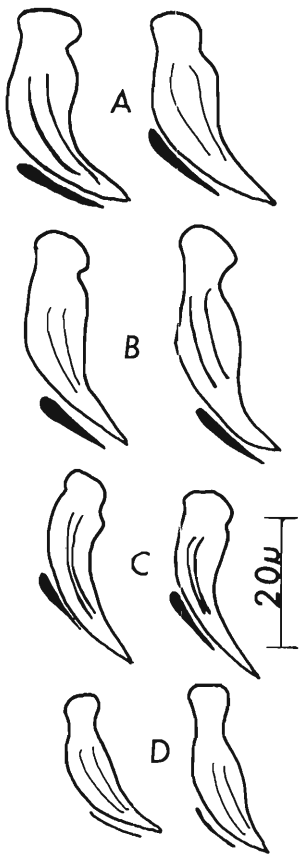

Fig. 2. Spicules and gubernacula of (A) *Anguina tritici* from wheat from Georgia, (B) *A. agropyronifloris* from florets with two to four adults, (C) *A. agropyronifloris* from florets with many adults, and (D) *A. agrostis* from *Agrostis tenuis* from Oregon.

Table 1. Length, a, b, c, and V values of *Aguina agropyronifloris* from florets with many or with two to four adults. Average in parentheses.

Adults in floret	Number of observations	Length mm	a	b	c	V
				Female		
Many	16	1.17–1.98 (1.61)	18–31 (23.8)	8.2–14.1 (10.5)	17.8–26.0 (22.8)	80.8–90.3 (86.8)
2–4	20	2.66–4.15 (3.54)	22–31 (25.3)	15–24 (19.9)	28–52 (43)	89.9–94.8 (91.9)
				Male		
Many	4	1.07–1.90 (1.34)	26.7–31.3 (29.0)	8.92–9.61 (9.26)	13.4–15.6 (14.5)	
2–4	14	1.42–2.09 (1.67)	18.3–33.0 (25.5)	8.2–11.0 (9.8)	21.0–27.0 (25.0)	

each individual (if feeding occurs) and because of the pressures of the developing internal organs and the resulting change in body shapes, some of the traditional de Man criteria are probably not valid for nematodes of this type, as has been pointed out by Thorne (1961). This is also true for the number of flexures in a gonad. Where many adults were in a floret, the gonad was sometimes largely outstretched and often terminated in the region of the median esophageal bulb. The presence of a storage organ, the shape of the spicules and gubernacula were similar in both sets of nematodes. The spicules and gubernacula of *A. agropyronifloris*, *A. agrostis* and *A. tritici* are compared in Figure 2.

Egg production: It is well known that the egg-producing capacity of *Anguina* is prodigious. One large female of *A. agropyronifloris* was observed to lay 245 eggs over a 24-hr period. The eggs laid per hour ranged from three to 15, with an average of 10.2 per hr. The eggs were often catenulate, up to five eggs being observed in a chain after being laid, a phenomenon observed by Bauer (1823) for *A. tritici*.

Hosts: *Agropyron smithii* was the only plant in which successful infection was obtained in the greenhouse. Inoculations were made by placing approximately 1,000 juveniles around each seed. Other plants in which inoculations were made at least twice, using at least 15 plants per test, with negative results, were, *Festuca rubra* L. (creeping red fescue), *F. rubra* var *commutata* Gaud. (Chewings fescue), *Poa pratensis* L., *Agropyron trachycaulum*, *Triticum aestivum*, *Secale cereale* L., *Hordeum vulgare* L., *Agrostis tenuis* Sibth., and *Phleum pratense* L. *Anguina agrostis* was inoculated on western wheatgrass but with negative results.

One phenomenon was very striking. When dried galls containing *A. agrostis* and *A. tenuis* were broken in water, the emerging juveniles were predominantly coiled, while those of *A. agropyronifloris* from western wheatgrass were predominantly outstretched or nearly so.

A. agropyronifloris has been collected from western wheatgrass samples from seed dealers from nearly all midwestern states from Iowa to the Rocky Mountains. Field infestations, however, have been traced only to Kansas (Gove County), Montana (Phillips or Valley counties), and South Dakota. The exact locations of the fields are unknown.

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Oostenbrinkella oostenbrinki n. gen., n. sp. (Nematoda : Leptonchidae) from the Soil around the Roots of the Jacktree

M. SHAMIM JAIRAJPURI[1]

A large number of specimens of *Oostenbrinkella oostenbrinki*[2] n. gen., n. sp., were found in soil samples from around roots of jacktree, *Artocarpus integrifolia* L. from Andamans, India.

GENUS *Oostenbrinkella* n. gen.

DIAGNOSIS: Leptonchidae. Head provided with a labial disc. Spear attenuated. Spear extensions broadly flanged. Guiding ring single. Esophagus a slender tube with a short basal bulb. Vulva transverse, preequatorial; posterior sexual branch normal, anterior rudimentary; ovary reflexed. Testes and spicules dorylaimoid. Only an adanal pair of supplements present; ventromedians absent. Lateral guiding pieces present. Tail of sexes similar, long, and filiform.

TYPE AND ONLY SPECIES: *Oostenbrinkella oostenbrinki* n. sp.

RELATIONSHIP: The subfamily Xiphinemellinae Jairajpuri, 1964 includes only two genera, *Xiphinemella* Loos, 1950 and *Botalium* Heyns, 1963. *Oostenbrinkella* n. gen. differs from both of them in having a single guiding ring; basal bulb of esophagus not set off from the anterior slender part; vulva preequatorial; only posterior sexual branch normal, anterior rudimentary (opisthodelphic type of reproductive organs); ventromedian supplements absent and tail long and filiform. *Oostenbrinkella* also has many affinities with *Doryllium* Cobb, 1920 of the subfamily Tylencholaimellinae Jairajpuri, 1964 but differs in having attenuated spear, nature of spear extensions, basal bulb not set off and ventromedian supplements absent.

Oostenbrinkella oostenbrinki n. sp.

(Fig. 1, A–F)

FEMALES (10): L = 1.00–1.35 mm; a = 45–53; b = 7.0–7.6; c = 4.9–6.2; V = 24–27.

MALES (10): L = 0.98–1.30 mm; a = 50–54; b = 6.1–7.2; c = 4.6–5.2.

HOLOTYPE (female): L = 1.3 mm; a = 49; b = 7.3; c = 5.2; V = 26.

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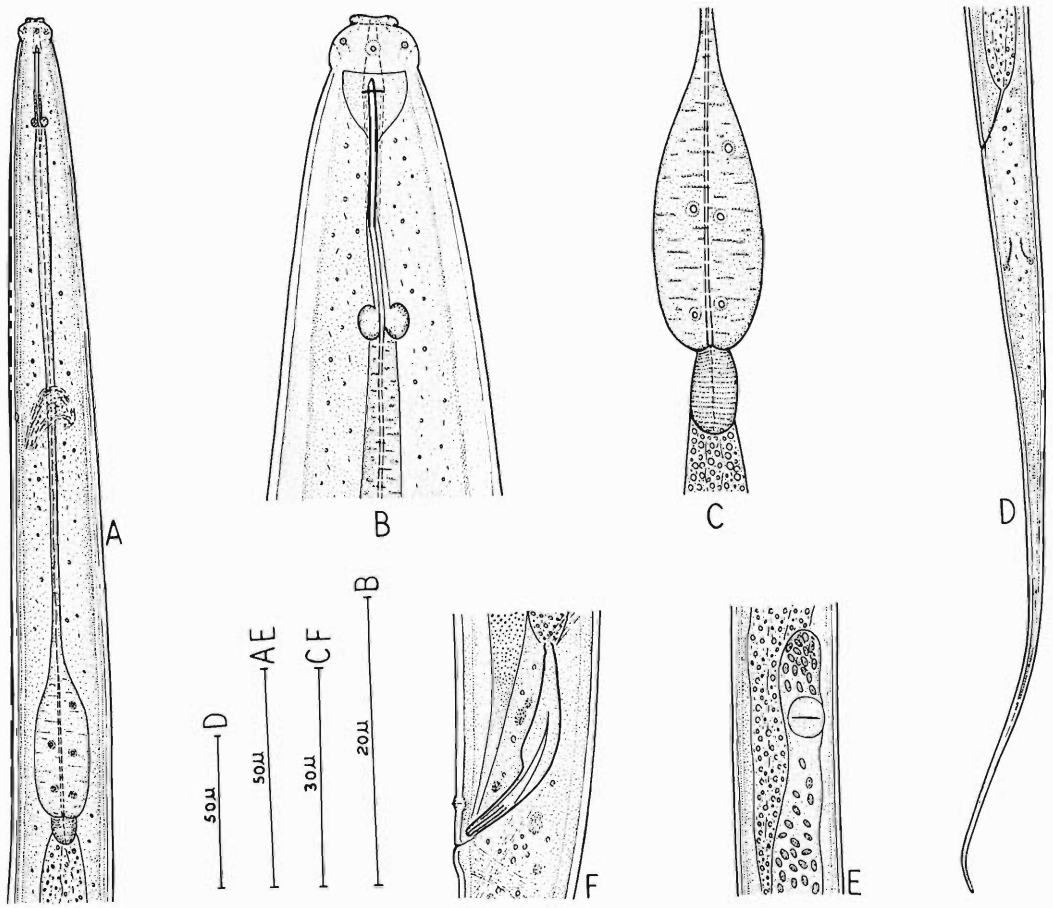

Fig. 1, A–F. *Oostenbrinkella oostenbrinki* n. gen., n. sp. A, Esophageal region; B, Head end; C, Basal bulb of esophagus; D, female tail; E, Vulval region; F, Male anal region.

ALLOTYPE (male): L = 1.3 mm; a = 54; b = 7.2; c = 5.2.

DESCRIPTION: FEMALE (holotype): Body cylindroid, tapering towards both extremities and almost straight when relaxed. Cuticle and subcuticle finely striated. Lateral chords about one-third of body width. Lip region well set off, about one-third as wide as neck base and forming a prominent labial disc around vestibule. Amphids stirrup-shaped, their apertures about three-fourths as wide as head; sensillae pouches not discernible. Spear 12 μ long, attenuated. Spear extensions 8 μ long, broadly flanged at base. Stoma faint; guiding ring single, distinct. Esophagus a slender tube with a short basal bulb which is about twice as long as wide and one-sixth of neck length. Nerve ring along middle of anterior slender part of esophagus. Hemizonid opposite nerve ring. Cardia elongate–cylindroid; intestine attached to the posterior region of cardia. Vulva a transverse slit; vagina about one-third the body width and with thick cuticular walls. Anterior uterine sac less than the body width, containing sperms. Posterior sexual branch normal; ovary reflexed almost back to vulva. Oocytes arranged in a single row except at tip of ovary. Sperms also present in normal uterine branch. Rectum about one anal body width long; prerectum about thrice as long as rectum.

Tail long, filiform, about fourteen anal body widths long. A pair of caudal pores present. MALE (allotype): Similar to female in general morphology. Testes dorylaimoid. Supplements an adanal pair only, ventromedians absent. Spicules dorylaimoid, 26 μ long. Lateral guiding pieces present. Tail long filiform, about fifteen anal body widths long.

HOLOTYPE, ALLOTYPE, AND PARATYPES: Collected in October, 1964 and deposited in the Zoology Museum of Aligarh Muslim University.

SUMMARY

A new nematode genus, *Oostenbrinkella* belonging to Leptonchidae Thorne, 1935 is reported from Andamans, India. It is distinctive in having attenuated spear, flanged extensions, single guiding ring, basal expanded portion of esophagus not set off, vulva preequatorial, only posterior ovary functional, ventromedian supplements absent and tail long and filiform in both sexes.

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Digenetic Trematodes of Amphibians and Reptiles from North Borneo (Malaysia)[1]

JACOB H. FISCHTHAL AND ROBERT E. KUNTZ[2]

The trematodes of this report were part of a collection made by the junior author while a member of the U. S. Naval Medical Research Unit No. 2, Taipei, Taiwan. Parasites were washed in saline, killed in hot water, and transferred immediately to FAA fixative. After 4–8 hrs they were stored in 70% alcohol plus 2% glycerine. Staining was in Mayer's carmalum, and all were mounted in permount. Measurements are in microns.

FAMILY GORGODERIDAE

Gorgoderina malaysiensis n. sp. (Figs. 1, 2)

HOST: *Rana kuhli* (Ranidae).

HABITAT: Small intestine.

LOCALITY: Ranau, North Borneo.

DATE: 18 September 1960.

TYPES: U.S.N.M. Helm. Coll. No. 60935 (one slide of holotype and one of paratype).

DIAGNOSIS (based on one complete specimen and one with part of posttesticular body missing): Body 3,574 (holotype) by 675 to 844, elongate, smooth; anterior extremity to posterior margin of posterior testis 2,140 to 2,194; forebody 568 to 720, hind body 2,239; posttesticular space 1,381; postcecal space 422. Oral sucker 444 to 498 by 475 to 544, slightly wider than long, subterminal; acetabulum 453 to 567 by 625 to 767, raised from body, much elongate transversely, aperature transverse; sucker length ratio 1 : 1.02 to 1.14. Esophagus (holotype) 148 long.

Testes two, at mid-body, oblique, levels overlapping with left testis more anterior, in contact or nearly so, smooth, much longer than wide, dorsal to uterus; anterior testis 545 to 614 by 228 to 239, just overlapping level of posterior margin of acetabulum, dorsal to left cecum but partly intercecal and may also be partly extracecal, anterior margin in contact with or just overlapping left vitellarium ventrally; posterior testis 767 to 775 by 222 to 224, lying 92 to 192 postacetabular, intercecal but may just overlap edge of right cecum dorsally, anterior margin in contact with right vitellarium or with ovary.

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The authors are indebted to Dr. Robert F. Inger, Curator of Reptiles, Chicago Natural History Museum, for host identifications, and to Woodrow Bistline, HMC, USN, Bob Ray Davis, HM1, USN, Dr. Chang-sheng Tseng, Messrs. Chin-tsong Lo, Charles Cheng, Chau-tyen Lane, Shih-shun Chen, Chin-kuei Hung, Te-yi Chang, Michael Pan, and Avtar Gill for assistance in the collection and examination of hosts. Mr. Henry Holland, Director, Kepayan Veterinary Station, Jesselton, provided laboratory facilities for the NAMRU field party, and Mr. G. L. Carson, Conservator of Forests, Sandakan, made arrangements and provided permits for the collection of vertebrates.

Seminal vesicle (paratype) 96 by 107, bulbous, preacetabular, postbifurcal, median. Genital pore (paratype) 103 postbifurcal, 110 preacetabular, median.

Ovary 250 to 316 by 184 to 202, just overlapping posterior margin of acetabulum to 16 postacetabular, smooth, oval, dextral, partly intercecal and partly ventral to right cecum, lying posterodextral to right vitellarium and anterodextral to and in contact with posterior testis (holotype) or mostly between right vitellarium it overlaps ventrally and posterior testis it just overlaps dorsally (paratype). Vitellaria with five to six superficial lobes, overlapping posterior part of acetabulum, right vitellarium 173 to 202 by 121 to 151, left vitellarium 173 to 210 by 125. Uterus filling posttesticular space, extending to body margins as far forward as ovarian level, mainly ventral to gonads and vitellaria where overlapping them, with undulations ascending more or less in midline to genital pore. Twelve eggs measuring 28 to 36 by 16 to 19, numerous, with fully developed miracidia.

DISCUSSION: Pereira and Cuocolo (1940) divided the genus *Gorgoderina* Looss, 1902, into two subgenera, *Gorgoderina* Looss, 1902, and *Neogorgoderina*. Dollfus (1958), Yamaguti (1958). and Fernandes (1959) stated that the latter subgenus should be suppressed as its type species is the type of the genus. Dollfus also questioned the validity of creating subgenera on the basis of the lobation of the vitellaria or its absence. Pigulevsky (1953) recognized two subgenera in the genus: *Gorgoderina* (vitellaria far posterior to the acetabulum); *Gorgorimma* Pigulevsky, 1952 (vitellaria just posterior to acetabulum). Our form fits the latter subgenus. In the key to the species of *Gorgorimma* given by Pigulevsky (1953) it comes closest to *Gorgoderina* (*Gorgorimma*) *tenua* Rankin, 1937, from a plethodontid salamander from North Carolina but differs from the latter in geographical distribution and in having the testes greatly elongate and more anteriorly placed, vitellaria overlapping dorsally the posterior part of the acetabulum, acetabulum much elongate transversely, and genital pore postbifurcal. Yamaguti (1958) included *Gorgorimma* in *Gorgoderina*. Fernandes (1959) recognized three subgenera of the genus *Gorgoderina*: *Gorgoderina* (vitellaria lobed superficially or deeply, not divided into free acini with separate ducts); *Gorgorimma* (vitellaria compact, unlobed); *Metagorgoderina* (vitellaria deeply lobed, divided into free acini, each with a separate duct connecting the right or left vitelline ducts). Our form fits Fernandes' description of the subgenus *Gorgoderina* and can be differentiated from the species he listed therein as discussed above in relation to Pigulevsky (1953). The presence of our specimens in the small intestine rather than the urinary bladder appears to be unusual for the genus and may be due to postmortem wandering or contamination during host examination.

FAMILY HAEMATOLOECHIDAE

Ostiolum borneoensis n. sp. (Figs. 3, 4)

HOST: *Rana erythraea* (Ranidae).

HABITAT: Small intestine (probably should be lungs).

LOCALITY: Penampang, North Borneo.

DATE: 1 September 1960.

TYPE: U.S.N.M. Helm. Coll. No. 60936 (one slide of holotype and three with one paratype each).

DIAGNOSIS (based on four specimens): Body, length 4,950 to 5,995, width (in two) 514 to 629 and depth (in two) 483 to 575 at anterior margin of vitellaria, width 706 to 920 and depth 744 to 767 at testicular level; narrower anteriorly and gradually widening to testicular region, both extremities bluntly rounded. Cuticle thick, fine spines from anterior extremity to ovarian level, sparse but more numerous anteriorly than posteriorly. Forebody (in one) 1,575, hind body (in one) 4,322, posttesticular space 1,467 to 1,672. Gland cells in parenchyma on each side of pharynx and at posterolateral margins of oral sucker, ducts leading anteriorly to anterior extremity. Oral sucker, length 313 to 327, width (in two) 316 to 320, depth (in two) 287 to 305, subterminal ventral, mouth anteroventral. Acetabulum (in one) 98 long, 57 deep, small, poorly developed, at about anterior body fourth. Sucker length ratio (in one) 1 : 0.31. Prepharynx very short, almost nonexistent. Pharynx, length 141 to 160, width (in two) 147 to 150, depth (in two) 141 to 147, overlapping posterior part of oral sucker ventrally. Esophagus short, displaced by body contraction. Cecal bifurcation close behind pharynx. Ceca inflated, extending 137 to 200 from posterior extremity, containing host blood cells

throughout length. Excretory system obscured by eggs.

Testes two, smooth to slightly lobed, longitudinally elongate, slightly diagonal, in contact or slightly separated, mostly intercecal, occupying region from mid-body length posteriorly; anterior (left) testis, length 537 to 652, width (in three) 253 to 407, depth (in one) 391; posterior (right) testis, length 621 to 752, width (in three) 322 to 384, depth (in one) 391. Cirrus sac (in one) 1,000 in longitudinal extent, 80 deep, long, sinuous, slightly muscular, relatively thick walled, commencing 1,280 from anterior extremity and 295 preacetabular, containing seminal vesicle 707 in longitudinal extent by 70 deep, pars prostatica, prostate cells, and muscular cirrus. Genital atrium short. Genital pore ventral to posterior half of oral sucker, submedian to left.

Ovary, length 544 to 698, width (in two) 284 to 307, depth (in two) 322 to 368, longitudinally elongate, deeply lobed compared to testes, lobes few, mostly intercecal, median or slightly submedian to right, 1,250 to 1,713 from anterior extremity, 40 postacetabular (in one). Seminal receptacle, length (in three) 310 to 405, width (in one) 380, depth (in two) 258 to 346, ventral to ovary. Mehlis' gland well developed, at ovarian level. Oviduct short, thick walled, muscular, arising from about mid-length of median side of ovary. Vitellaria mainly in lateral groups of eight to nine symmetrical, rosettelike follicular clusters, fields confluent dorsally at anterior and posteriormost levels, commencing 775 to 960 from anterior extremity, terminating 683 to 1,290 from posterior extremity. Vitelline reservoir at posterior margin of ovary, common vitelline duct entering oviduct. Uterus extensively coiled, overlapping ceca and extending to lateral body margins especially in posterior body half, many coils extending from one side of body to other, anteriorly directed extracecal loops absent. Metraterm thick walled, shorter than cirrus sac. Eggs numerous, brown, operculate, 20 measuring 17 to 23 by 11 to 15.

DISCUSSION: Because of the mass of brown eggs in the uterus the poorly developed acetabulum and the extent of the cirrus sac were completely masked from view in all but one specimen mounted in lateral view. For the same reason the extent of the pars prostatica and cirrus could not be determined. In lacking anteriorly directed extracecal loops our form fits the genus *Ostiolum* Pratt, 1902. Except for one species reported from Africa this genus is known only from North America. Odening (1958) considered *Ostiolum* a subgenus of the genus *Haematoloechus* Looss, 1899, but later (1960a) returned it to generic status with nine valid species. Yamaguti (1958) listed it as a synonym of the genus *Haematoloechus*. Skrjabin and Antipin (1962) considered *Ostiolum* a valid genus containing 11 species. In the key to the species groups of the subfamily Haematoloechinae Freitas and Lent, 1939 (syn. Pneumonoecinae Mehra, 1937) given by Odening (1960a) our form keyed to a choice between the *coloradense* group of *Ostiolum* and *O. medioplexus* (Stafford, 1902) but would not entirely fit either. In the key the *coloradense* group differs in having a sucker length ratio of 1 : 0.63 to 0.86, while *O. medioplexus* differs in having its entire cuticle spined; both differ in geographical distribution. In the key to the species of *Ostiolum* given by Odening (1960a) our form keyed to *O. medioplexus*. In the latter paper Odening presented a composite description of the latter species based on five earlier accounts. *O. medioplexus* differs further from our form in having the genital pore at the posterior margin of the pharynx, the testes never elongated, the ovary anterior to the seminal receptacle, and the vitellaria not in symmetrical clusters. Odening (1964) erected the family Haematoloechidae, placing therein the genera *Haematoloechus* (type), *Ostiolum*, *Neohaematoloechus* Odening, 1960, and *Ostioloides* Odening, 1960.

FAMILY MESOCOELIIDAE

Mesocoelium sociale (Lühe, 1901) Odhner, 1911

SYNONYMS: *Distomum sociale* Lühe, 1901; *Mesocoelium meggitti* Bhalerao, 1927.

HOSTS: *Bufo asper* (Bufonidae); *Kaloula baleata* (Brevicipitidae, syn. Microhylidae); *Rana cancrivora cancrivora*, *R. erythraea* (Ranidae); *Rhacophorus leucomystax* (Ranidae, syn. Rhacophoridae); *Calotes cristatellus* (Agamidae).

HABITAT: Small intestine.

LOCALITIES: Kasiqui (*B. asper*), Jesselton (*K. baleata*, *R. c. cancrivora*, *R. erythraea*), Tanjong aru (*R. c. cancrivora*), Petergas (*R. erythraea*), Penampang (*R. leucomystax*),

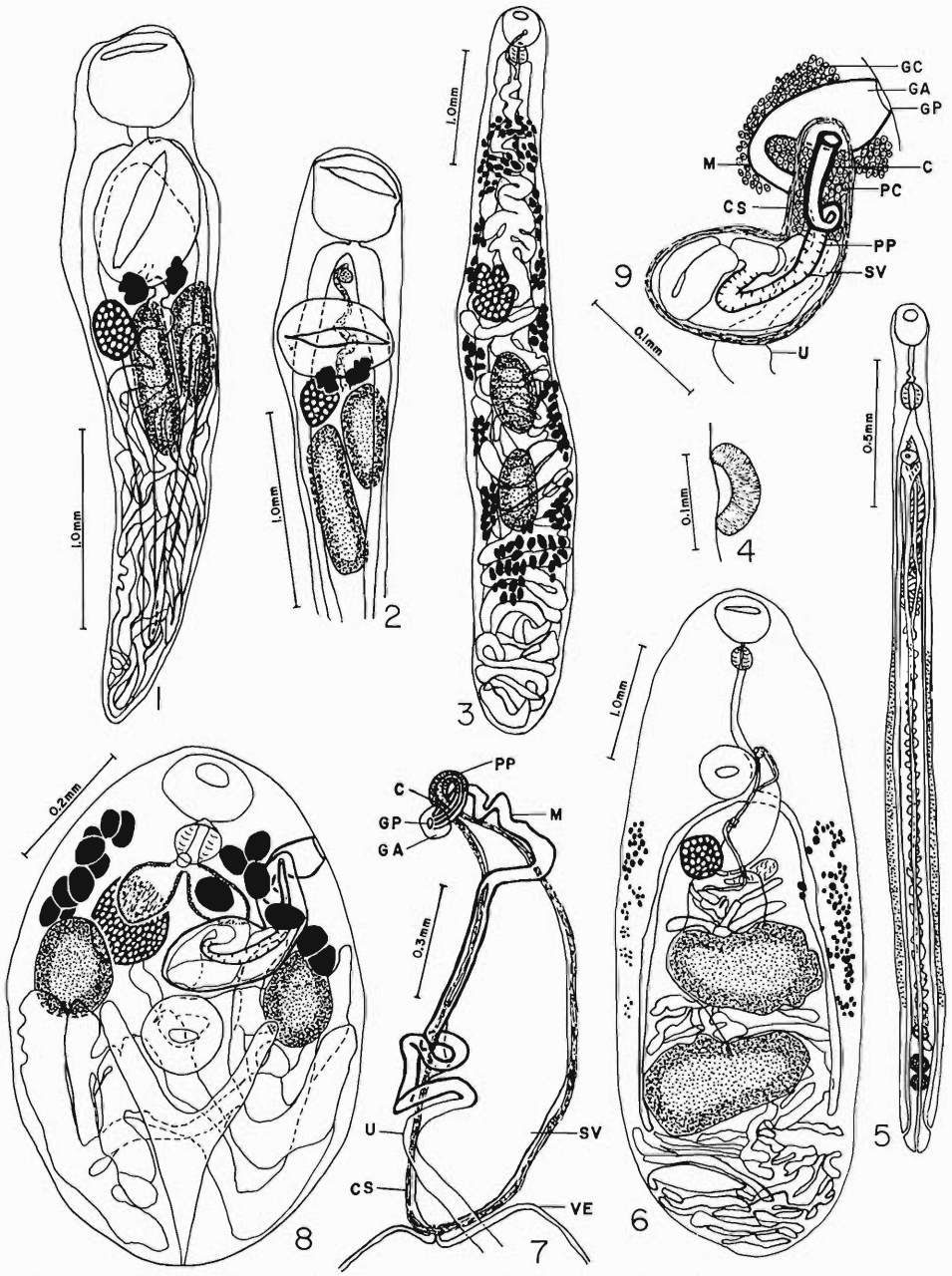

Fig. 1. *Gorgoderina malaysiensis*, holotype, ventral view. Fig. 2. Same. Paratype, ventral view. Fig. 3. *Ostiolum borneoensis*, holotype, ventral view. Fig. 4. Same. Acetabulum, sinistrolateral view. Fig. 5. *Paracanthostomum cerberi*, holotype, ventral view. Fig. 6. *Astiotrema magniovum*, holotype, ventral view. Fig. 7. Same. Terminal genitalia of holotype, ventral view. Fig. 8. *Pseudosonsinotrema sphenomorphi*, holotype, ventral view. Fig. 9. Same. Terminal genitalia of paratype, ventral view.

Tuaran (*R. leucomystax*), Ranau (*C. cristatellus*); North Borneo.

DATES: 29, 30 August (*B. asper*); 6 September and 6, 22 October (*K. baleata*); 17, 30 September (*R. c. cancrivora*); 16, 30 September (*R. erythraea*); 1 September and 13 October (*R. leucomystax*); 18 September (*C. cristatellus*); 1960.

SPECIMENS: U.S.N.M. Helm. Coll. No. 60937 (three slides with one specimen each from *B. asper*); No. 60938 (two slides with one specimen each from *K. baleata*); No. 60939 (two slides with one specimen each from *R. c. cancrivora*); No. 60940 (two slides with one specimen each from *R. erythraea*); No. 60941 (three slides with one specimen each from *R. leucomystax*); No. 60942 (two slides with one specimen each from *C. cristatellus*).

MEASUREMENTS and some pertinent data (based on 32 specimens from two *B. asper*, three measured; 13 from three *K. baleata*, two measured; three from two *R. c. cancrivora*, two measured; five from two *R. erythraea*, two measured; 15 from two *R. leucomystax*, two measured; two from one *C. cristatellus*, both measured): Body 599 to 2,787 by 215 to 955; forebody 195 to 645, hind body 307 to 1,885; preoral body 13 to 16 long; oral sucker 121 to 315 by 126 to 280, acetabulum 97 to 272 by 97 to 275, sucker length ratio 1 : 0.51 to 0.88; prepharynx up to 61 long; pharynx 52 to 123 by 53 to 136; esophagus short; right testis 73 to 202 by 67 to 225; left testis 69 to 213 by 73 to 196; cirrus sac 95 to 250 by 46 to 150, proximal part overlapping anterior portion of acetabulum 27 to 73; seminal vesicle bipartite, posterior chamber 34 to 162 by 36 to 147, anterior chamber 27 to 68 by 27 to 70; prostatic vesicle 15 to 41 by 15 to 34; cirrus (in nine) 28 to 82 by 8 to 13; genital pore median to submedian at pharyngeal level, zero to 80 posterior to oral sucker, 48 to 205 preacetabular; ovary 68 to 235 by 57 to 240, on right or left; uterus ascending on side opposite ovary; metraterm muscular, longer than cirrus sac; 59 operculate eggs measuring 31 to 46 by 19 to 29.

DISCUSSION: We (1964b) reviewed the host and geographical distribution of this species. Again, much morphological variation is evident. In the key given by Cheng (1960) our present specimens, depending upon the position of the genital pore, keyed to either *M. sociale*, *M. meggitti*, or *M. monadi* Dollfus, 1929. In the key given by Freitas (1963) our specimens, with one exception, keyed to *M. monas* (Rudolphi, 1819) Freitas, 1958. The exception from *Calotes cristatellus*, with a sucker length ratio of 1 : 0.51 (1.96 : 1), keyed to a choice between *M. danforthi* Hoffman, 1935, and *M. geoemydae* Ozaki, 1936, but does not fit the descriptions of either; the ratio of the other specimen from *C. cristatellus* is 1 : 0.58 (1.73 : 1). Freitas considered *M. sociale* and at least 18 other species from a wide variety of amphibians and reptiles from North America, Central America, South America, Africa, Asia, and Oceania as synonymous with *M. monas*. Dollfus (1954) questioned the presence of *M. sociale* in South America as its hosts are neither migratory nor transported by man or birds. Contrariwise Freitas stated that *M. monas* originated on the American continent and expanded to other parts of the world through the transport of its intermediate and definitive hosts. While much variation is evident in species of *Mesocoelium* Odhner, 1911, we reiterate our earlier (1965) query as to whether the extensive synonymy expressed by Freitas is entirely valid, it being used solely on morphological characteristics of adult specimens from so many different hosts with a very wide geographical distribution. Again, it appears to us that the question of species validity requires the elucidation of most life histories.

FAMILY ACANTHOSTOMIDAE

Paracanthostomum n. gen.

DIAGNOSIS: Body elongate, narrow; cuticle spined. Circumoral crown of spines lacking. Oral sucker larger than acetabulum, latter in anterior body fourth. Prepharynx very long, longer than pharynx; esophagus shorter than prepharynx or pharynx. Cecal bifurcation preacetabular. Ceca of more or less uniform width, terminating near posterior extremity, opening through anal pores at posterolateral body margins. Excretory bladder Y-shaped, stem passing ventral to gonads, bifurcating near acetabulum, arms extending only to acetabular level, pore terminal. Testes two, tandem, within posterior body fourth. Cirrus sac lacking. Seminal vesicle convoluted, mostly postacetabular. Genital atrium tubular. Genital pore median, just preacetabular. "Genital sac" (invagination of ventral body surface) anterior to genital pore. Ovary pretesticular. Seminal receptacle and Laurer's canal present. Vitel-

line follicles in lateral fields, postacetabular, pretesticular, mostly extracecal; vitelline reservoir present. Uterus ascending from ovary, mostly intercecal, uniting with duct from seminal vesicle dorsal to acetabulum. Eggs operculate. Parasitic in small intestine of snake.

TYPE SPECIES: *P. cerberi* n. sp.

Paracanthostomum cerberi n. sp. (Fig. 5)

HOST: *Cerberus rhynchops* (Colubridae, syn. Homalopsidae).

HABITAT: Small intestine.

LOCALITY: Ranau, North Borneo.

DATES: 20, 21 October 1960.

TYPES: U.S.N.M. Helm. Coll. No. 60943 (one slide of holotype and four with one paratype each).

DIAGNOSIS (based on 19 specimens; three mature in ventral and three in lateral view measured): Body length 2,880 to 4,885, width 165 to 215, depth 215 to 227, elongate, narrow, nearly uniform in width; cuticle spined to short distance preovarian, spines more numerous and coarser anteriorly. Circumoral crown of spines lacking. Forebody 375 to 615; hind body 2,335 to 4,190; posttesticular space 206 to 365; postcecal space 51 to 102. Pigment granules in parenchyma throughout body length. Oral sucker, length 116 to 157, width (in two) 111 to 116, depth (in four) 109 to 138, subterminal; acetabulum, length 62 to 80, width (in two) 67 to 72, depth (in four) 70 to 77, at level of anterior 11 to 18% of body length; sucker length ratio 1 : 0.51 to 0.56. Prepharynx (extended in four) 110 to 215 long; pharynx, length 91 to 123, width (in two) 80 to 92, depth (in four) 94 to 109, shorter then prepharynx; esophagus 19 to 46 long; cecal bifurcation preacetabular, slightly overlapping anterior part of acetabulum, inflated; ceca relatively narrow, extending to near posterior extremity, each opening laterally at slightly different levels through anal pores. Excretory bladder Y-shaped, stem very long, tubular, extending anteriorly ventral to gonads, uterus and seminal vesicle to near acetabulum where it becomes somewhat inflated; arms short, inflated, only extending to acetabular level; collecting ducts extending anteriorly to short distance behind oral sucker; bladder connected to terminal pore by short, narrow canal.

Testes two, tandem, in contact or up to 29 apart, 15 to 58 postovarian, usually oval, smooth, intercecal or slightly overlapping ceca dorsally, lying within posterior 12 to 18% of body length; anterior testis, length 74 to 143, width 73 to 74, depth 77 to 111, 1,985 to 3,545 postacetabular; posterior testis, length 74 to 170, width 68 to 77, depth 94 to 113, 2,057 to 3,695 postacetabular. Cirrus sac lacking. Seminal vesicle commencing 330 to 695 postacetabular, elongate, much convoluted, mostly intercecal, overlapping ceca dorsally, proximal end may be saccular, remainder tubular. Genital atrium tubular, formed by union of duct from seminal vesicle and uterus dorsal to acetabulum. Genital pore median, just preacetabular. "Genital sac" short distance anterior to genital pore, an invagination of ventral body surface.

Ovary, length 62 to 115, width 55 to 70, depth 75 to 85, oval, smooth, submedian to right or left, intercecal or may slightly overlap cecum dorsally, 1,895 to 3,365 postacetabular. Mehlis' gland well developed, dorsal and anteromedian to ovary. Seminal receptacle, length 66 to 143, width 42 to 67, depth 58 to 66, elongate, saccular, commencing median to ovary, oriented diagonally and lying between ovary and anterior testis, slightly overlapping former dorsally and in contact with latter or nearly so, intercecal or distal end overlapping cecum dorsally. Laurer's canal muscular, convoluted, median to seminal receptacle and opening dorsally at level of latter. Vitelline follicles small, extracecal but may slightly overlap ceca, fields 1,125 to 2,420 long, extending from short distance posterior to seminal vesicle to anterior margin of ovary or preovarian, commencing 550 to 750 postacetabular and terminating 480 to 960 from posterior extremity; vitelline duct descending medianly from each field, uniting dorsal to ovary to form short reservoir. Uterus ascending from ovary in transverse, more or less intercecal coils to level of posterior part of seminal vesicle, then continuing ascent in more or less straight path to union with duct of seminal vesicle dorsal to acetabulum. Eggs numerous, operculate, with opercular collar, 30 measuring 26 to 33 by 16 to 21.

DISCUSSION: Our collection consisted of 19 specimens from four snakes: two with two immature specimens each; one with three mature, one just starting egg production, and three immature specimens; one with eight mature specimens. A "genital sac" similar to that noted in our species has been described and

illustrated by Coil and Kuntz (1960) for *Acanthostomum pakistanensis*. Three genera of acanthostomids have been reported from reptiles: *Acanthostomum* Looss, 1899, *Caimanicola* Freitas and Lent, 1938, *Ateuchocephala* Coil and Kuntz, 1960. Khalil (1963) reviewed the genus *Acanthostomum*, recognizing four subgenera: *Acanthostomum*, *Atrophecaecum*, *Haplocaecum*, *Gymnatotrema*; all but the latter have been reported from reptiles. Khalil overlooked the genus *Proctocaecum* erected by Baugh (1957a) for three species of *Acanthostomum* possessing anal pores. However, such pores are present in many, if not all, species of *Acanthostomum*. Therefore, we declare *Proctocaecum* a synonym of the latter. The three species in *Proctocaecum* were listed by Khalil in the subgenus *Acanthostomum*. Our form most closely resembles the genus *Acanthostomum*, but the lack of a circumoral crown of spines and the presence of short excretory arms reaching only to the acetabular level rather than the pharynx make it necessary to erect a new genus for it. A careful study of our specimens, most of which are in excellent condition, failed to reveal any evidence of circumoral spines. Our earlier (1963) study of the two species of *Acanthostomum* noted that when circumoral spines were lost scars were visible where formerly they were imbedded. Four genera of acanthostomids are known in which circumoral spines are lacking (*Anisocoelium* Lühe, 1900, *Paraisocoelium* Ozaki, 1932, *Isocoelium* Ozaki, 1927, *Ateuchocephala*), but our form does not resemble any of them.

FAMILY *Dicrocoeliidae*

Paradistomum gregarium Tubangui, 1929

SYNONYMS: *Paradistomum magnum* Tubangui, 1928, nec Travassos, 1919; *Paradistomoides gregarium* (Tubangui, 1929) Travassos, 1944.

HOST: *Hemidactylus frenatus* (Gekkonidae).

HABITAT: Gallbladder.

LOCALITIES: Kasiqui, Ranau and Menggatal, North Borneo.

DATES: 26 August, 22, 30 September 1960.

SPECIMENS: U.S.N.M. Helm. Coll. No. 60944 (five slides with one specimen each).

MEASUREMENTS and some pertinent data (based on 11 specimens, three young and four old adults measured): Body 1,093 to 2,240 by 522 to 1,265; forebody 372 to 598, hind body 548 to 1,304; preoral body present or not; oral sucker 180 to 309 by 173 to 255, acetabulum 162 to 199 by 169 to 228, sucker length ratio 1 : 0.64 to 0.92; very short prepharynx in some; pharynx 68 to 125 by 63 to 132; esophagus 36 to 147 long; right testis 103 to 177 by 104 to 239; left testis 87 to 210 by 87 to 224; cirrus sac 147 to 302 by 71 to 118, commencing well preacetabular or at level of anterior margin of acetabulum or partly overlapping latter; genital pore to oral sucker 4 to 111, to acetabulum 103 to 254, ventral to pharynx or esophagus; ovary 100 to 224 by 114 to 276; seminal receptacle 77 to 120 by 86 to 136; 33 operculate eggs measuring 31 to 41 by 18 to 27.

DISCUSSION: Our collection consisted of one, four, and six worms from three lizards. This parasite has been reported from the same host from Luzon and Palawan islands, Philippines, and from *Hemidactylus gleodovi* from Burma. Considerable variations similar to those previously noted by us (1964b) occur in the present specimens. No doubt much synonymy exists between known species of *Paradistomum* Kossack, 1910, but extensive life history studies are required before its extent can be determined.

A single specimen (U.S.N.M. Helm. Coll. No. 60945) with the entire preacetabular body missing and healed over was taken from the bile duct of the lizard, *Gehyra mutilata* (Gekkonidae), collected at Ranau on 22 September 1960. It appears to be *Paradistomum gregarium*.

Euparadistomum varani Tubangui, 1931

SYNONYM: *Platynotrema varani* (Tubangui, 1931) Chatterji, 1948.

HOST: *Varanus rudicollis* (Varanidae).

HABITAT: Gallbladder.

LOCALITY: Ranau, North Borneo.

DATE: 23 September 1960.

SPECIMEN: U.S.N.M. Helm. Coll. No. 60946.

MEASUREMENTS and some pertinent data (based on a single specimen): Body 4,318 by 2,600; forebody 1,818, hind body 1,710, preoral body 55, postcecal space 621; oral sucker 706 by 621, acetabulum 790 in diameter, sucker length ratio 1 : 1.12, center of acetabulum slightly postequatorial; pharynx 169 by 206; esophagus 414 long; testes slightly overlapping acetabulum, right testis 266 by 202, left testis 313 by 228; cirrus sac 342 by 96,

anteriormost margin 50 anterior to genital pore, posterior margin 235 preacetabular, containing seminal vesicle, pars prostatica, prostate cells and cirrus 145 by 29; genital atrium 80 by 75, anterior margin lying 25 anterior to genital pore; latter bifurcal, lying 406 postpharyngeal and 560 preacetabular; ovary 302 by 313, slightly overlapping posterosinistral part of acetabulum; metraterm to right of cirrus sac, opening into genital atrium dextral to cirrus opening; 15 operculate eggs measuring 40 to 48 by 22 to 29; excretory bladder Y-shaped, main stem bifurcating 176 postovarian, arms extending anterolaterally almost to ceca and terminating at immediate postovarian level.

DISCUSSION: This species has been reported from *Varanus salvator* from Luzon and Palawan islands, Philippines, and from *Chamaeleo* spp. from Madagascar. In having its acetabulum slightly larger than the oral sucker rather than smaller our specimen resembles *E. varani* var. *madagascariensis* described by Capron, Deblock and Brygoo (1961). We (1964b) reviewed the status of the genus *Euparadistomum* Tubangui, 1931, but overlooked the paper by Baugh (1957b) which noted that the latter genus was a synonym of *Platynotrema* Nicoll, 1914. We reiterate that *Euparadistomum* is valid in possessing a Y-shaped excretory bladder, whereas the latter has a tubular one. Therefore, we are transferring Baugh's *Platynotrema indica* to *Euparadistomum* as *E. indicum* (Baugh, 1957) n. comb.

FAMILY DIDYMOZOIDAE

Torticaecum nipponecum Yamaguti, 1942

HOST: *Cerberus rhynchops* (Colubridae, syn. Homalopsidae).

HABITAT: Small intestine.

LOCALITY: Ranau, North Borneo.

DATE: 21 October 1960.

SPECIMEN: U.S.N.M. Helm. Coll. No. 60947.

MEASUREMENTS and some pertinent data (based on a single specimen): Body 726 by 114; forebody 157, hind body 490; oral sucker 38 by 28, entirely muscular; acetabulum 79 by 65, one-fourth body length from anterior extremity; sucker length ratio 1 : 2.08; pharynx 13 by 10; esophagus 67 long, bifurcation preacetabular; postcecal space 44.

DISCUSSION: This immature didymozoid was first described by Yamaguti (1942) from the small intestine of various marine fishes from Japan, and briefly redescribed by us (1964a) from another fish from Palawan Island, Philippines. We presented a review of the immature didymozoids. Our present specimen from a snake, which may serve as a paratenic host in the life history of this parasite, represents the first record of this group from a reptile. Dollfus (1963a) reported an unidentified metacercaria living in an oleocyst in a marine coelenterate, *Ablyopsis tetragona* (class Hydrazoa, order Siphonophora, family Diphyidae), from Algeria. Two rows of postacetabular round bodies were characterized by him as testes. In viewing Dollfus' figure 9 it is apparent that he is dealing with an immature didymozoid and that the two rows of bodies represent cecal swellings; additionally, the oral sucker is entirely muscular, a pharynx is present, and the cecal bifurcation is preacetabular. Dollfus' form resembles *Distomum fenestratum* Linton, 1907.

FAMILY ENCYCLOMETRIDAE

Encyclometra colubrimurorum (Rudolphi, 1819) Dollfus, 1929

HOST: *Enhydris plumbea* (Colubridae, syn. Hydrophiidae).

HABITAT: Small intestine.

LOCALITY: Ranau, North Borneo.

DATE: 22 October 1960.

SPECIMEN: U.S.N.M. Helm. Coll. No. 60948.

MEASUREMENTS and some pertinent data (based on single specimen): Body 3,250 by 1,067; forebody 893, hind body 1,866, preoral body 51, posttesticular space 1,112; oral sucker 453 by 377, acetabulum 491 by 525, sucker length ratio 1 : 1.08; pharynx 180 by 239; cecal bifurcation 162 preacetabular; posterior extremity to right cecum 430, to left cecum 376; testes slightly lobed, diagonal; anterior (left) testis 195 by 213, 345 postacetabular; posterior (right) testis 202 by 191, 552 postacetabular; cirrus sac 210 wide proximally, shaped like broad, inverted U with proximal part overlapping middle of acetabulum 165, mostly preacetabular; genital pore sinistrolateral to acetabulum; ovary 210 by 325, smooth, transversely oval, median, entirely dorsal to acetabulum; acetabulum to right vitelline field 199, to left field 253; posterior extremity to right vitelline field 215, to left field 261; vitelline reservoir dorsal to posterosinistral part of acetabulum and posterosinistral to ovary; uterus descending on right, ascending on left, ventral

to testes; five eggs measuring 65 to 88 by 36 to 41.

DISCUSSION: Our record from North Borneo is new for *Encyclometra* Baylis and Cannon, 1924. The synonymy of species appears to be great, but complete accord as to which are valid is lacking. Yeh (1958) recognized only three species: *E. colubrimurorum*, *E. asymmetrica* Wallace, 1936, *E. japonica* Yoshida and Ozaki, 1929. Yamaguti (1958) listed seven species, and Skrjabin and Antipin (1960) reviewed six. Dollfus (1963b) recognized *E. colubrimurorum* and *E. asymmetrica*, but doubted the validity of *E. japonica* which he considered similar to the first species. Dollfus disagreed with much of Yeh's synonymy of species with *E. japonica* as most equally fit *E. colubrimurorum*; additionally, while Yeh declared *E. vitellata* N. K. Gupta, 1954, a synonym of *E. japonica*, Dollfus placed it in synonymy with *E. asymmetrica*. A knowledge of the complete life histories of the various species would aid considerably in clarifying the extent of synonymy. Until such information is available we prefer to follow Dollfus and therefore are listing our specimen as *E. colubrimurorum*. From the same host as our form has been reported *E. microrchis* Yamaguti, 1933, from Taiwan. On the basis of differences in the excretory system Odening (1960b) removed the genus from Plagiorchiidae and erected the family Encyclometridae, provisionally placing it in the suborder Plagiorchiata until the larval stages from the molluscan intermediate host were known.

FAMILY HETEROPHYIDAE

Haplorchis pumilio (Looss, 1896) Looss, 1899

SYNONYMS: *Monostomum pumilio* Looss, 1896; *Monorchotrema taihokui* Nishigori, 1924; *Haplorchis milvi* Gohar, 1934; *Kasr aini* Khalil, 1932; *Haplorchis taihokui* (Nishigori, 1924) Yamaguti, 1958.

HOSTS: *Cerberus rhynchops* (Colubridae, syn. Homalopsidae); *Varanus salvator* (Varanidae).

HABITAT: Small intestine.

LOCALITY: Ranau, North Borneo.

DATES: 13 (*C. rhynchops*), 26 (*V. salvator*) October 1960.

SPECIMENS: U.S.N.M. Helm. Coll. No. 60949 (five slides with one specimen each from *C. rhynchops*); No. 60950 (one slide with two specimens and two with one each from *V. salvator*).

MEASUREMENTS and some pertinent data (based on 15 specimens from *C. rhynchops*, five measured, and seven from *V. salvator*, two measured): Body 412 to 605 by 145 to 240; oral sucker 60 to 65 by 64 to 74, slightly wider than long; acetabulum 38 to 62 by 41 to 74, usually wider than long, bearing almost complete circlet of about 34 to 38 spines and additional group of simple spines in interrupted area; prepharynx 10 to 18 long; pharynx 36 to 46 by 29 to 41, usually longer than wide; esophagus 43 to 90 long; testis 65 to 124 by 65 to 116; ovary 56 to 97 by 43 to 81; seminal receptacle 36 to 70 by 43 to 72; 29 operculate eggs measuring 27 to 35 by 15 to 21.

DISCUSSION: These are the first records of adult Heterophyidae from reptiles. Adult *H. pumilio* have been reported from avian and mammalian hosts from North Africa, Middle East, Southeast Asia, and Oceania. Comparison of our specimens with three *H. pumilio* (one deposited by Dr. J. C. Pearson in U.S.N.M. Helm. Coll. No. 60310, and two donated by him to the senior author) from the water rat, *Hydromys chrysogaster*, from Brisbane, Australia, showed them to be identical. Our specimens readily fit the descriptions given by Chen (1936) and Pearson (1964); the structure and number of acetabular spines are as described and illustrated by both authors.

FAMILY PLAGIORCHIIDAE

Astiotrema magniovum n. sp. (Figs. 6, 7)

HOST: *Dogania subplana* (Trionychidae).

HABITAT: Large intestine.

LOCALITY: Kasiqui, North Borneo.

DATE: 29 August 1960.

HOLOTYPE: U.S.N.M. Helm. Coll. No. 60951.

DIAGNOSIS (based on a single specimen): Body 6,080 by 2,110, elongate, broad, entirely spined, latter heavier and more numerous anteriorly. Forebody 1,316, hind body 4,266, preoral body 43, posttesticular space 1,077. Oral sucker 422 by 483, subterminal, aperture a transverse slit at anterior third of sucker length; acetabulum 498 by 552, at anterior fourth of body length, aperture a transverse oval; sucker length ratio 1 : 1.18. Prepharynx 66 long; pharynx 199 by 173; esophagus 1,074 in longitudinal extent, bifurcating at posterior margin of acetabulum; ceca narrow, extending to level

of posterior margin of posterior testis. Excretory pore just subterminal dorsal.

Testes two, slightly lobed, much wider than long, tandem but 123 apart, postequatorial, intercecal but may contact cecum, dorsal to uterus; anterior testis 845 by 1,380, 360 postacetabular; posterior testis 845 by 1,488, 1,344 postacetabular. Vasa efferentia entering cirrus sac side by side. Cirrus sac 1,192 in longitudinal extent by 372, extending from 652 postacetabular to 48 preacetabular, slightly overlapping sinistral part of ovary ventrally, ascending next to sinistral margin of acetabulum, saccular, with proximal loop, containing seminal vesicle, pars prostatica, prostate cells, and cirrus. Seminal vesicle 1,075 by 327, filling most of the cirrus sac. Pars prostatica cell lined, relatively thick walled, in proximal loop of cirrus sac, surrounded by prostate cells. Cirrus short, muscular. Genital atrium shallow. Genital pore at anterosinistral margin of acetabulum.

Ovary 391 in diameter, smooth, submedian to right, intercecal, 276 postacetabular, 310 pretesticular. Ootype complex large, posteromedian to ovary and posterior to cirrus sac. Mehlis' gland well developed. Seminal receptacle 805 by 220, transversely elongate, extending from posterior to ovary along posterior and posterosinistral parts of cirrus sac. Laurer's canal muscular, winding, opening on dorsal surface between cirrus sac and anterior testis. Vitellaria follicular, in lateral fields at about mid-body length, mostly extracecal, commencing 2,021 from anterior extremity, 207 to 215 postacetabular and 61 to 69 preovarian, fields 1,588 to 1,718 long, terminating 2,333 from posterior extremity. Uterus winding, descending between testes to posterior extremity, filling posttesticular space. Metraterm muscular, winding, commencing just preovarian, crossing and overlapping cirrus sac ventrally, entering genital atrium sinistral to cirrus. Eggs numerous, operculate, relatively large, 20 measuring 62 to 76 by 28 to 35.

DISCUSSION: Yeh and Fotedar (1958) reviewed the genus, recognizing only four species: *A. reniferum* (Looss, 1898) Looss, 1900, *A. impletum* (Looss, 1898) Looss, 1900, *A. monticellii* Stossich, 1904, *A. odhneri* Bhalerao, 1936. Khalil (1959) declared *A. odhneri* a synonym of *A. reniferum*, recognizing the latter, *A. impletum*, *A. monticellii*, *A. geomydia* Siddiqui, 1958, and *A. sudanensis* which he described in his paper. Tiwari (1958) described three additional species, and Grabda (1959a) one. Ahluwalia (1961) declared *A. geomydia* a synonym of *A. impletum*. Our form differs from all the above species in the large size of its eggs, hence the specific name *magniovum*. In the key to the species given by Yeh and Fotedar (1958) our specimen keyed to *A. odhneri*. In the key given by Khalil (1959) it keyed to a choice between *A. monticellii* and *A. reniferum*, but did not entirely fit either one; it resembles the former in having the cecal bifurcation at the posterior margin of the acetabulum, and the latter in having the ceca extend more posteriorly and the vitellaria more dispersed (but not as much as for the latter species). Whether the extensive synonymy stated by Yeh and Fotedar and by Khalil, based solely on adult morphological characteristics, is entirely valid can not be ascertained until additional life histories are elucidated. Grabda (1959b) presented the life history of *A. trituri* and Shevchenko and Vergun (1960) that of *A. monticellii*.

FAMILY PLEUROGENIDAE

Pseudosonsinotrema sphenomorphi n. sp.
(Figs. 8, 9)

HOST: Type, *Sphenomorphus multisquamatus* (Scincidae); *Bufo asper* (Bufonidae).

HABITAT: Small intestine.

LOCALITY: Ranau, North Borneo.

DATES: 15 (*B. asper*), 20 (*S. multisquamatus*) September 1960.

TYPES: U.S.N.M. Helm. Coll. No. 60952 (one slide of holotype and four with one paratype each from *S. multisquamatus*); No. 60953 (one paratype from *B. asper*).

DIAGNOSIS (based on nine mature and two immature specimens from *S. multisquamatus*, seven mature measured): Body 605 to 798 by 380 to 527, oval, cuticle completely spined, spines more numerous anteriorly. Forebody 240 to 380, hind body 210 to 301; preoral body usually present. Subcuticular layer of parenchymal glands throughout body, especially concentrated anteriorly. Oral sucker 95 to 131 by 100 to 150, subterminal ventral; acetabulum 117 to 145 by 114 to 150, center just postequatorial; sucker length ratio 1 : 0.95 to 1.30. Prepharynx very short; pharynx 41 to 65 by 52 to 75, may overlap oral sucker dorsally; esophagus short, dorsally directed; ceca short, preace-

tabular, usually inflated, lined internally with conspicuous thick cell layer, right cecum overlapping ovary ventrally, left cecum usually overlapping cirrus sac dorsally or occasionally in contact with it. Excretory bladder Y-shaped, lined with conspicuous cell layer, ventral to uterus; main stem gradually widening from terminal pore anteriorly to bifurcation which lies 20 to 66 postacetabular; arms extending lateral to acetabulum, usually overlapping testes ventrally; large concretion in main stem of one.

Testes two, smooth, usually longitudinally elongate but may be round, symmetrical, one on each side of acetabulum, usually extending partly preacetabular, postcecal, in half of specimens anterior margin of right testis slightly more anterior than left testis and at about same level in other half; right testis 92 to 158 by 48 to 145, left testis 73 to 148 by 73 to 121. Vas efferens emerging from posteromedian margin of each testis, entering cirrus sac side by side. Cirrus sac about 220 to 307 long, 87 to 109 wide at longer swollen proximal part, muscular, thick-walled, club-shaped but anterior to mid-length bends at right or wider angle; usually commencing near midline of body dorsal to anterior part of acetabulum but may be at anterior margin of latter, proceeding sinistrally or anterosinistrally, then turning anteriorly to terminate prececally short of lateral body margin at pharyngeal level; containing seminal vesicle, pars prostatica and prostate cells in swollen proximal part and cirrus and cells in narrower distal part. Seminal vesicle thin walled, tubular, much coiled. Pars prostatica cell lined, muscular, thick-walled, tubular, hook-shaped, commencing at about mid-length of proximal swollen part of cirrus sac, terminating at bend of latter. Prostate cells distributed from bend in cirrus sac to near its anterior end. Cirrus long, muscular, thick-walled, protrusible, with proximal loop when retracted, opening into genital atrium. Latter relatively large, muscular, thick-walled, surrounded by dense mass of gland cells. Genital pore usually at sinistrolateral body margin at pharyngeal level but may be sublateral dorsal.

Ovary 80 to 138 by 80 to 123, round to longitudinally elongate, smooth, dextral, usually anteromedian to right testis and partly overlapping latter dorsally but may be at same level, usually preacetabular but may overlap acetabular level, opposite proximal part of cirrus sac. Ootype complex posteromedian to ovary, partly dorsal to acetabulum. Mehlis' gland well developed. Seminal receptacle 47 to 70 by 26 to 59, may overlap ovary ventrally. Vitelline follicles large, in two separated lateral clusters distributed between testes and posterior part of oral sucker or more narrowly massed, nine follicles on right and seven left in seven specimens measured, left field passing dorsal to cirrus sac and sometimes left cecum, more on one plane compared to right field; vitelline ducts uniting posteromedian to ovary to form small vitelline reservoir. Oviduct muscular, thick-walled, arising from median margin of ovary. Uterus essentially in lateral fields, proceeding from ootype complex dorsal to acetabulum to left side of body, then to posterior extremity, anteriorly with some windings to left testis, then across to right side of body dorsal to excretory bladder, winding from right testis or ovarian level to posterior extremity, then proceeding across to left side of body postacetabularly, winding between acetabulum and left body margin, finally ascending in undulating fashion dorsal to left testis and cirrus sac to form metraterm. Metraterm muscular, thick-walled, surrounded by dense mass of gland cells, shorter than cirrus sac, opening into genital atrium. Eggs numerous, operculate, 35 measuring 21 to 27 by 11 to 16.

MEASUREMENTS of single specimen from *Bufo asper*: Body 800 by 600; oral sucker 109 by 114; pharynx 49 by 65; right testis 182 by 210; left testis 162 by 174; cirrus sac 305 by 131; ovary 194 by 160; nine vitelline follicles right, seven left; eight eggs measuring 24 to 27 by 11 to 15.

DISCUSSION: Neither the acetabulum nor the excretory bladder were visible in the specimen from the toad, *B. asper*, but other features readily fit those from the lizard, *S. multisquamatus*. Our specimens differ significantly from the only other species in the genus, *P. chamaeleonis*, described by Dollfus (1951) from *Chamaeleon chamaeleon* from Tunisia, in the lesser number and distribution of vitelline follicles and in having larger eggs. Odening, (1959) erected the family Pleurogenidae for those genera included in the subfamily Pleurogeninae, family Lecithodendriidae.

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Abbreviations: C, cirrus; CS, cirrus sac; GA, genital atrium; GC, gland cells; GP, genital pore; M, metraterm; PC, prostate cells; PP, pars prostatica; SV, seminal vesicle; U, uterus; VE, vas efferens.

Scutellonema mangiferae n. sp. (Nematoda : Hoplolaimidae) from India[1]

SHAHID HASAN KHAN AND M. A. BASIR

In a collection of plant parasitic nematodes made in District Narsinghpur (M.P.) in early January 1964, both male and female specimens of a hitherto undescribed species of *Scutellonema* Andrássy, 1958, were recovered. The name, *S. mangiferae* n. sp., is proposed for it. Its description is given below.

Scutellonema mangiferae n. sp.

MEASUREMENTS: PARATYPES: *Females* (5): L = 1.00–1.24 mm; a = 27–33; b = 7.1–8.8; c = 39–62; v = 54.6–56.9; spear = 32–35 μ; O = 16.0–21.8%.[2] *Males* (3): L = 0.980–1.067 mm; a = 31–39.5; b = 7.6–8.08; c = 32–42; spear = 30–32 μ; O = 16.6–20; spicula = 41–45 μ; Gubernaculum = 17–19 μ.

HOLOTYPE: *Female*: L = 1.01 mm; a = 33; b = 8.8; c = 39.3; v = 54.7; spear =32 μ; O = 21.8.

ALLOTYPE: *Male*: L = 1.067 mm; a = 39.5; b = 8.08; c = 41.03; spear = 30 μ; O = 20; spicula =45 μ; Gubernaculum = 18 μ; Telamon = 14 μ.

DESCRIPTION: HOLOTYPE: Body slightly ventrally curved when relaxed in hot water. Lip region broadly hemispherical, not set off, with 5 annules (in paratypes 5–7 annules). Basal head annule devoid of any longitudinal marking. Spear massively built, 32 μ long. Metenchium shorter than telenchium. Spear knobs rounded, 6.5 μ across, with anterior surfaces slightly cupped. Excretory pore opposite nerve ring. Hemizonid 4 μ long, eight annules below excretory pore. Esophagus typical of the genus; median esophageal bulb strongly developed, rounded; esophageal glands with three distinct nuclei, compact, forming a short lobe on the dorsal side of the intestine, extending 15 μ from the esophago-intestinal junction. Esophago-intestinal junction oval, 3.1 × 2.2 μ in size. Intestine packed with food granules, slightly overlapping rectum. Rectum about 14 μ long, slightly dorsally curved. Anus distinct, at 16th annule from tail tip (at 13th–16th annule in paratypes).

Ovaries opposed, outstretched. Spermatheca

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[2] O = the distance of the gland opening from the base of the spear expressed as a percentage of the total length of the spear.

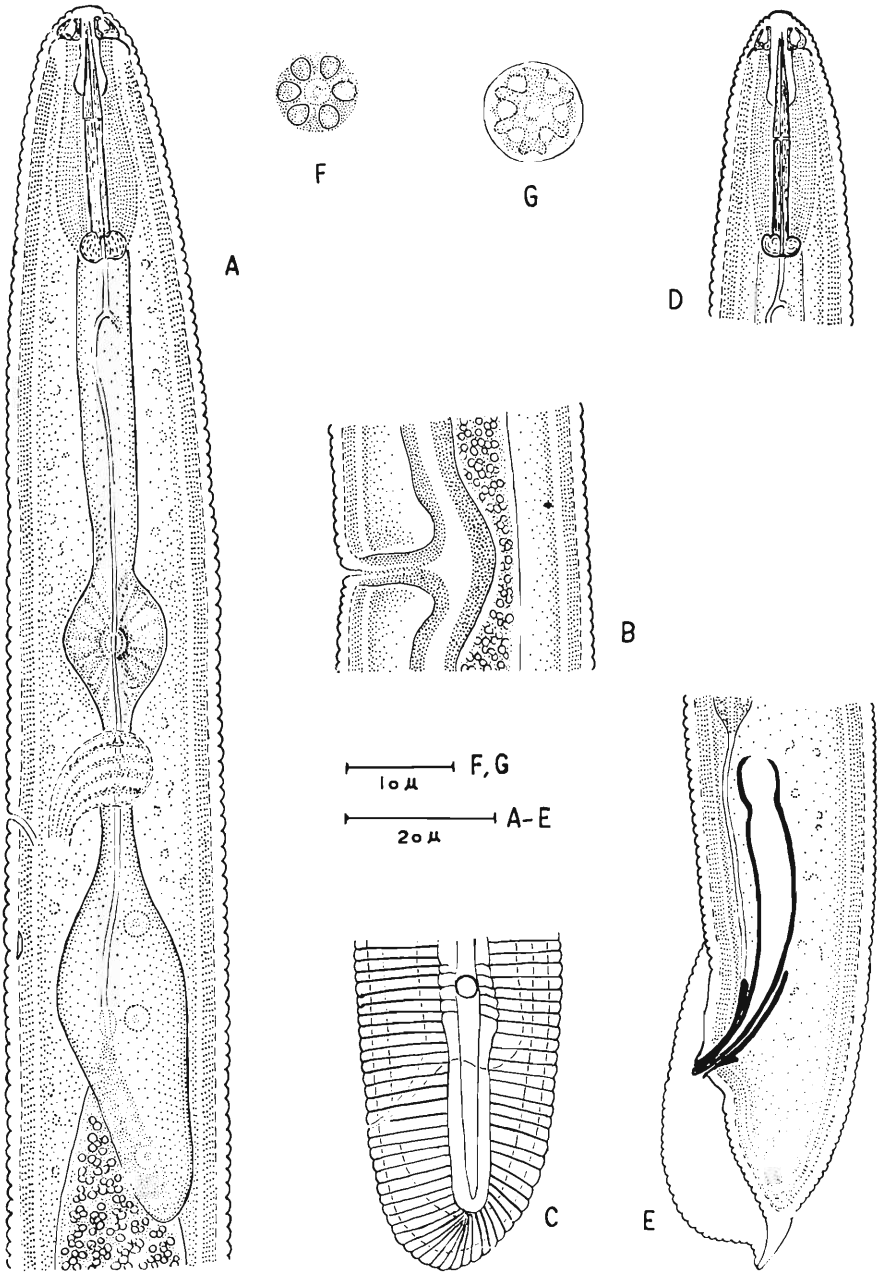

Fig. 1. *Scutellonema mangiferae* n. sp. A, Esophageal region of female, lateral view. B, Region of vulva, lateral view. C, Tail of female, lateral view. D, Anterior end of male, lateral view. E, Posterior end of male, lateral view. F, Female, *en face* view. G, Cross section through basal annule of lip region of female.

distinct. Phasmids 3 μ in diameter, ten annules above latitude of anus. Lateral fields visibly aerolated in region of phasmids. Tail tapering, rounded.

ALLOTYPE: Body curved ventrally. Lip region broadly hemispherical, not set off, with seven annules (6–7 annules in paratypes). Spear massive, 30 μ long. Metenchium shorter than telenchium. Spear knobs rounded, 5 μ across, with distinct anterior processes. Excretory pore opposite anterior portion of esophageal gland. Hemizonid seven annules below excretory pore. Testis outstretched. Spicula and gubernaculum typical of the genus, measuring 45 and 18 μ, respectively. Phasmids at level of anus, 3.5 μ in diameter.

TYPE HABITAT AND LOCALITY: Collected from soil around roots of *Mangifera indica* L., at Kareli town, District Narsinghpur (M.P.), India.

TYPE MATERIAL: Holotype, allotype, and paratypes deposited with the Zoology Museum, Aligarh Muslim University, Aligarh, India.

DIAGNOSIS: *Scutellonema* with above description and measurements. It comes closest to *S. grande* Sher, 1963, and *S. validum* Sher, 1963. From the former it differs in having a smaller spear (spear 35–39 μ in *S. grande*) and a more posterior dorsal esophageal gland opening (O = 9–12 in *S. grande*). The males of this species further differ in having larger spicula and a larger gubernaculum (spicula 32–37 μ and gubernaculum 13–17 μ in *S. grande*). From the latter it differs in having an anteriorly located excretory pore (excretory pore in the region of esophageal glands in *S. validum*), and in the shape and number of annules of female tail.

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Contributions to the Life History of *Cotylurus flabelliformis* (Faust, 1917) (Trematoda : Strigeidae)[1]

ALEXANDER D. ACHOLONU[2]

ABSTRACT

Certain aspects of the life history of *Cotylurus flabelliformis* have been successfully repeated. In this study seven cases were encountered where the sporocysts, cercariae, and metacercariae were found in the same snail. In addition, metacercariae, presumably identical with those found in the hermaphroditic gland of infected snails, occurred in some of the sporocysts.

Chicks, ducklings, and goslings, but not albino rats, harbored adult worms after being fed infected snails and/or isolated tetracotyles.

New intermediate host (*Lymnaea auricularia*), definitive host (goose), and locality (Colorado) records have thus been established for *C. flabelliformis*.

Various stages of the life history of *Cotylurus flabelliformis* have been studied by several investigators. Hughes (1929) redescribed the tetracotyle of *C. flabelliformis*, originally described by Faust (1917) as *Cercaria flabelliformis*. Van Haitsma (1931) worked out the life history of this parasite, designating *Cercaria douglasi* Cort, 1914, as its larva. Olivier and Cort (1941) pointed out that *Cercaria douglasi* and the cercaria of *C. flabelliformis* are two different species which bear striking resemblance. They compared the two species and proved that *Cercaria douglasi* is not the larvae of *C. flabelliformis*, pointing out that the cercaria of *C. flabelliformis* is found only in snails of the family Lymnaeidae while *C. douglasi* occurs in the Physidae. Ulmer (1957) described developmental stages of the tetracotyle of *C. flabelliformis*. A restudy of certain aspects of the life history of this parasite was made by the writer.

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MATERIALS AND METHODS

During the summer of 1963, about 95% of numerous *Lymnaea auricularia* (L.), collected from Dixon Lake near Fort Collins, Colorado, were parasitized by cercariae and metacercariae tentatively identified as those of *C. flabelliformis*. Seven cases were encountered where sporocysts, cercariae, and metacercariae were found together in a single snail. Also some metacercariae, which presumably are identical with those found in the hermaphroditic gland of the infected snails occurred in some of the sporocysts. It is difficult, however, to state unequivocally that the furcocercous cercariae had encysted *in situ* or had penetrated the snails from the water and subsequently entered the sporocysts.

In an attempt to recover the adult worm for specific identification, laboratory-reared 19- to 37-day-old ducklings, 3- to 35-day-old chicks, 4- to 13-day-old goslings, and 7- to 9-week-old albino rats were force-fed infected snails and/or isolated fully developed metacercariae.

RESULTS

Adult worms identified as *C. flabelliformis* were recovered from the large intestine and ceca of all the species of experimental animals with the exception of the albino rats. The first successful infection was obtained from a duckling autopsied 5 days after having been fed metacercariae. The largest number of parasites recovered from one of three ducklings was 53, and from one of three goslings was over 200. While the largest number of parasites (over 200) was collected from a gosling autopsied 14 days postfeeding; a duckling, the natural host, autopsied after the same duration harbored only one worm. Some of the adult parasites were in copulation. The developmental stages of the tetracotyle described and figured by Ulmer (1957) were observed from many infected snails. They are so adequately described as to warrant no further description here.

DISCUSSION

When sporocysts, cercariae, and metacercariae occurred in the same snail, it is probable that the metacercariae in the infected snail were acquired before the penetration of the miracidia which gave rise to the sporocysts and subsequently the cercariae.

A previous study by Cort, Olivier, and Brackett (1941) showed that tetracotyles of *C. flabelliformis* develop normally in the tissues of the same species of snail in which they developed as cercariae. If the cercariae enter physid or planorbid snails, no development takes place unless these snails are infected already with some species of trematodes. In this case, the cercariae enter the sporocysts or rediae of the trematodes present instead of the hermaphroditic gland which is their normal location and develop into encysted tetracotyles, but somewhat more rapidly than in the lymnaeid snails.

Winfield (1932) exposed snails harboring sporocysts of *C. flabelliformis* to their cercariae and found the mollusks highly resistant to penetration. Nolf and Cort (1933) repeated this study and confirmed the validity of Winfield's work. The above studies together with the fact that the species of snail involved here is a lymnaeid instead of a physid or planorbid and the sporocyst is not that of another trematode, make it seem improbable that the furcocercous cercariae of *C. flabelliformis* penetrated the already infected snails and thereafter migrated to the sporocysts.

It is most likely that the cercariae encysted *in situ*. This represents a case of precocious development of the metacercarial stage in the sporocyst such as previously reported by other investigators for various species (Cort and Brackett (1937), Ingles (1935), Stunkard (1934), and Tanabe (1922)), and is being reported here for *C. flabelliformis* for the first time.

From this study, new first and second intermediate host records (*Lymnaea auricularia*), definitive host record (gosling), and locality record (Colorado) have been established for *C. flabelliformis*.

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Systematic Notes on Some North American Microphallid Trematodes

HILDA LEI CHING[1]

This paper is based on the author's collections of microphallid trematodes from birds of the Pacific coast of North America. However, specimens of trematodes were borrowed from other investigators and freely used for comparison. In two instances, it was necessary to obtain adults from feedings of metacercariae to experimental hosts so that past findings could be corroborated. The generous loan of trematode specimens from the parasitologists mentioned in the text and in particular, the personal communications with Drs. S. Deblock of Lille, France, and M. M. Belopolskaia of Leningrad, U.S.S.R. greatly facilitated the identification of species in this taxonomically complex group.

Ascorhytis n. gen., *A. charadriformis* (Young, 1949) n. comb.

Young (1949) described *Levenseniella charadriformis* from *Limosa fedoa* (L., 1758) and *Catoptrophorus semipalmatus inornatus* (Brewster, 1887) from California, but nowhere did he suggest that the life cycle involved *Olivella biplicata* (Sowerby, 1825) and *Emerita analoga* (Stimson, 1857) as stated by Yamaguti (1958). Ching (1963) redescribed *L. charadriformis* after comparisons with type specimens and specimens from experimental definitive hosts; she found stages in the life cycle to occur naturally in *Littorina scutulata* Gould, 1849, *Hemigrapsus oregonensis* (Dana, 1851), and *H. nudus* (Dana, 1851), and *Larus glaucescens* Naumann, 1840. New natural definitive hosts in Vancouver, Canada include:

Larus canus Linnaeus, 1758 and *L. philadelphia* (Ord, 1815). Both S. Deblock and M. M. Belopolskaia (pers. comm.) have suggested that *L. charadriformis* should be placed in a new genus equivalent to *Levenseniella* because the species differs from such typical members as *L. brachysoma* (Creplin, 1837) Stiles and Hassall, 1901; *L. pellucida* Jaegerskioeld, 1907; *L. propinqua* Jaegerskioeld, 1907; and *L. polydactyla* Deblock and Rosé, 1962. The concept of *Levenseniella* as a genus with a male copulatory pouch containing four complicated, cuticular pockets has been modified by Deblock who reexamined type specimens of *L. brachysoma* (three instead of four pockets), and described *L. polydactyla* (12 pockets). The author assumed that a succession of species in the genus would begin with *L. charadriformis* which has no cuticular pockets and end with *L. polydactyla*. However, microphallid taxon-

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omy presently involves minor differences in the terminal genitalia, in a group that is otherwise remarkably uniform in body size, shape of vitellaria, and arrangement of gonads. The comparison of *L. charadriformis* with *L. propinqua* demonstrated generic differences:

	L. charadriformis	*L. propinqua*
Suckers:	Equal, or oral sucker smaller	Oral sucker larger
Pharynx:	Small, weak	Large, powerful
Seminal vesicle:	Spherical or ovoid	Retort-shaped
Prostate cells:	Small, sparse	Large, abundant
Pars prostatica:	Short, nonglandular	Long, arched, with glandular lining
Male papilla:	Small, muscular, conical	Fleshy, massive
Male copulatory pouch:	No cuticular pockets	Four cuticular pockets
	Irregular-shaped, muscular, highly folded	Round, with gland cells
Female pouch:	Thick-walled, pear-shaped	Thin-walled, round "crumpled" interior
Uterus:	Opens superficially at genital pore	Opens deeply under male papilla in atrium

The constitution of the male copulatory organ is the major difference between the two species and the distinguishing feature of the new genus, *Ascorhytis*. In *L. charadriformis*, it is an irregular-shaped, highly folded muscular organ surrounded in young specimens by gland cells. In *L. propinqua*, the equivalent organ is round and contains four cuticular pockets surrounded by gland cells and muscle fibers. The small, muscular male papilla of *L. charadriformis* is similar to that in the genus *Microphallus* while the male papilla in other species of *Levenseniella* is fleshy when present or completely absent. The female pouch is facultative in *Levenseniella* and when present is thin-walled with a crumpled appearance as compared to the thick-walled, pear-shaped equivalent in *L. charadriformis*.

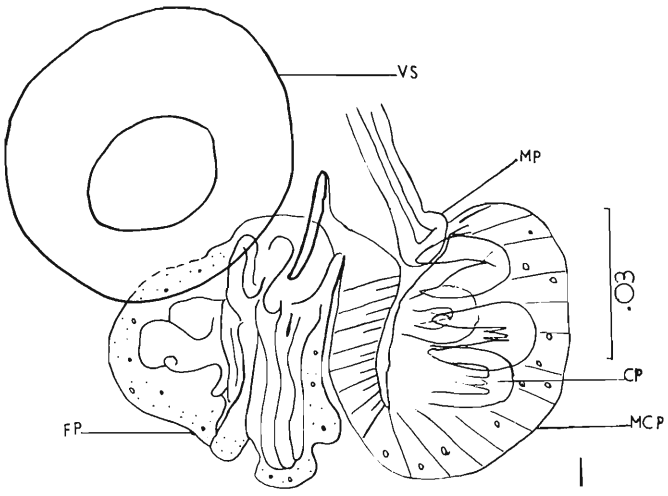
DIAGNOSIS of *Aschorhytis* n. gen.: Small, spined microphallids with pear-shaped bodies. Oral sucker, acetabulum equal in size or oral sucker smaller. Prepharynx short, pharynx small, oval; esophagus long. Ceca short, lined with simple cells, not reaching posterior to acetabulum. Reproductive organs in posterior one-fifth to one-half of body. Genital opening located at left of acetabulum. Cirrus sac lacking. Seminal vesicle globular, anterior to acetabulum. Pars prostatica short; prostate cells small, sparse. Male papilla conical, small, muscular, opening into genital pore. Male copulatory organ present at left of genital opening, with muscular folds; no cuticular pockets, cuticular supports, hooks or ribs; irregular in shape. Female pocket or accessory pouch present on right or posterior to genital pore, thick-walled, pear-shaped. Testes symmetrical, far apart, commencing at postacetabular level. Ovary to right of acetabulum slightly anterior to it. Oviduct coiled. "Fertilization chamber," Mehlis' gland, Laurer's canal present. Uterine coils confined posterior to acetabulum. Metraterm opening superficially into anterior portion of genital pore next to male papilla. Vitellaria posttesticular, arranged in clusters on right and left sides of body. Eggs small, oval. Excretory bladder V-shaped, not reaching anterior to testes. Excretory formula determined from metacercariae: $2[(2+2)+(2+2)]$. Stylet cercaria with suckers, encysting as metacercaria in crustaceans, maturing in intestine of shorebirds.

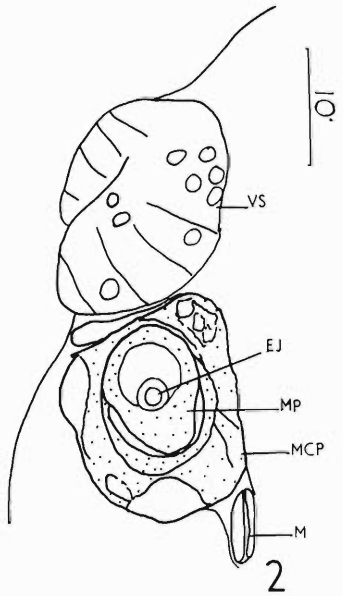
TYPE SPECIES: *A. charadriformis* (Young, 1949) n. comb.

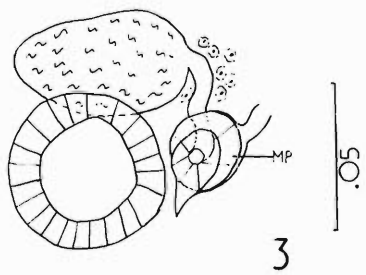
SYNONYM: *Levenseniella c.*

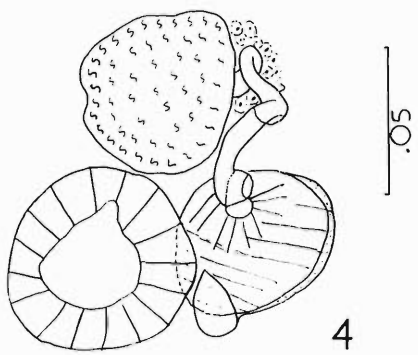
Levenseniella propinqua Jaegerskioeld, 1909
(Fig. 1)

This species was reported earlier (Ching, 1960) from *Haematopus bachmani* Audubon, 1938. Since then, specimens of the species collected by Dr. D. N. Jensen from *Pulvialis dominica* (Müller, 1776) and *Arenaria melanocephala* (Vigors, 1828) from Long Beach, B. C. have been studied from whole mounts and histological sections of the worms stained with PAS-Alcian blue. For comparison, specimens of *L. propinqua* from *Charadrius hiaticula* L., 1758, were obtained from S. Deblock and M. M. Belopolskaia. It was concluded from studies of all specimens in whole mounts that the number of cuticular pockets varied, with most worms showing two or three but not all four pockets simultaneously. Also, the appearance of hooks, knobs, ribs, etc. within the pockets would probably be influenced by the type of fixation so that the best method of determining the number and nature of the pockets is by examination of living specimens. In addition, a number of specimens should be available to determine the constancy of cuticular pockets









All figures were drawn with the aid of a camera lucida. Measurements on scales indicate millimeters.

Fig. 1. Terminal genitalia of *Levenseniella propinqua*. CP, cuticular pocket; FP, female pouch, MCP, male copulatory pouch; MP, male papilla; VS, ventral sucker.

in a particular species since Deblock has found *L. brachysoma* (= *L. tridigitata*) to have only three instead of four pockets.

The determination of the species, *L. propinqua*, was based on the four cuticular pockets in a round pouch of equal size to the ventral sucker, the pockets showing irregular, triradiate hooks with AFA fixation (Fig. 1). The well-developed female pouch is highly folded and at least one-half the size of the male pouch; the fleshy male papilla and long pars prostatica with large prostate cells are characteristic of the species.

Atriophallophorus minuta Deblock and Rose, 1964 (Fig. 2)

From a scoter in the West Indies, Price (1934) described *Levenseniella minuta* as having a relatively large genital sinus containing apparently three papilla-like processes. Stunkard (1958) worked out the abbreviated life cycle of *L. minuta* and redescribed the species. The genital atrium had a folded, fibrous wall with no definite pockets, no cuticular supports, hooks, or ribs. The small, male papilla opened on the dorsal face of the genital atrium; the atrial wall can be everted from the pore as a copulatory organ with the male papilla at its tip. Burns (1963) reported *L. minuta* in a new locality with new intermediate and definitive hosts.

Specimens of *L. minuta* were borrowed from Drs. Stunkard and Burns and from the U.S.N.M. Helm. Coll. (Price's paratype No. 38704). In addition, Dr. Ivan Pratt collected and sent to the author the molluscan host reported by Burns, *Oxytrema silicula* (Gould), from which the metacercariae were obtained and fed experimentally to white mice. The large numbers of adults that were received after 48 hr from the mice were studied alive, and after heat and formalin fixation in whole mounts and histological sections.

Deblock and Rose (1964a) described a new genus, new species, *Atriophallophorus samarae*, whose unique characteristic was a kind of supernumerary genital atrium, "the phallophore," on which the male papilla was supported. Shortly after, they (1964b) suggested that *Atriophallophorus samarae* was probably a synonym of *Levenseniella minuta sensu* Price, 1934.

In general, the description by Deblock and Rose agrees with the appearance of the author's specimens, and barring different states of preservation, characterizes the specimens of what earlier authors called *Levenseniella minuta*. The minute size of the worm makes study of the sex organs very difficult. The conventional staining of whole mounts with hematoxylin or carmine does not aid in determining the structural components of the terminal genitalia, hence the conflicts in earlier descriptions of their fibrous or muscular nature. Finally, the size and shape of the phalliphore and male papilla varies upon the state of eversion of the latter. The identification of this species becomes most laborious to anyone trying to classify trematodes. The phallophore of *Atriophallophorus* is essentially the male copulatory pouch of the genus *Levenseniella* but without the cuticular pockets, hooks, or ribs. The genus *Atriotrema* Belopolskaia, 1958 has a large, folded, thick-walled genital atrium which might be similar to the phallophore of *Atriophallophorus*.

Microphallus nicolli (Cable and Hunninen, 1938) Baer, 1943 (Fig. 3)

Although Young (1938) described the life cycle of what he tentatively identified as *Levenseniella cruzi*, he later (1949) corrected the identity of the species to *Spelotrema nicolli* Cable and Hunninen, 1938. Intermediate hosts listed for *L. cruzi* in Yamaguti's (1958) treatise are consequently incorrect. Young preferred to consider his specimens as conspecific with *S. nicolli* although the hosts at each stage of the life cycle differed from those reported by Cable and Hunninen (1940) for this species on the

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Fig. 2. Sagittal section of genital atrium of *Atriophallophorus minuta*. EJ, ejaculatory duct; M, metraterm; MP; male papilla; MCP, male copulatory pouch.
Fig. 3. Ventral view of male papilla of *Microphallus nicolli*.
Fig. 4. Ventral view of male papilla of *Microphallus similis*.

east coast of North America; egg sizes, form of vitellaria, and proportions of the suckers were also mentioned as somewhat different. Subsequently, the genus *Spelotrema* has been synonymized with *Microphallus*, the species becoming *M. nicolli*.

The author obtained approximately 100 mole crabs, *Emerita analoga* from Santa Barbara, California and found that the metacercariae infecting the crabs was that of a single species, *M. nicolli*. Large numbers of metacercariae were fed to a mouse, and sexually mature worms were recovered after 33 hr. Metacercariae that were kept in sea water at 37 C also produced eggs readily after 48-hr incubation. Specimens of *Microphallus* from *Larus glaucescens* in the author's collection were similar to those from *Emerita analoga*, i.e., *M. nicolli*; no distinct differences could be found from the holotype of *M. nicolli* or the original description. Egg sizes overlapped those quoted in the original description and suckers were found to be almost equal in size. In young specimens the vitellaria consisted of five to six lobes fused in the center, but changed drastically in older specimens to become indistinct clusters. The male papilla opens symmetrically within the genital pore. The ejaculatory duct ends centrally within the male papilla which is one-third to one-half the diameter of the ventral sucker.

Microphallus similis (Jaegerskioeld, 1900) Baer, 1943 (Fig. 4)

Of the five species of *Microphallus* present in this locality, *Microphallus similis* is the largest in body size (0.4–0.6 × 0.2–0.35 in ten specimens measured) with the most complicated male papilla. The male papilla is slightly smaller than the ventral sucker; the ejaculatory duct curves in an S-shape before piercing the male papilla excentrically and usually in a sinuous direction. The genital opening contains part of the muscular male papilla but not the opening of the ejaculatory duct.

The presence of *M. similis* in large numbers in the intestine of *Larus glaucescens* indicates a new host record and new locality for this parasite.

Microphallus pirum (Afanassjew, 1941) Belopolskaia, 1952 (Figs. 5, 6)

Schiller (1959) reviewed the taxonomic changes of the species, *Microphallus pirum* (syn.: *Paraheterophyes p.* Afanassjew, 1941; *Spelotrema p.* (A.) Belopolskaia, 1952; *Microphallus enhydrae* Rausch and Locker, 1951). His report on its life cycle is incorrect, as far as the sporocyst and cercarial stages are concerned. The "early stage" cercaria is a microphallid type but the "completely developed" cercaria is a renicolid type as pointed out by Cable (1963). "Sporocysts" reared experimentally appear to be hemiuroid cercariae enveloped within their membranous cysts and are like those that the writer has found in natural infections of *Thais emarginata* (Deshayes, 1839), the experimental host used by Schiller. Microphallid metacercariae from *Paqurus hirsutiusculus* (Dana, 1851) and *Telmessus* may be that of *M. pirum*, but the average length, 0.580, is much greater than the average length, 0.350, of specimens found in *Enhydra lutris* (L.), the natural host. Schiller fed metacercariae from *P. hirsutiusculus* to experimental hosts which included the hamster, red fox, arctic fox, and glaucous winged gull. Specimens varied greatly in body size with each host, but the proportions of the esophagus and suckers remained the same.

Measurements of *M. enhydrae* as given by Rausch and Locker (1951) generally overlap those of *M. pirum* as quoted by Belopolskaia (1952). However, most of the specimens of *M. enhydrae* were shorter than 0.580 while the range in length for *M. pirum* was given as 0.70–0.80. The figure of *M. enhydrae* shows a prominent pharynx which is nearly the size of the oral sucker, but specimens of *M. enhydrae* donated by R. Rausch show a pharynx less than one-third the size of the oral sucker. The male papilla in *M. enhydrae* is about one-half the size of the ventral sucker, while the male papilla in the figure of *M. pirum* is slightly less than the diameter of the ventral sucker. Since *M. enhydrae* and *M. pirum* were found in the same hosts, it is highly likely that they are conspecific despite the differences mentioned above.

On the basis of Rausch and Locker's description of *M. enhydrae*, Biguet, Deblock, and Capron (1958) suggested that it was a new synonym of *Microphallus pygmaeum*. However, specimens of *M. pygmaeum* in the writer's collection were compared with *M. pirum* from Rausch's collection and found to be quite dif-

ferent. *Microphallus pygmaeum* is roughly triangular in body shape, heavily spined, with few, large eggs restricted to the posterior fourth of the body. *Microphallus pirum* (= *M. enhydrae*) has a pointed anterior end and broadly rounded posterior end, with very few, small spines, and abundant eggs located in the posterior one-third to one-half of the body.

Specimens of *M. pirum* in the minimum size range (0.11–0.34 × 0.08–0.26) but with the same body shape and egg size as specimens from *Enhydra lutris*, were found in the white winged scoter, *Melanitta deglandi* (Bonaparte, 1850). In unflattened specimens, the edges of the hind body are curled ventrally (Fig. 5). Flattened specimens reveal an exaggerated posterior end filled with numerous eggs; the relatively short, widely divergent ceca are located at mid-body (Fig. 6).

Microphallus oblonga n. sp. (Figs. 7, 8)

This species was tentatively referred to as *M. primas* (Jaegerskioeld, 1909) by Ching (1960) but differed from the original description in the equal size of the suckers, male papilla as large as the acetabulum, and testes of equal or larger size than the ovary. Deblock (pers. comm.) examined Jaegerskioeld's original work and felt certain that *Microphallus canchei* Biguet, Deblock, and Capron, 1958 was synonymous with *M. primas*. While Biguet, Deblock, and Capron (1958) preferred to consider the genus *Microphallus* as a heterogenous group with *Carneophallus* as one of its synonyms, Cable, Connor, and Balling (1960) continued to recognize *Carneophallus* and transferred *M. canchei* to this genus.

In addition to the characteristics mentioned above, *M. oblonga* differs from specimens of *M. primas* which were donated by Deblock, in the absence of dorsal and ventral lobes at the distal end of the male papilla, in the relatively small size of the seminal vesicle and metraterm, and in the structure of both metraterm and the prostate cells. The male papilla of *M. oblonga* is usually seen in lateral view (Fig. 8) as an oblong organ with an uneven but unlobed distal end in comparison to the round or extremely elongate, lobed male papillae of other species of *Microphallus*.

As mentioned earlier (1960, p. 58), only eight specimens, barely ovigerous, were recovered from *Haematopus bachmani*. They were preserved in their natural position except for one flattened, elongate specimen. This specimen, the holotype, unfortunately has the distal end of the male papilla turned ventrally so that the male papilla appears rounded and smaller than the acetabulum (Fig. 7). A better view of the male papilla is shown in its paratype (Fig. 8). Following are the measurements of the holotype and short description based on the entire collection. Diagnosis: Small, pyriform Microphallinae. Spination to mid-body. Length, 0.541, width at level of acetabulum, 0.199. Suckers equal in size, 0.053 in transverse diameter. Prepharynx short, pharynx 0.027 by 0.019. Esophagus length, 0.103; ceca bifurcating in sharp angles, extending in hind body to level of midacetabulum. Testes suboval, transverse diameter of right, 0.101; left, 0.084; symmetrical in hind body. Cirrus sac lacking. Seminal vesicle smaller than acetabulum, globular to clavate, anterior to acetabulum. Prostate cells large, overlapping acetabulum dorsally. Ejaculatory duct enlarging before entering male papilla dorsally; male papilla oblong in lateral view, 0.053 by 0.045, with no muscular, terminal dorsal, or ventral lobes; ends of male papilla ending unequally, sometimes with slight cleft dorsally (Fig. 8). Genital atrium entirely filled with male papilla, genital pore to left of acetabulum. Metraterm superficially entering genital atrium near distal end of male papilla as a thick, well-developed duct, dorsally often underlying genital atrium. Ovary roughly triangular, transverse diameter, 0.087, directly to right of acetabulum. Seminal receptacle present. Vitellaria in two groups of five lobes. Eggs, 18–25 by 8–9 μ. Type specimen 60469, U.S.N.M. Helm. Coll.

The five species of *Microphallus* of the Pacific coast of North America can be readily separated with the following key:

1. (6) Male papilla one-third to one-half the size of ventral sucker 2
2. (5) Body less than 0.5 mm in length 3
3. (4) Body roughly triangular, few eggs, heavy spines ..... *M. pygmaeum*
4. (3) Body pear-shaped, many eggs, few spines ..... *M. pirum*
5. (2) Body larger than 0.5 mm, pear-shaped, heavy spines ..... *M. nicolli*

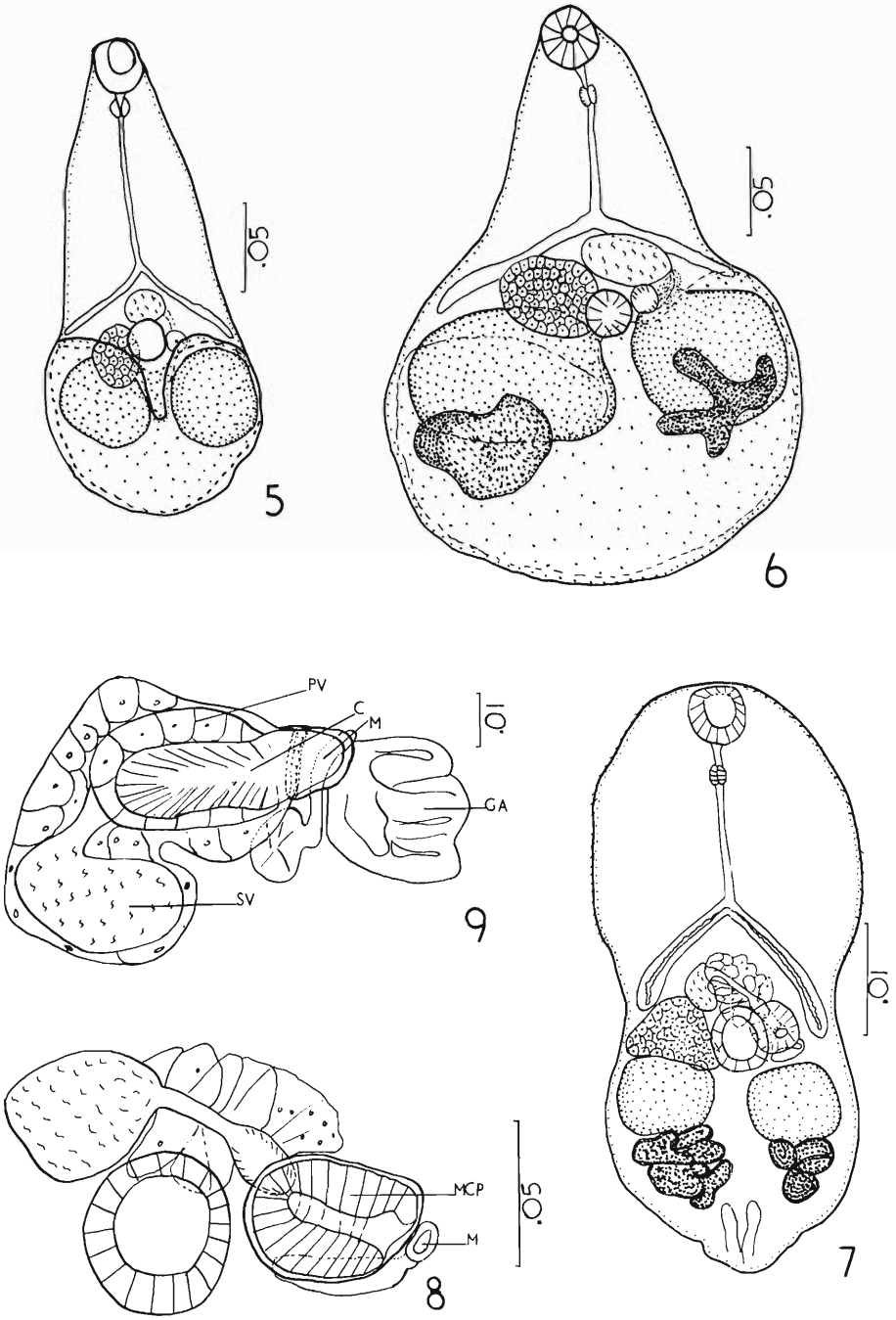

Fig. 5. Whole mount, unflattened, ventral view of *Microphallus pirum* from *Melanitta deglandi*.
Fig. 6. Flattened specimen of *M. pirum* from *M. deglandi*.

6. (1) Male papilla almost the size of ventral sucker 7
7. (8) Male papilla asymmetrical, eccentric opening ..... *M. similis*
8. (7) Male papilla symmetrical, oblong ..... *M. oblonga*

Plenosoma minimum Ching, 1960 (Fig. 9)

An enlarged drawing of the terminal genitalia is presented. All ten specimens recovered from the oystercatcher, *Hematopus bachmani*, showed the cirrus withdrawn into the cirrus sac with the interior of the cirrus containing sharply tapered cells; the exterior appears to be spined. Dorsal to the oval to elongate cirrus is the prostatic vesicle containing large, delicate cells. These characteristics were not described fully in the original description. The metraterm joins the genital pore superficially and dorsally at the anterior edge so that the organ to the left of the genital pore can only be described as part of the genital atrium. However, this part of the genital atrium looks similar to the thick-walled female pouch of *Ascorhytis*. Additional, live specimens should immeasurably improve the concept of this interesting genus.

SUMMARY

Ascorhytis n. gen. (type: *A. charadriformis* (Young, 1949) n. comb.) differs from the genus *Levenseniella* in having a folded, muscular, male copulatory pouch completely lacking in cuticular pockets; a pear-shaped, thick-walled female pouch; a small, muscular male papilla; and short pars prostatica with small prostate cells. *Levenseniella propinqua* and *Atriophallophorus minuta* were identified. *Microphallus oblonga* n. sp. from *Haematopus bachmani* differs from the closely related *M. primas* in the absence of dorsal and ventral lobes on the male papilla, in the structure of the metraterm and prostate cells, and in the relatively small size of the seminal vesicle and metraterm. The species *Microphallus nicolli*, *M. similis*, and *M. pirum* are reported from new definitive hosts and distinguished from *Microphallus oblonga* and *M. pygmaeum*.

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Fig. 7. Holotype of *Microphallus oblonga*, ventral view.
Fig. 8. Male papilla of paratype *M. oblonga*.
Fig. 9. Terminal genitalia of *Plenosoma minimum*. C, cirrus; GA, genital atrium; M, metraterm; PV, prostatic vesicle; SV, seminal vesicle.

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Life History of *Pelodera strongyloides* (Schneider) in the Orbits of Murid Rodents in Great Britain[1]

GEORGE O. POINAR, JR.

The free-living soil nematode, *Pelodera strongyloides* (Schneider) can be cultivated successfully on artificial media through several generations if adequate numbers of bacteria are supplied as food. Trapido (1965), however, discovered larvae of *Pelodera strongyloides* in the orbits of Muridae in England and Scotland in June, 1963, and brought this association to the attention of the author, then working at Rothamsted Experimental Station in Harpenden, England.

In this association, the nematodes occurred only in lacrimal fluid of the ocular orbit and were never found inside the eyeball.

P. strongyloides has been found in a number of habitats and there are reports of its occurrence in skin pustules of mammals. These findings have been summarized by Chitwood (1932) who examined specimens from the skin of dogs. He concluded that, under rare conditions, this species is capable of secondary invasion into animal tissues.

Stammer (1956) and Osche (1963) found *P. strongyloides* in the orbits of rodents in Germany. Similar larvae were collected by Dr. C. J. Weinmann from the orbits of a specimen of *Microtus californicus* (Peale) in California. Another possible record may be the report by Rausch (1952) who found nematodes in the orbits of lemmings in Alaska.

In England, the nematodes often occurred in large numbers in the corners of the orbits of infected rodents and moved actively through the lacrimal fluid when the eyelid was drawn back. In one instance, 1,293 larvae were removed from the orbits of a bank vole, *Clethrionomys glareolus* (Schreber). More than 90% of *C. glareolus* sampled in the vicinity of Oxford, England, were infected. Specimens of *Apodemus sylvaticus* (L.) were also infected, but to a lesser extent.

LIFE HISTORY: The life history of *P. strongyloides* was studied in the laboratory. Twelve infected specimens of *C. glareolus* were collected from the field and placed in small cages partially filled with moist, sterilized soil. Over a period of several months, soil samples were removed from each cage and the nematodes extracted by a modified Baermann funnel. At the same time, a sample of nematode larvae was removed from the lacrimal fluid for examination.

Two weeks after the infected voles were introduced into the cages, all stages of *P. strongyloides* could be extracted from the soil. When transferred to Nigon's nutrient agar medium (Nigon, 1949), the nematodes went

[1] From the Division of Invertebrate Pathology, University of California, Berkeley, California. This study was financed by the National Institutes of Health while the author was at Rothamsted Experimental Station, Harpenden, Herts., England. I thank Dr. J. Webster, Dr. J. B. Goodey, Mr. F. G. W. Jones, and Mr. C. Doncaster at Rothamsted for help in various aspects of the problem, Dr. Harold Trapido for furnishing infected voles from Oxford, England, and Dr. W. G. Inglis at the British Museum for helpful comments.

through several generations without any association with the voles or vole products. During the following 2 weeks, the soil in several cages became fairly dry and was found to contain a number of "infective" larvae of *P. strongyloides*

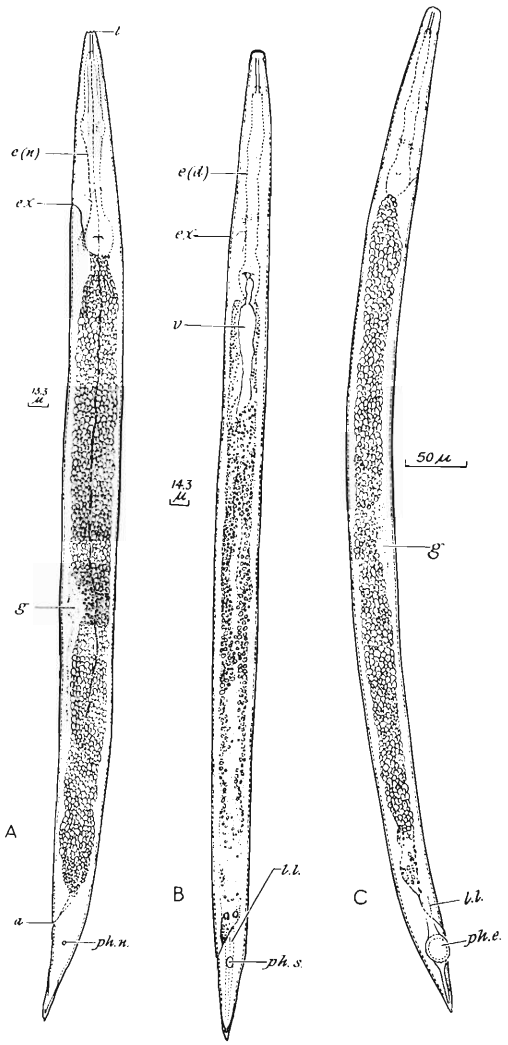

Fig. 1. Comparison of free-living, infective, and parasitic larvae of *Pelodera strongyloides* (Schneider). (A) A free-living larva as developed on Nigon's medium. (B) An "infective" larva recovered from soil in a cage containing infected individuals of *Clethrionomys glareolus*. (C) A mature parasitic larva removed from the lacrimal fluid of *Clethrionomys glareolus*.

still enclosed in their last-stage cuticle (Fig. 1, B). They were much slower-moving than the free-living larvae (Fig. 1, A) and when placed in water moved slowly back and forth inside their cuticles. These ensheathed larvae were narrower than the larvae of the free-living generation and would often remain motionless in culture plates for a long time. The lips were offset, the stoma long and narrow, and the esophagus appeared degenerate, with both the metacorpus and the basal bulb musculature reduced. Many possessed a viscous material behind the bulb flaps which often extended into the anterior portion of the intestine. The oval-shaped phasmids were slightly enlarged.

Coincident with the appearance of ensheathed larvae in the soil was the finding of identical forms in samples from the lacrimal fluid of caged voles.

The development of the larvae in the lacrimal fluid was studied by periodic sampling of infected *C. glareolus* in metal bottom cages, which prevented reinfection of the orbits from soil.

After several days, the newly introduced ensheathed larvae would exsheath and begin to move slowly through the lacrimal fluid. Development of the exsheathed larva in the lacrimal fluid usually took 2–3 weeks. This is relatively long, considering the life cycle of the free-living generation takes only 5 days on Nigon's medium.

During this developmental period in the lacrimal fluid, the body increased in length and width and gradually became granular from the deposition of food material in the intestine. The lips gradually became less offset.

Most remarkable was the enlargement of the phasmids (Fig. 2). Shortly after the newly introduced larvae exsheathed in the lacrimal fluid, the phasmids, although larger than those of the free-living larvae, appeared as small discs (Fig. 2, A). The phasmidial glands contained secretions which reached the exterior via a phasmidial duct. After 2 days, the contents of the glands increased, enlarging the gland reservoirs and forcing material into the phasmidial ducts (Fig. 2, B). Eventually, each gland enlarged to a point where its inner wall was in contact with that of the opposite pair and at the same time, forced the phasmidial ducts apart and stretched the phasmidial opening (Fig. 2, C). At this time, secretions

could be seen in phasmidial canals, which extended anteriorly into the body cavity. When the larva was fully developed, the phasmidial openings enlarged and appeared as a pair of discs on the tail of the nematode (Fig. 2, D).

Soon after this phase, parasitic larvae were found in the soil under the infected voles (Fig. 1, C). These were postparasitic larvae and when removed to Nigon's medium, they molted to the adult stage and began a free-living existence. I was unable to find any sign of a molt occurring between the period of exsheathment and the final molt in the soil to the adult form. Further studies are now in progress to determine the total number of molts in this species and the stage of the infective form. The phasmidial discs were shed with the last cuticle and the adults, which now had normal phasmids, appeared morphologically identical to free-living adults reared several generations on media in the laboratory. The sexual stages of *P. strongyloides* are illustrated in detail by Chitwood and Chitwood (1937, see p. 8–9), but no mention has been made of enlarged phasmids in previous cases of *strongyloides*–mammal associations.

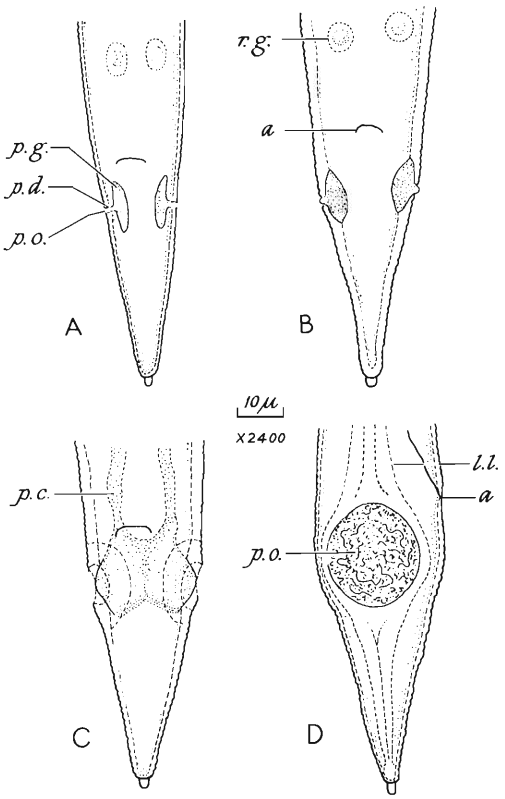

Fig. 2. Phasmidial development in a recently exsheathed parasitic larva of *Pelodera strongyloides* (Schneider). (A) Ventral view of larval tail in an individual which had recently exsheathed. (B) Ventral view of larval tail showing initial swelling of phasmids. (C) Ventral view of tail of an older parasitic larva. (D) Lateral view of tail in a mature parasitic larva showing how the enlarged phasmidial opening has distended the lateral line.

DISCUSSION

The larvae of *Pelora strongyloides* (Schneider) gain entrance into the lacrimal fluid of Muridae through the development of special infective larvae which are formed in the soil. Low humidity stimulates the formation of "infective" larvae, which withstand extremes of temperature and drought that often kill the remainder of the population.

The actual manner of entrance into the orbit is not known, but observations indicate that the infective larvae may be picked up on the feet of the rodents and transmitted to their orbits while the rodents are grooming.

Shortly after entrance, the ensheathed nematode exsheaths and begins development in the lacrimal fluid. During this period, the body size increases and phasmids enlarge. When fully developed, the larvae leaves the orbit and enters the soil where it molts to the adult stage.

One rodent can serve as "host" for several generations of nematode larvae. The death of the vole is not necessary for the completion of nematode development. In fact, when experimental voles died, most of the nematode larvae also died and only a few larvae entered the soil.

The enlargement of the phasmids in larvae living in a somewhat hypertonic environment suggests a possible function of these structures. Thorne (1961) states that the function of phasmids in nematodes is not known, but thinks that in some cases fluid may be expelled from them for the purpose of leaving a scent trail which would attract other members of the same species. Wallace (1963) states that the phasmids in plant parasitic nematodes are probably sensory. This view is also shared by Hyman (1951) who mentions that they are best developed in parasitic forms.

Stephenson (1942) found that the phasmids of *Rhabditis terrestris* Stephenson become enlarged when nematodes are placed in a 0.34 M solution of NaCl. This hypertrophied condition is frequently seen during the recovery process 20–30 hours after immersion in the salt solution when the larvae were adjusting to the hypertonic environment.

From my findings and Stephenson's, it seems that the phasmids may be connected with maintaining the correct osmotic balance in the body, since lacrimal fluid contains about 1.30% inorganic salts.

Throughout the entire study, I have found no obvious pathological effects from the presence of *strongyloides* in the orbits of *C. glareolus*. In cases where hundreds of nematode larvae occur in each orbit, there may be a mechanical obstruction of vision, but inflammation of the eye or associated tissues was never observed. Possibly the nematode larvae obtain their nourishment from solutes in the lacrimal fluid and may also ingest bacteria or debris introduced into the orbit.

I have not been able to restore development of free-living populations of *strongyloides* from the infective larvae. When these "dauer" forms are transferred from dry soil to rich bacteria-laden agar cultures they do not feed or develop but remain quiescent.

The movement of larvae into the orbits of rodents may benefit *strongyloides* (1) by carrying the nematode over periods of adversity, (2) by providing a relatively unexploited ecological niche resulting in little competition for food, and (3) by providing an excellent means of distribution.

SUMMARY

Pelodera strongyloides (Schneider) is capable of forming an infective, ensheathed larva which can develop in the lacrimal fluid of murid rodents. After a developmental period of 2–3 weeks, the larvae leave the orbits and molt to the adult stage in the soil.

While in the lacrimal fluid, the larvae develop enlarged phasmids which may be associated with the excretion of salts, thus regulating their osmotic balance.

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Abbreviations used: a—anus; e(d)—degenerative esophagus; 3(n)—normal esophagus; ex—excretory pore; g—primordial gonad; l.—lips; l.l.—lateral line; p.c.—phasmidial canals; p.d.—phasmidial duct; p.g.—phasmidial gland; p.o.—phasmidial opening; ph.e.—enlarged phasmid; ph.n.—normal phasmid; ph.s.—slightly enlarged phasmid; r.g.—rectal glands; v—viscous material.

Studies on Freshwater Larval Trematodes. Part IX. A new Species of a Gymnocephalic Cercaria, *Cercaria sucrensis*, from Venezuela[1]

P. NASIR AND C. A. ACUÑA

Several hundred specimens of *Marisa cornuarietis* (L.) were examined from Quebrada Chacaracul, Station 38, Cumaná, Venezuela and two of these were emitting a nonocellate Gymnocephalic cercaria with a fin fold limited to its distal third part of the tail. As a result of detailed comparative study of the related species it proved to be a new larval trematode and named *Cercaria sucrensis* after the state of Sucre which houses the Sucre branch of the Universidad de Oriente where the present work on freshwater larval trematodes of Venezuela is being conducted.

Cercaria sucrensis n. sp. (Figs. 1, 2)

DESCRIPTION: Body and tail aspinose, without papillae, having several rows of hairlike processes. No eyespots. Posterior one-third of tail furnished with a fin fold in a dorsoventral aspect. Oral sucker larger than ventral sucker. Oral orifice bordered with a complete circlet of papillae. Ventral sucker without papillae, lying slightly behind equatorial line of body. Extreme anterior end of body lined with eight apertures. Only in a few specimens ductlike extensions could be associated with these apertures. Cystogenous glands with rodlike contents, yellow in color. A small prepharynx present. Pharynx muscular. Esophagus short. Ceca not extending up to equator of ventral sucker. Cerebral mass lying dorsally over prepharynx. Genital rudiments represented by three nucleated masses, one anterior and two posterior to ventral sucker. Excretory vesicle somewhat rectangular, part of it extending into proximal part of tail. Caudal duct dividing into two lateral branches, extending as far as middle level of tail. Main excretory tubes enclosing refractile excretory granules through their extent. Each of the main tubes after forming a loop in oral region continued posteriorly, as far as halfway in postacetabular region dividing into an anterior and a posterior lateral connecting tube. Secondary excretory tubes ciliated except for a short distance anteriorly. Flame-cell formula: $2[(2 + 2 + 2) + (2 + 2 + 2)] = 24$. No definite time of emergence. Negatively phototactic. Measurements (in mm) of ten naturally emerged cercariae killed by plunging into hot 10% formalin: body 0.147–0.174 by 0.090–0.144; tail 0.111–0.186 by 0.031–0.087; oral sucker 0.033–0.045 in diameter; ventral sucker

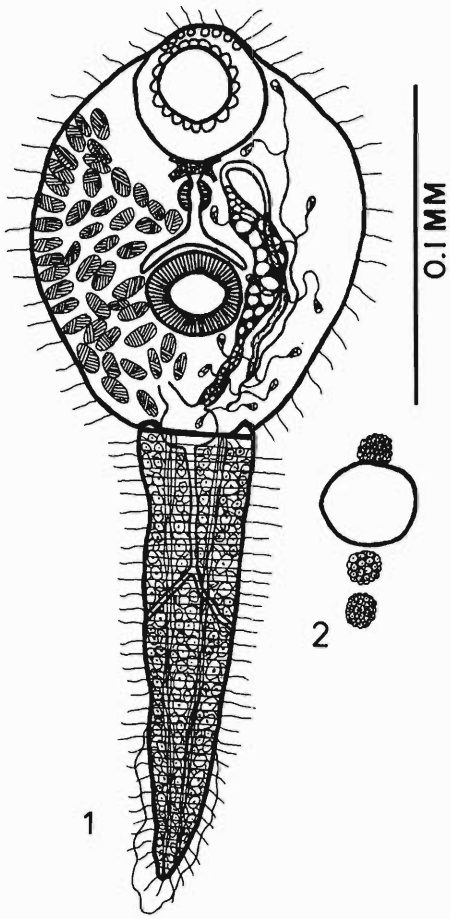

Fig. 1. *Cercaria sucrensis* n. sp., ventral view.
Fig. 2. Pattern of genital rudiments of *C. sucrei*, ventral view.

[1] Contribution from Escuela de Biologia, Departmento de Parasitologia, Universidad de Oriente, Cerro Colorado, Cumaná, Venezuela.

0.027–0.039 in diameter; prepharynx 0.005–0.012 long; pharynx 0.009–0.013 in diameter; esophagus 0.006–0.012 long. Development in rediae, having a pharynx, a complete collar, a saccate gut and a pair of posterior locomotor appendages. Total length of rediae, 0.162–1.056 by 0.069–0.168; pharynx 0.042–0.060 in diameter; intestine 0.042–0.588.

TYPE SPECIMEN: Laboratorio de Parasitologia, Universidad de Oriente, Cumaná, Venezuela, Nos. UDOPL-LT 11 and UDOPL-LT 12.

DISCUSSION

Cercaria reflexae Cort (1914) as described by Feldman (1941), *C. penthesilia* Faust (1921), *C. helvetica XVII* Dubois (1929) = *C. obscura* as described by Wesenberg-Lund (1934), *C. sudanensis No. 4* Archibald and Marshall (1932), *C. ornaticauda* Brooks (1943), and cercaria of *Sphaeridiotrema spinoacetabulum* Burns (1961) are all nonocellate Gymnocephalic cercariae with a caudal fin fold. Cercaria of *S. spinoacetabulum* is clearly distinguishable from *C. sucrei* in having granular but not rodlike contents of cystogenous gland cells. And same is the case with *C. reflexae* as well as *C. ornatocaudata*. *Cercaria sudanensis* is poorly described. However, from the fragmentary information it appears that its tail is completely surrounded by a fin fold and ceca extend to posterior border of ventral sucker. In *C. sucrensis* only the posterior third of tail is beset with a thin membrane and ceca do not extend even up to the equatorial level of the ventral sucker. *Cercaria penthesilia* and *C. helvetica XVII* have rhabditiform contents of cystogenous glands and are, therefore, more closely lined with *C. sucrensis*. *Cercaria penthesilia* bears a further resemblance in having a fin fold limited to the distal third of tail. It differs from *C. sucrensis* in that its body is spinose, esophagus divides immediately posterior to pharynx, and ceca extend to posterior end of body. *Cercaria helvitica XVII* has a fin fold running along the entire caudal extent, esophagus ending blindly and the ventral sucker is so far posteriorly located that Wesenberg-Lund, at first, thought it to be an Amphistome larva.

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Six Digenetic Trematodes of Mammals from North Borneo (Malaysia)[1]

JACOB H. FISCHTHAL AND ROBERT E. KUNTZ[2]

The trematodes of this report represent a portion of a collection from mammals made by the junior author while a member of the U.S. Naval Medical Research Unit No. 2, Taipei, Taiwan. Schad, Kuntz, Anteson, and Webster (1964) studied the amphistomes. The present specimens were washed in saline, killed in hot water, and transferred immediately to FAA fixative. After 4–8 hr they were stored in 70% alcohol plus 2% glycerine. Staining was in hematoxylin or Mayer's carmalum, and all were mounted in permount. Unless otherwise indicated measurements are in microns.

FAMILY DICROCOELIIDAE

Leipertrema vitellariolateralis Rohde, 1963 (Fig. 1)

HOST: *Callosciurus notatus dilutus* (Sciuridae).

HABITAT: Small intestine.

LOCALITIES: Jesselton and Kepayan, North Borneo.

DATES: 31 August (Jesselton), 27 September (Kepayan) 1960.

SPECIMENS: U.S.N.M. Helm. Coll. No. 60969 (two slides with one specimen each).

DISCUSSION: This worm was first described by Rohde (1963a) from the small intestine of *Callosciurus notatus* from Malaya, and again was reported by him (1963b) from the pancreas of *C. caniceps*. The measurements of our four specimens were within the ranges given by Rohde (1963a) and compared favorably with all five of the latter's syntypes (U.S.N.M. Helm. Coll. No. 39469) examined by us. In our specimens the vitellaria on both sides of the body were more laterally and longitudinally distributed. One of Rohde's syntypes showed the right vitelline field more longitudinally distributed than he described. Neither Sandosham (1951) for *Leipertrema rewelli* (type and only other species in the genus) nor Rohde (1936a, b) for the latter and for *L. vitellariolateralis* described or illustrated the details of the terminal genitalia. In our specimens the vasa efferentia join to form a short vas deferens entering the proximal end of the cirrus sac. The latter is somewhat oval, relatively thick walled, and muscular, containing a much coiled, thin walled, tubular seminal vesicle, a short, thin walled, cell lined pars prostatica, a long, thick walled, muscular, winding cirrus opening into a shallow genital atrium, and prostate cells surrounding the pars prostatica and cirrus. The metraterm is thick walled, muscular, slightly winding, surrounded by gland cells throughout its length, slightly longer than the cirrus sac, and opens into the genital atrium.

Lutztrema callosciuri n. sp. (Figs. 2, 3)

HOST: *Callosciurus prevostii pluto* (Sciuridae).

HABITAT: Liver.

LOCALITY: Ranau, North Borneo.

DATE: 22 September 1960.

TYPES: U.S.N.M. Helm. Coll. No. 60970 (one slide of holotype and one of paratype).

DIAGNOSIS (based on four specimens, two measured): Body narrow, elongate, length 1,901 to 2,685, forebody width 106 to 133, width at vitellaria 305 to 350. Forebody 395 to 465, hind body 1,740 to 2,066; postovarian space 1,250 to 1,400, postvitellarian space 850 to 974. Preoral body 10 to 12 long, tapered to blunt point, humplike. Oral sucker (in three) 73 to 133 by 65 to 116, subterminal ventral. Acetabulum (in three) 81 to 155 by 118 to 179, nearly as wide as body, slightly elevated from body surface. Sucker length ratio (in three) 1 : 1.11 to 1.17. Pharynx 47 to 52 by 61 to 67, overlapping oral sucker dorsally.

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The authors are indebted to Dr. David H. Johnson, Curator of Mammals, U.S. National Museum, for host identifications, and to Woodrow Bristline, HMC, USN, Bob Ray Davis, HM1, USN, Jack Hegg, HM1, USN, Dr. Chang-sheng Tseng, Mr. Ching-tsong Lo, and Mr. Atvar Gill for assistance in the collection and examination of hosts. Mr. Henry Holland, Director, Kepayan Veterinary Station, Jesselton, provided facilities for the NAMRU field party, and Mr. G. L. Carson, Conservator of Forests, Sandakan, provided permits for the collection of mammals.

Cecum single, descending right of midline to posterior testis level before being masked by eggs, dorsal to acetabulum, testes and uterus. Excretory bladder not visible; pore terminal.

Testes two, diagonal, large relative to body width, smooth, elongate oval; anterior (left) testis 155 to 186 by 123 to 167, 29 to 58 postacetabular; posterior (right) testis 182 to 211 by 140 to 179, 177 to 260 postacetabular, overlapping level of anterior testis in one and 29 posterior in one, 5 to 70 preovarian. Cirrus sac 117 to 140 by 43 to 65, thick walled, muscular, commencing 29 to 61 preacetabular, containing seminal vesicle, pars prostatica, prostate cells and cirrus. Seminal vesicle tubular, much coiled, thin walled; pars prostatica short, thin walled, surrounded by prostate cells; cirrus long, straight, thick walled, muscular, surrounded by prostate cells, opening into genital atrium. Genital pore median to slightly submedian, 142 to 196 preacetabular, 87 to 103 postpharyngeal, 121 to 130 posterior to oral sucker.

Ovary 128 to 133 by 140 to 158, wider than long, smooth, sinistral, diagonal to posterior testis and in line with anterior testis, 355 to 555 postacetabular. Seminal receptacle (in one) 48 by 57, dorsal, overlapping posterodorsal edge of ovary. Laurer's canal muscular, sinuous, posterosinistral to ovary, sinistral to seminal receptacle. Vitellaria more or less in band across body, longitudinal extent 320 to 325, entire left field slightly more anteriorly placed than right, 515 to 735 postacetabular, 32 to 53 postovarian. Uterus voluminous, filling entire postovarian body; ascending right of ovary, crossing body between testes, right of anterior testis, crossing body between latter and acetabulum, over left portion of latter in slightly sinuous path to genital pore. Metraterm slightly thick walled, muscular, slightly shorter than cirrus sac. Eggs numerous, thick shelled, operculate, 18 measuring 29 to 36 by 18 to 23.

DISCUSSION: This is the first record of the genus from mammals; all other species are from birds. Skrjabin and Evranova (1953) placed seven species in the genus and Yamaguti (1958) 15; two additional species not listed in either volume have been described: *L. skrjabini* Rysavy, 1955; *L. heterocoraxi* Bisseru, 1960. Localities from which species of *Lutztrema* Travassos, 1941, have previously been reported are South, Central and North America, Europe, South Africa, India, and Japan. Our specimens appear closest to *L. colorosum* (Patwardhan, 1935) Travassos, 1944 (syn. *Lyperosomum bhattacharyai* Pande, 1939) from Indian birds but differ in having a mammalian host and suckers which are subequal in length rather than with a ratio of about 1 : 2.

Platynosomum fastosum Kossack, 1910

HOST: *Felis catus domesticus* (Felidae).

HABITATS: Liver and small intestine.

LOCALITIES: Jesselton, Tuaran, Kepayan; North Borneo.

DATES: 31 August, 16, 29 September 1960.

SPECIMENS: U.S.N.M. Helm Coll. No. 60971 (five slides with one specimen each).

MEASUREMENTS and some pertinent data (based on 20 specimens, nine measured): Body, length 4,031 to 6,201, forebody width at genital pore level 630 to 897, hind body maximum width 1,028 to 1,970, widest at testicular level in five and at vitellaria in four; forebody 798 to 1,335, hind body 2,876 to 4,563; preoral body 6 to 40, postovarian space 2,364 to 3,528, postvitellarian space 1,572 to 2,677, postcecal space 395 to 752; oral sucker 335 to 445 by 300 to 450; acetabulum 357 to 480 by 340 to 475, entirely muscular in 11 specimens, partly parenchymatous to varying extents in five; sucker length ratio 1 : 1.05 to 1.18; pharynx 116 to 140 by 116 to 150; esophagus 75 to 305 in longitudinal extent, bifurcating 260 to 480 preacetabular; right testis 455 to 690 by 315 to 480; left testis 460 to 675 by 310 to 522; cirrus sac 300 to 415 by 116 to 159, overlapping acetabulum 9 in one and 63 to 185 preacetabular in eight, entirely preacetabular in eight other specimens, containing a much coiled, tubular, thick-walled, cellular seminal vesicle, a short pars prostatica, a long, sometimes sinuous, thick-walled, muscular, protrusible cirrus, and prostate cells surrounding the latter and pars prostatica; genital pore prebifurcal, median, 295 to 587 preacetabular, 50 to 167 postpharyngeal, 135 to 280 posterior to oral sucker; ovary 247 to 450 by 220 to 380, submedian to right in eight, to left in eight; seminal receptacle 101 to 157 by 101 to 157, from longer than wide to round to wider than long, dorsal to posteromedian part of ovary; vitelline fields 813 to 1,640 long; metraterm thick walled, muscular, straight, about same length as or slightly shorter than cirrus sac; 45

operculate eggs measuring 29 to 44 by 19 to 27.

DISCUSSION: Four and 12 worms, respectively, were taken from the liver of two domestic cats and four from the small intestine of a third. Rohde (1962) reported this species from the same habitats and host species from Malaya (Malaysia). Additional hosts reported by various authors are *Oncoides minuta*, *Grison vittata*, and *Herpailurus y. yaguarondi*; additional localities are Hawaii, Brazil, Cuba, Puerto Rico, Bahamas, North America, and Africa.

Zonorchis borneoensis n. sp. (Figs. 4, 5)

HOSTS: Type, *Callosciurus prevostii pluto*; *C. notatus dilutus* (Sciuridae).

HABITATS: Liver and small intestine.

LOCALITIES: Ranau (*C. prevostii*) and Kasiqui (*C. notatus*), North Borneo.

DATES: 30 August (Kasiqui), 20, 24 September (Ranau), 1960.

TYPES: U.S.N.M. Helm. Coll. No. 60972 (one slide of holotype and four with one paratype each).

DIAGNOSIS (based on 17 specimens, nine measured): Body elongate, tapering to blunt point at both extremities, widest at gonadal or just postgonadal level, length 1,891 to 5,758, forebody width at pharynx–esophagus junction 175 to 458, hind body width 365 to 1,495. Forebody 305 to 860, hind body 1,435 to 4,398; no preoral body in two, up to 34 long in others; postovarian space 1,070 to 3,288, postvitellarian space 310 to 1,438, postcecal space 225 to 1,115. Oral sucker 109 to 290 by 109 to 285, subterminal ventral. Acetabulum 151 to 500 by 170 to 510, elevated from body surface. Sucker length ratio 1 : 1.39 to 1.86. Pharynx 56 to 180 by 61 to 165, overlapping oral sucker dorsally. Esophagus 73 to 215 long, bifurcating 5 to 250 preacetabular. Ceca long, narrow, extending postvitellarian, terminating well short of posterior extremity, usually of unequal lengths. Excretory bladder tabular to I- to Y-shaped; stem long, slender, dorsal to uterus, commencing or bifurcating 200 to 430 postovarian (in three specimens 3,591 to 5,758 long); only one or both primary collecting tubules at junction with bladder may be inflated into short excretory arms of varying lengths; primary tubules extending to pharyngeal level; excretory pore terminal.

Testes two, symmetrical, short distance postacetabular, close together, intercecal but may slightly overlap cecum dorsally, usually elongate–oval, usually smooth; right testis 109 to 820 by 73 to 440; left testis 109 to 540 by 80 to 425. Vasa efferentia from anterodorsal surface of testes entering cirrus sac side by side. Cirrus sac 167 to 562 by 51 to 170, thick-walled, muscular, elongate, straight, more or less median, overlapping anterior part of acetabulum 17 to 182, containing seminal vesicle, pars prostatica, prostate cells, and cirrus. Seminal vesicle tubular, much coiled, thick-walled, cellular; pars prostatica short; cirrus long, sinuous, thick-walled, muscular, opening into small genital atrium; prostate cells relatively few, beside distal part of seminal vesicle, the pars prostatica and cirrus; cirrus sac protrusible. Genital pore median to slightly submedian, 120 to 363 preacetabular, 15 to 44 postpharyngeal, 44 to 175 posterior to oral sucker.

Ovary 68 to 285 by 73 to 305, essentially round, smooth; submedian to left in nine, to right in five; slightly overlapping testicular level to 94 posttesticular. Seminal receptacle 38 to 143 by 40 to 155, posterior to ovary, contiguous with or slightly overlapping latter dorsally. Laurer's canal muscular, sinuous, median to seminal receptacle. Mehlis' gland well developed, posteromedian to ovary. Oviduct thick-walled, from posterior of ovary. Vitellaria follicular, in long extracecal fields but may

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Fig. 1. *Leipertrema vitellariolateralis*, terminal genitalia, dorsal view.

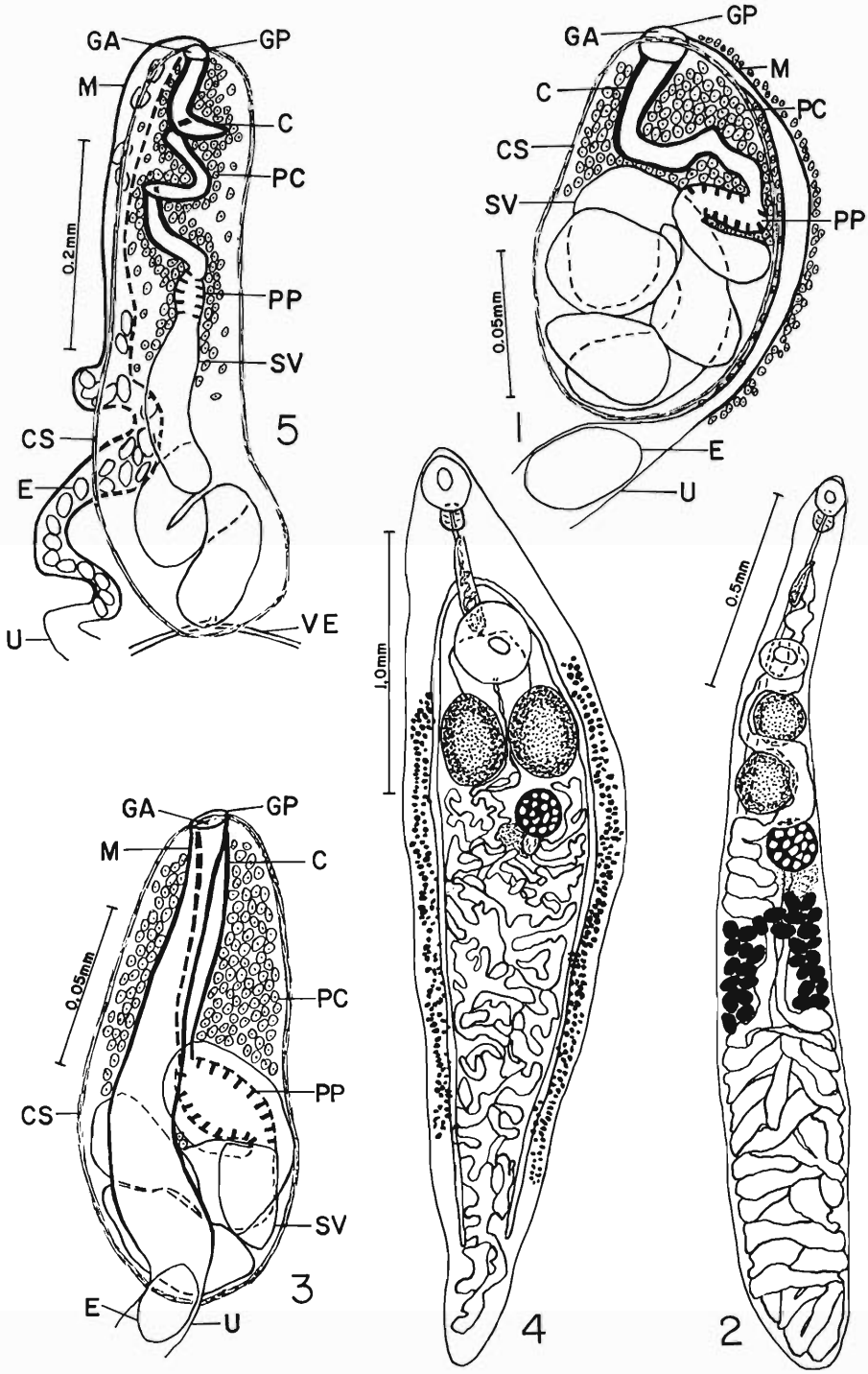
Fig. 2. *Lutztrema callosciuri*, holotype, ventral view.

Fig. 3. Same. Terminal genitalia, paratype, dorsal view.

Fig. 4. *Zonorchis borneoensis*, holotype, ventral view.

Fig. 5. Same. Terminal genitalia, paratype, ventral view.

Abbreviations: C, cirrus; CS, cirrus sac; E, egg; GA, genital atrium; GP, genital pore; M, metraterm; PC, prostate cells; PP, pars prostatica; SV, seminal vesicle; U, uterus; VE, vas efferens.



overlap ceca slightly and rarely protrude into intercecal space, commencing at level of posterior half of acetabulum, terminating well short of cecal at different levels; right and left vitelline ducts postovarian, uniting median to seminal receptacle and ventral to Mehlis' gland to form small reservoir. Uterus extensive, filling most of posttesticular body, mainly intercecal but may overlap ceca; descending on left and ascending on right if ovary on left, reverse condition if ovary on right, coils ascending on median side of ovary and between testes to genital pore; metraterm thick-walled, muscular, sinuous, as long as cirrus sac or shorter. Eggs numerous, operculate, 50 measuring 25 to 32 by 16 to 22.

DISCUSSION: Six specimens were taken from the liver of one *Callosciurus prevostii pluto* and two and eight, respectively, from the small intestine of two others; one worm was from the liver of one *C. notatus dilutus*. Skrjabin and Evranova (1953) recognized seven species from birds and four from mammals, while Yamaguti (1958) listed ten and four, respectively; eight additional species not listed in either volume have been described: From birds, *Z. travassosi* Jaiswal, 1957; *Z. singhi* Jaiswal, 1957; *Z. costarricensis* Brenes and Jiménez-Quirós, 1959; *Z. macroovaricus* Jiménez-Quirós and Arroyo, 1960; *Z. dureni* Vercammen-Grandjean, 1960; *Z. dollfusi* Richard, 1962; *Z. hartwichi* Odening, 1964; from mammals, *Z. australiensis* Sandars, 1958. The latter (from Australia) and three other mammalian species (from Brazil, Panama, Trinidad) are from marsupials. *Z. komareki* (McIntosh, 1939) Travassos, 1944, has been taken from two species of cricetid rodents, *Peromyscus g. gossypinus* and *Oryzomys palustris*, in the United States. Our new species from sciurid rodents differs from *Z. komareki* in geographical distribution and in having much shorter ceca, the testes entirely postacetabular and close together, and the cirrus sac overlapping the acetabulum.

FAMILY HETEROPHYIDAE

Haplorchis pumilio (Looss, 1896) Looss, 1899

HOST: *Prionailurus bengalensis borneoensis* (Felidae).
HABITAT: Small intestine.
LOCALITY: Ranau, North Borneo.
DATE: 18 September 1960.
SPECIMENS: U.S.N.M. Helm. Coll. No. 60973 (five slides with one specimen each).

MEASUREMENTS and some pertinent data (based on 21 specimens from one host, six measured): Body 430 to 513 by 145 to 167; oral sucker 43 to 51 by 53 to 58, wider than long; acetabulum 34 to 54 by 46 to 64, usually wider than long, bearing almost complete circlet of 33 to 38 spines and additional group of simple spines in interrupted area; prepharynx 21 to 29 long; pharynx 27 to 34 by 25 to 32; esophagus 70 to 123 long; testis 63 to 77 by 57 to 74; ovary 43 to 47 by 41 to 53; seminal receptacle 46 to 54 by 44 to 52; 30 eggs measuring 25 to 31 by 14 to 19.

DISCUSSION: Pearson (1964) reviewed and redescribed *H. pumilio*. We (1965) reported this species from two species of reptiles from North Borneo. Comparison of the present specimens from the leopard cat with the latter and with three of Dr. Pearson's worms from the water rat, *Hydromys chrysogaster*, from Brisbane, Australia, showed them to be identical.

FAMILY PARAGONIMIDAE

Paragonimus westermani (Kerbert, 1878) Braun, 1899

HOST: *Prionailurus bengalensis borneoensis* (Felidae).
HABITAT: Lungs.
LOCALITY: Ranau, North Borneo.
DATE: 27 September 1960.
SPECIMENS: U.S.N.M. Helm. Coll. No. 60974 (five slides with one specimen each).

DISCUSSION: Our collection consisted of 13 worms measuring 7 to 8.8 mm in length from a single leopard cat. Yokogawa, Cort, and Yokogawa (1960) noted that specific identification of members of the genus *Paragonimus* Braun, 1899, is most difficult. They also noted that *P. westermani* was originally described from Indian tigers that died in zoological gardens in Holland and Germany. The most recent Malaysian report of this trematode is by Rohde (1963b) from a tiger from Malaya. *P. westermani* has been reported from a wide variety of hosts (mainly the cat family) distributed from Japan, Korea, and Manchuria on the north to the Philippines, Indonesia, and India on the south.

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Hypsoperine spartinae n. sp., a Gall-forming Nematode on the Roots of Smooth Cordgrass

GEORGE J. RAU AND GEORGE FASSULIOTIS[1]

In 1958 the senior author found that galls on smooth cordgrass roots from Marineland, Florida, were caused by a plant-parasitic nematode which belonged neither to the genus *Heterodera* nor to that of *Meloidogyne*. Smooth cordgrass, *Spartina alterniflora* Loiselius, is a common saltwater-tolerant plant of tidal marshes growing where the water has a sodium chloride content of about 2.1%. It occupies thousands of acres from Newfoundland to Florida, along the Gulf Coast, and in many other parts of the world.

Sledge and Golden (1964) erected the genus *Hypsoperine* to include the intermediate forms that differ from either the *Heterodera* or the *Meloidogyne*. They represent a description of *H. graminis* from St. Augustine grass, *Stenotaphrum secundatum* (Walt.) Kuntze.

Although some of the characters of this nematode do not correspond with the *Hypsoperine* as outlined by Sledge and Golden, it is tentatively assigned to that genus.

The following changes are presented in the diagnosis of the *Hypsoperine*: Female body transparent to white, oval to lemon-shaped, often with a thick cuticle and well-defined, protruding neck usually situated to one side. Eggs are deposited outside of the body, usually in a gelatinous matrix.

Hypsoperine spartinae n. sp.

FEMALES (Fig. 1, A and H): Length 0.851 ± 0.104 mm (0.600–1.140 mm), n = 158[2]; width 0.504 ± 0.095 mm (0.270–0.870 mm), n = 158; stylet 13.0 ± 0.8 μ (11.0–17.0 μ), n = 80; a = 1.7 (1.2–2.7), n = 158; and distance from anus to vulva 21.7 ± 2.58 μ (15.4–29.4 μ), n = 103.

Body oval to lemon-shape with a distinct neck length of 98 ± 22.1 μ (49–140 μ), n = 15. In older specimens the neck is reflexed to meet the contour of the body. Vulva terminal and protruding. Lip region distinctly set off from neck, with two annules, the second wider than the first. Cephalic sclerotization indistinct. Transparent cuticle marked by distinct transverse striae in the neck region; these gradually become indistinct on the rest of the body. The cuticle is quite thin, measuring 2–4 μ in the middle of the body.

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[2] Here and elsewhere in this paper, the first figure is the mean, the second the standard deviation. The figures in parenthesis are the minimum and maximum respectively. The letter "n" after the parenthesis represents the number of specimens measured.

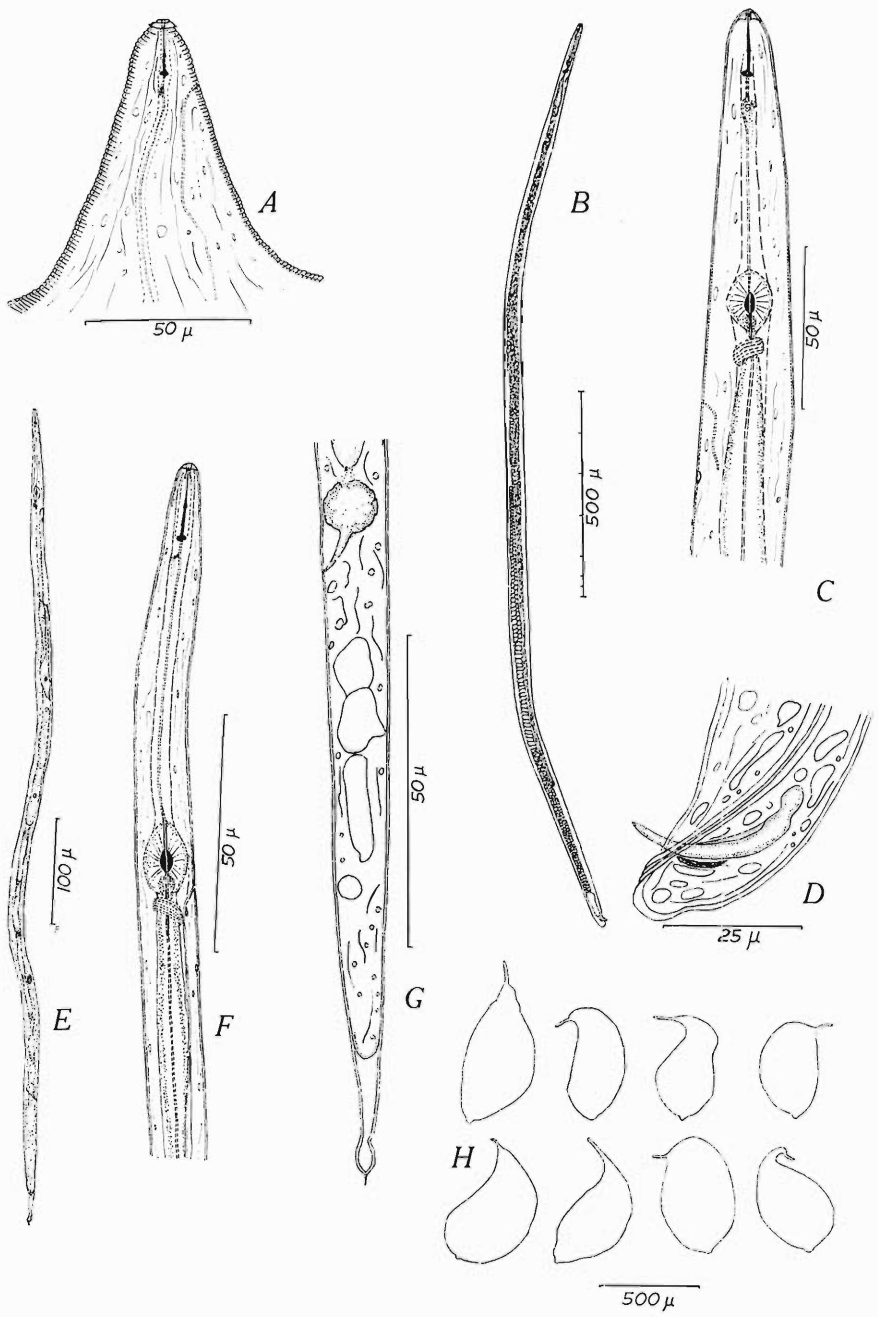

Fig. 1. Drawings of *Hypsoperine spartinae* n. sp. A, Anterior portion of female. B, Male. C, Anterior portion of male. D, Posterior portion of male, slightly compressed. E, Larva. F, Anterior portion of larva. G, Posterior portion of larva. H, Outlines of eight females.

Stylet with distinct rounded knobs. Dorsal esophageal gland duct opening 4.2 ± 0.3 μ (2.8–5.6 μ), n = 76 posterior to stylet knobs. Median esophageal bulb nearly spherical, length 31.0 ± 4.6 μ (21.0–44.8 μ), n = 27; width 30.0 ± 3.5 μ (23.8–35.0 μ), n = 27. Excretory pore distinct, 18.8 ± 3.7 μ (11.2–28.0 μ), n = 80 from anterior end, or generally only a few microns posterior to the stylet knobs.

Perineal pattern (Fig. 2) often indistinct and somewhat resembling that of *Meloidogyne incognita acrita* (Kofoid and White, 1919) Chitwood, 1949 but appears to differ in the more truncate pattern above the anus and in the less zigzag and broken-up inner portion together with indistinct punctation in the region of the vulva opening. Six rectal glands similar to those described for *Meloidogyne* species by Maggenti and Allen (1960) are visible in young females when viewed from the caudal end.

MALES (Fig. 1, B–D): Length 2.250 ± 0.212 mm (1.676–2.592 mm), n = 110; width 43 ± 7.1 μ (25–59 μ), n = 110; stylet 19.7 ± 1.0 μ (16.8–21.0 μ), n = 108; a = 52.9 (33.8–76.4), n = 110; c = 178.6 (111.0–240.6), n = 103; tail 12.6 ± 1.2 μ (9.8–15.4 μ), n = 103.

Dorsal gland duct opening 4.8 ± 0.64 μ (3.5–7.0 μ), n = 108 posterior to stylet knobs. Median esophageal bulb distinct, 97.9 ± 6.81 μ (81.2–116.2 μ), n = 92 from lip region. Excretory pore distinct, 131.3 ± 13.6 μ (84.0–172.0 μ), n = 107 from anterior end. Hemizonid located approximately 20 μ posterior to excretory pore. The single testis is usually outstretched; length 1.086 ± 0.170 mm (0.466–1.356 mm), n = 85. Spicule length 31.4 ± 2.81 μ (25.2–40.0 μ), n = 50 measured along chord of arc. Gubernaculum 8.3 ± 0.9 μ (7.0–9.8 μ), n = 23. Phasmids small near terminus.

Body cylindrical for most of its length, tapering slightly at each end. Lip region not offset from body; smooth with indistinct narrow subcuticular annulations. Cuticle of body smooth, subcuticle with fine transverse striae approximately 0.7 to 1.0 μ wide. Lateral field about one-fifth body width, starting anterior to the median bulb and continuing around the twisted tail (Fig. 1, D); with four lines, the middle two much closer than the outer pair.

HATCHED LARVAE (presumably second stage) (Fig. 1, E–G): Length 0.773 ± 0.153 mm (0.612–0.912 mm), n = 105, width 15.0 ± 0.86 μ (14.0–16.8 μ), n = 105; a = 53.3 (43.2–65.1), n = 103; c = 7.6 (6.7–9.0), n = 82; tail 99.7 ± 7.44 μ (77.0–113.4 μ), n = 82.

Body cylindrical, elongate, tapering markedly toward the posterior end. Lip region not offset from body and apparently not annulated. Cuticular annulations not visible at the middle of body. Lateral field indistinct; three lines. Tail asymmetrical and bulbous with a small, elongate, terminal process 1 to 5 μ long.

Stylet 15.4 ± 0.29 μ (14.0–16.8 μ), n = 102; slender with small rounded knobs less than 3 μ wide. Cephalic framework lightly sclerotized. Dorsal esophageal gland duct opening 4–6 μ from base of stylet knobs. Median bulb 75.8 ± 5.0 μ (63.0–105.0 μ), n = 98 from lip region. Excretory pore 101.0 ± 5.1 μ (88.2–117.6 μ), n = 87 from anterior end; the terminal duct leading to a large distinct nucleus which is usually on the right side of the body and located 217.0 ± 17.8 μ (182.6–264.6 μ), n = 43 from the anterior end. Hemizonid located approximately 20 μ posterior to the excretory pore. Genital primordium 218.2 ± 35.12 μ

Fig. 2. Perineal pattern of *Hypsoperine spartinae* n. sp.

(182.6–264.6 μ), n = 59 from terminus. Length of hyaline portion of tail 22.3 ± 2.5 μ (16.8–28.0 μ), n = 97. The anus is associated with an irregular globular structure about 4 μ wide and is presumed to be a rectum; however, no distinct connection to the intestine has been found.

EGGS: 121 μ (100.8–132.3 μ) by 54.25 μ (47.25–63.00 μ) for ten specimens.

TYPE HOST: Smooth cordgrass, *Spartina alterniflora* Loiselius, growing in black silt marsh muck.

TYPE LOCALITY: Banks of Long Branch Creek, east of the U.S. Vegetable Breeding Laboratory farm 3 miles southwest of the city limits of Charleston, South Carolina.

HOLOTYPE (female): Collected at the type location 12 August 1962, by the authors. Slide T-52t U.S. Department of Agriculture Nematode Collection, Beltsville, Maryland.

ALLOTYPE (male): Same data as for holotype. Slide T-53t U.S. Department of Agriculture Nematode Collection.

PARATYPES: Females, males, larvae, and eggs. U.S. Department of Agriculture Nematode Collection.

LOCALITIES: This species has also been collected from the type host at the following locations:

Long Island, New York: Alongside the Jones Beach Bridge, and in the inlets and waterways away from the beach side of the 17-mile highway extending from Jones Beach to Captree Bridge, and at Freeport.

New Jersey: In the muck marshes near Somer's Point, alongside the bridge leading to Ocean City, and near bridges along the ocean highway to Cape May.

South Carolina: In the marsh areas away from the beaches at Myrtle Beach, Murrell's Inlet, and Pawley's Island; in the muck marshes of Bull's Island, Isle of Palms, Sullivan's Island, Folly Island, Fort Johnson, Kiawah Island, Seabrook Beach, Edisto Island, Hilton Head, and Hunting Island.

Georgia: In the salt muck of Sea Island and Jekyll Island.

Florida: Along the east coast in salt marsh areas at Fernandina Beach, Matanzas River Bridge, Marineland, Flagler Beach, Ormond Beach, Daytona Beach; at New Smyrna near the two causeways leading to Coronado Beach, near the Titusville Causeway, near Cape Kennedy, Cocoa Beach, and Eau Gallie. On the Gulf Coast at Cape San Blas and the Tallahassee State University Marine Station on Alligator Point.

DIAGNOSIS AND DISCUSSION

Hypsoperine spartinae is readily distinguished from either *H. graminis* or *H. acronea* (Coetzee, 1956) Sledge and Golden, 1964 by its rather large size. The minimum values of *H. spartinae* of all the measurements exceed the maximum values of the other described species. The most distinctive character of this species is the extremely long second-stage larva, with its asymmetrical, spiked, bulbous tail.

Unlike the thick cuticle of the female of both *H. graminis* and *H. acronea*, the cuticle of *H. spartinae* is exceedingly thin and readily ruptured when removing females from the roots. The eggs are not laid in a gelatinous matrix but are deposited free in the hollow spaces between the central cylinder and the inner wall of the gall. There is little or no gelatinous matrix. All stages are normally found in the apical galls of *S. alterniflora* roots and apparently more than one generation feed in the same gall, since old deflated and young gravid females have been found in the same gall.

The feeding position assumed by *H. spartinae* is unlike either *Meloidogyne* or *Heterodera*; i.e., parallel to the long axis of the root with the posterior part of the body oriented proximal to the root apex, but larvae and females are normally found in an inverted position with the posterior distal to the root apex.

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Rectal Matrix Glands in *Meloidogyne arenaria*[1]

NORMAN A. MINTON[2]

Maggenti and Allen described the rectal matrix glands in *Meloidogyne* spp. They gave several figures, but showed no photomicrographs of the glands. As a rule, in preparations made for microscopic viewing, only small portions of these relatively large glands are observed in one plane. My purpose is to illustrate them with a photomicrograph.

Among a group of lactophenol preparations of the perineal region of *M. arenaria* (Neal, 1889) Chitwood, 1949, I found a specimen with a large portion of the rectal matrix glands lying in one plane (Fig. 1). I prepared it by placing the posterior third of an adult pear-shaped female (with body contents still attached) on a dry slide with the posterior part pointing upward. I then placed a cover glass on the specimen, and applied a small drop of lactophenol mounting medium beside the cover glass, under which it was drawn by capillary attraction. The orientation of a large portion of the glands in one plane resulted from pressure exerted on the cover glass. The photomicrograph shows the six glands and the trunk portion of the glands at the anterior extremity of the rectum where the gland ducts enter the rectum. The two subventral glands, separated by the uterus, are farthest apart. The anterior termination of the rectum was observed when focusing between the two subventral glands, at a plane slightly above that at which the glands were photographed.

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MAGGENTI, A. R., AND M. W. ALLEN. 1960. The origin of the gelatinous matrix in Meloidogyne. Proc. Helm. Soc. Wash. 27: 4–10.

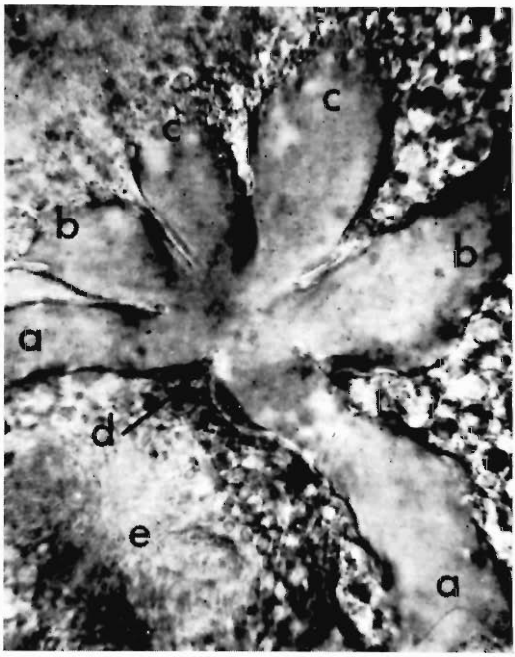

Fig. 1. Rectal matrix glands in *Meloidogyne arenaria*: (a) subventral glands, (b) lateral glands, (c) subdorsal glands, (d) rectal duct enters rectum at this position, (e) uterus.

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Studies on the Development of *Blatticola blattae* (Graeffe, 1860) Chitwood, 1932 within Its Host, *Blattella germanica* L.

C. T. CALI AND W. F. MAI

SUMMARY

Five stages with four intervening molts, occur in the life cycle of *Blatticola blattae* females. The first molt begins in the egg just prior to the resting stage and is completed within the host, *Blattella germanica*, approximately 3½ hr after ingestion. Each of the five active stages and the four intervening molts can be recognized by size and other morphological characters. Growth is associated with each of the four molts, which are accompanied by reduced physical activity. The second, third, and fourth molts occur within the host. The third larval stage was first recovered on the fourth day, the fourth on the tenth day and adult females on the fourteenth day after ingestion of the infective stage by the host.

Blatticola blattae is a nematode parasite of the alimentary tracts of German cockroaches, *Blattella germanica*. The parasite was originally described and named *Oxyuris blattae* in 1860 by Graeffe, was later renamed *Oxyuris blatticola* by Galeb (1877, 1878a, b). In 1926 Schwenk proposed the genus *Blatticola* to accommodate this single species. Because of priority Chitwood (1932) recognized the original species name, *Blatticola blattae*.

Most information published on *Blatticola blattae* concerned its morphology and taxonomic position until the study of its free-living stages by Bozeman in 1942. He observed eggs from the two-cell stage to the resting embryonic stage. The majority of the eggs were deposited by the nematode in the four-cell stage. The prevermiform stage occurred approximately 24 hr after the two-cell stage and the active embryonic stage 37½ hr after the prevermiform stage. The prevermiform stage was characterized by the noticeable development of the esophagus and the lashing of the tail. Bozeman describes subsequent in vitro development as follows: "Ten hours later the embryos became gradually inactive and began to molt; at least the behavior was so interpreted. Five hours after activity had ceased and the process of molting was complete, the "resting" embryonic stage was reached. In this stage the embryo was much shorter than in the active stage, and the esophagus was better developed. In vitro development stopped at this point."

Information was lacking on the parasitic phases of the life cycle such as time of hatching, number of molts, size of each stage, time between molts, and time required to reach sexual maturity. Thus in this investigation development in the roach was studied.

MATERIALS AND METHODS: Nematodes were obtained from German roaches collected in Comstock Hall on the Cornell University Campus and were also maintained on this insect. The roaches were cultured in 1-gallon glass jars containing excelsior, wire screening, dog-food pellets, and a birdcage water fountain. The temperature in the laboratory was 78–81 F and the relative humidity, although variable, was relatively high.

To obtain nematode-free roaches, 60 starved female roaches, each carrying a dark brown egg case, were placed individually into small glass jars and stored in a large cardboard box. Three days later 11 capsules hatched and the mothers were killed, dissected, and examined for nematode infection. Nine of these mothers were nematode free so the broods were isolated and raised to maturity in separate gallon jars. Because one-fourth or more of the offspring of each succeeding generation were dissected and found to be nematode free, it was considered that the test roaches used in the inoculation studies were not infected with nematodes.

To obtain nematode eggs for the inoculation studies, gravid females were dissected from roaches and placed in a deep-well slide containing 33% Ringer's solution. The worms were opened and enclosed eggs dispersed within the solution. Eggs in the deep-well slide were placed in a moist chamber and incubated 4

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A portion of a thesis presented by the senior author to the Graduate School at Cornell University in partial fulfillment of the Ph.D. degree.

Accepted for publication.

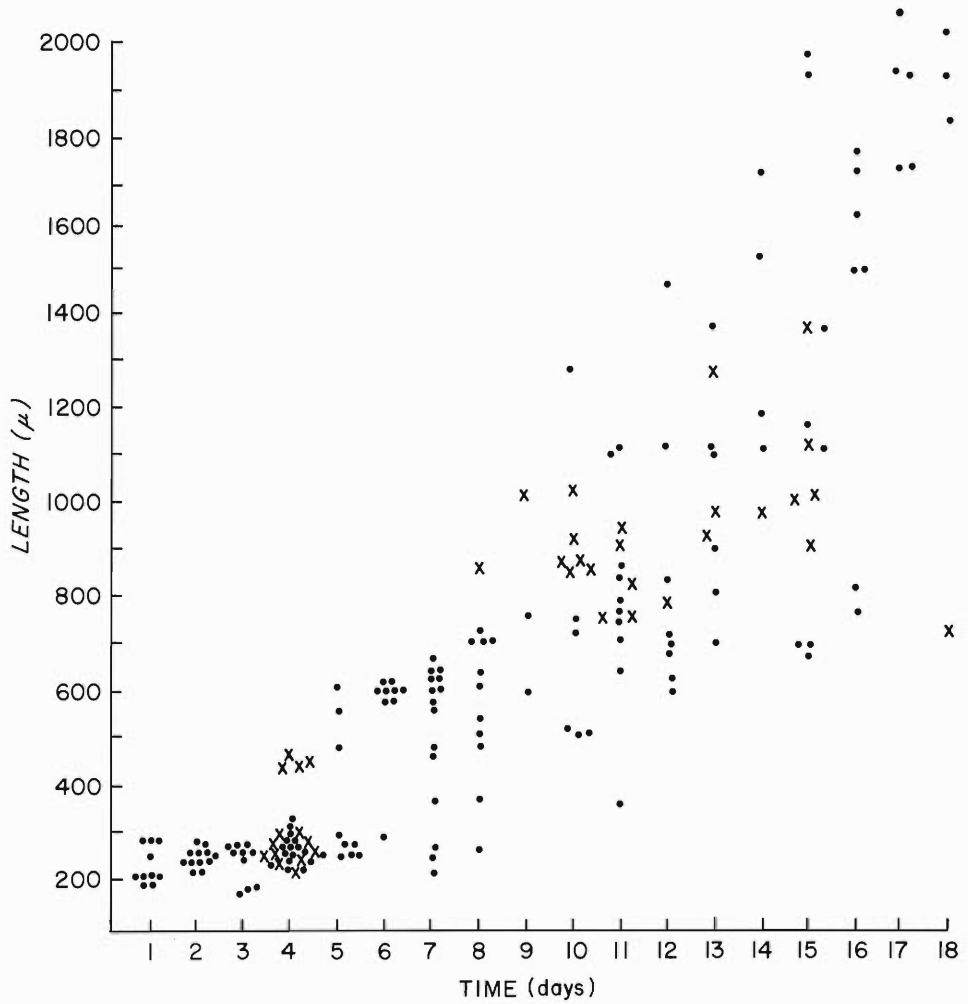

Fig. 1. Lengths of second-stage larvae and immature and mature female nematodes extracted from roaches; each "•" represents an active stage and each "x" a molting stage.

days at approximately 80 F. When the eggs had reached the resting or infective stage, the solution was removed with a hypodermic needle.

The roach to be inoculated was starved for at least 1½ hr and placed ventral side up on a microslide and held in position with masking tape. Eggs were removed singly from the well of the deep-well slide with a minuten pin, the tip of which had been dipped into thickened honey. Each egg was placed at the under edge of the roach's labrum so it could be easily drawn into the gullet. Close observation under a dissecting microscope assured that test eggs were swallowed by the roach. Using this method a known number of eggs were fed at designated times to individual roaches.

Before opening culture jars containing infected roaches they were placed in a sink containing a thin layer of water; roaches moved out of the jar and fell into the water. Individuals were anesthetized by transferring them

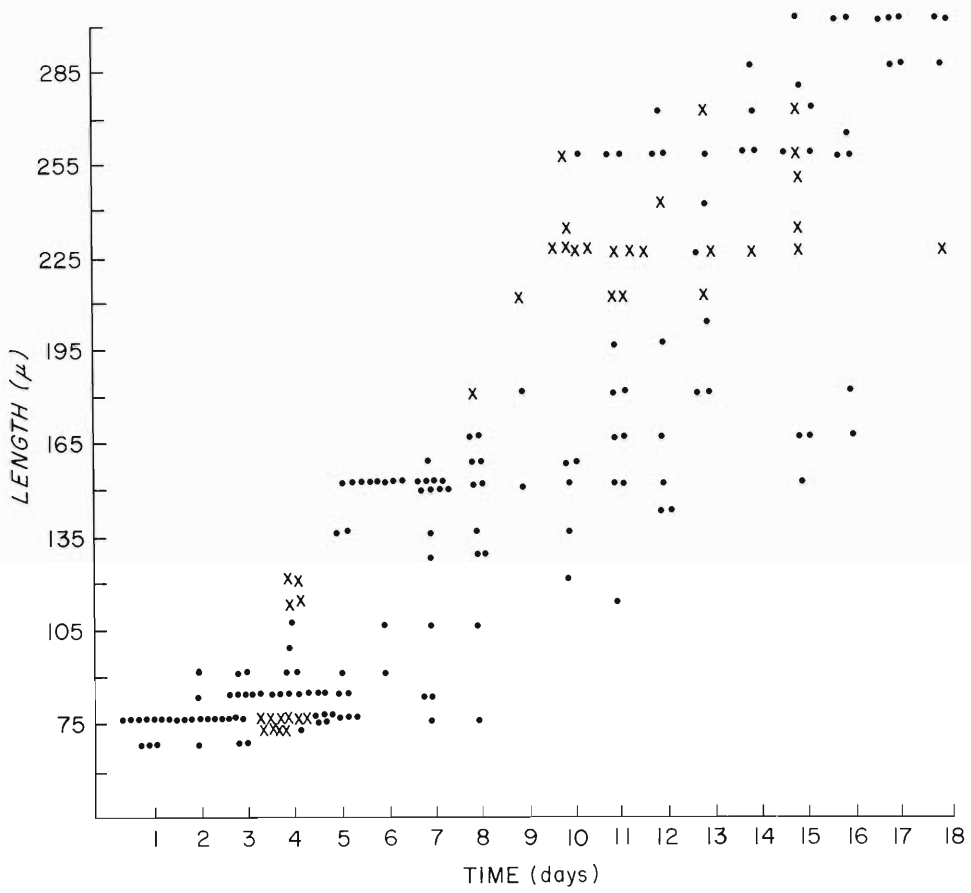

Fig. 2. Lengths of esophagi of second-stage larvae and immature and mature female nematodes extracted from roaches; each "•" represents an active stage and each "x" a molting stage.

with forceps from the water to a jar containing a high concentration of CO_2.

Anesthetized roaches were dissected on a shallow-well slide. When both mid- and hindguts were to be examined, the thoracic region of the roach was separated from the abdominal region. The midgut was severed anteriorly at the proventricules and posteriorly at the Malpighian tubule region, and was placed in a shallow well containing diluted Ringer's solution. The hindgut was severed at the rectal sac and placed in a second shallow-well slide. When only the hindgut was to be examined, the last visible abdominal segment was dissected, thus exposing the entire hindgut which was then removed.

The larger nematode stages were measured at 100× magnification and the smaller larvae at 430× magnification. All nematodes were in diluted Ringer's solution when measured.

In vitro observations of eggs similar to those described by Bozeman (1942) also were carried out. Eggs were immersed in diluted Ringer's solution during the observations.

RESULTS: Development of the nematode outside of the roach was similar to the description by Bozeman.

Only resting eggs were recovered from crops of nine roaches examined 2½ hr after inoculation. Hatching occurred in the mid- or hindgut from 2½ to 4 hr after egg ingestion.

Three hours after inoculation one egg was re-

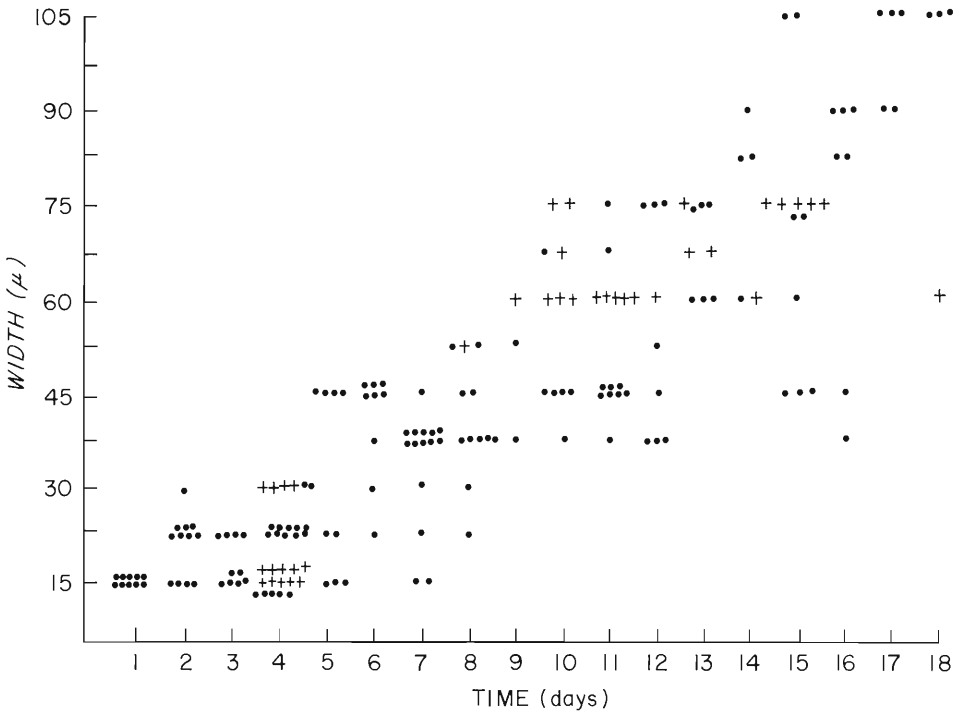

Fig. 3. Body widths of second-stage larvae and immature and mature female nematodes extracted from roaches; each "•" represents an active stage and each "+" a molting stage.

covered from each of three roaches; two were in the molting stage and one an active larva. The molting, ensheathed, second-stage larva within the egg became active and increased in size until it filled completely the uncast sheath of the first-stage larva. When this larva emerged from this uncast sheath its length was greater than that of the egg. The exsheathed second-stage larva changed positions many times before it broke the egg shell 45 min after the beginning of the observations. Other nematodes hatching in a similar manner were observed. Broken egg shells were recovered from the fore-, mid-, and hindguts.

Eggs stored in diluted Ringer's solution for 3 weeks or more contained active larvae. This solution also contained small opaque and sausage-shaped ensheathed larvae which moved with twitching undulations. Ensheathed larvae recovered from hindguts of roaches, also were small, opaque, and sausage-shaped.

Hatched female nematodes recovered from roaches during an 18-day period after inoculation could be separated into four morphologically distinct active stages and four morphologically distinct molting stages (Table 1). Size of worms was correlated with these morphological characters, chiefly of the reproductive and digestive systems (Tables 1 and 2). Active larval stages and adults had well-defined esophagi, a smooth cuticle, and moved with smooth undulations. Molting stage nematodes had thickened cuticles with longitudinal ridges, and indistinct esophageal tissue. Unlike the active movements of the larval stages and adults, those of the molting stages were sluggish with twitching movements or did not move but lay in a stiff extended position. Males could not be divided into stages and intermediate types because too few were recovered.

The second-stage larvae were distinguishable from others by light pigmentation and incomplete digestive systems. The mouth did not have lips, the intestinal tube was hour-glass in

Table 1. Morphology in relation to four active stages of nematodes recovered from cockroaches.

	Stage II larvae	Stage III larvae	Stage IV larvae	Adult females
lips	absent	partly formed	fully formed	fully formed
anus	absent	formed	formed	formed
pigment	light	dark	dark	dark
intestine	hourglass	straight	cardia	cardia
reproductive system	absent	partly formed	partly formed	two loops
vulva	absent	slit present	protruding vulva lips	protruding vulva lips
eggs	absent	absent	absent	present

shape, and the anus was not discernible. It was not possible to differentiate sexes of these nematodes. All second-stage larvae were recovered from hindguts.

Fourteen nematodes, 13 recovered from hindguts and one from a midgut, 4 days after inoculation were in a stiff and extended position and were designated as molting stage II. The light pigmentation of intestinal tracts resembled third-stage larvae.

In the third larval stage the intestine was uniform in width from the esophageal–intestinal attachment to the terminal end and was darkly pigmented. Although reproductive systems were embryonic, sexes were easily distinguished. Mouth lip and the anus were discernible. The vulval slit, which was not visible in the second was present in the third-stage larvae.

Twenty-two molting stage II nematodes were recovered from the 8th to the 18th day. The anterior part of the intestine was slightly dilated and vulval lip buds could be seen at the slit. Movements were sluggish with some twitching.

Fourth-stage larvae were distinguishable by the protruding vulval lips and the distinct linear arrangement of the cells within the ovary.

Only two molting-stage IV nematodes were recovered, one on the thirteenth and one on the fifteenth day. Both moved in the same manner as those of molting stage III. The reproductive systems were distinctly longer than those of fourth-stage larvae.

Adult females were distinguished by the doubly reflexed reproductive system. They were first observed on the fourteenth day after inoculation.

Table 2. Body length, width, and esophagus length of active and molting stages of nematodes recovered from cockroaches.

Types of nematodes	Number	Body length μ	Esophagus length μ	Body width μ
Stage II larvae	56	251.4± 3.9**	77.6±0.8	18.3±0.5
Molting stage II	14	314.6±25.1	86.7±5.1	19.3±1.9
Stage III larvae	65	620.4±17.5	148.8±3.0	41.9±0.9
Molting stage III	22	908.6±22.6	225.0±3.4	64.7±1.5
Stage IV larvae	14	1,223.5±37.5	253.9±2.9	72.5±1.8
Molting stage IV	2*	1,275.0 1,376.0	270.0 255.0	75.0 75.0
Adult females	17	1,803.5±47.1	285.8±4.0	95.9±2.2

* Measurements for both individuals given.
** Standard error.

The individual body measurements for all nematodes, exclusive of recognizable males, are recorded in Figures 1, 2, and 3. Larval stages and adults are represented by a "." and each molting stage by an "x."

DISCUSSION: These data and those presented by Bozeman (1942) show that females of *B. blattae* have five stages and molt four times, a life cycle typical for most nematodes. The first molt began in the egg and was completed in the host. Hyman (1951) states that juvenile nematodes may enter a quiescent phase inside the uncast cuticle which just serves as a cyst.

The second-stage larva within the uncast sheath of the first molt is the infective stage. Generally a host stimulus is required for hatching. In this host there are three less active molting stages spaced between four active larval stages. Sudden increases in body size are always associated with morphological changes and nematode activity.

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Kowalewskiella totani n. sp. (Cestoda : Dilepididae) from *Totanus flavipes*[1]

J. TEAGUE SELF AND JOHN JANOVY, JR.

Totanus flavipes (Gmelin) 1789 (lesser yellowlegs) collected from the Cheyenne Bottoms Waterfowl Management area, Barton County, Kansas was parasitized by cestodes belonging to the poorly known genus *Kowalewskiella* Baczynska 1914 and constituting a species new to science.

MATERIALS AND METHODS

All the worms were obtained from birds shot as they migrated through the Cheyenne Bottoms. Since the testes, and to a certain extent the complex of female glands, disappear as the proglottids become gravid in these worms, the study is based on observations of about 20 specimens in various stages of development. Also, since the tiny hooks of these worms are lost during routine staining procedures they were studied on fresh scolices crushed in Hoyer's Medium.

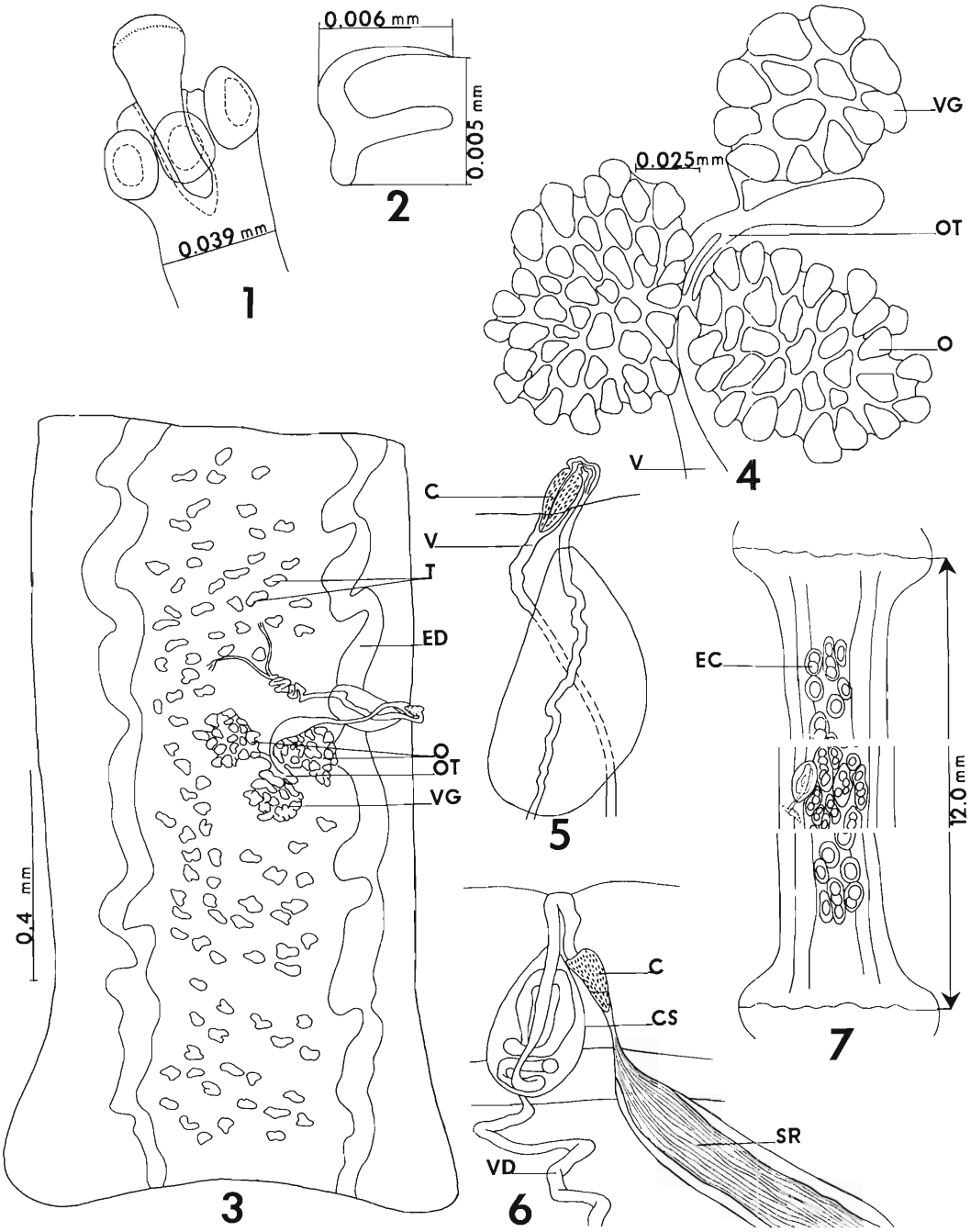
Kowalewskiella totani n. sp. (Figs. 1, 3, and 7)

DESCRIPTION (based on four specimens with all measurements in millimeters): Length of strobila 60. Diameter of scolex 0.118 (Fig. 1). Number of hooks 28–30. Size of hooks (Fig. 2) 0.006 from outer curvature to point and 0.005 from posterior margin of base to point. Diameter of suckers 0.04. Mature proglottid 1.42; width 0.68 (Fig. 3); and located 150 proglottids from neck. Number of testes 89. Length of cirrus sac 0.11; diameter 0.065 (Fig. 5). Length of seminal receptacle 0.074; diameter 0.037 (Fig. 3). Ovarian lobes 0.104 × 0.072. Diameter of vitelline gland 0.071. Length of gravid proglottid 12.0; width 0.68 (Fig. 7). Suckers round and weakly muscular lying close to scolex in fixed material. Rostellum relatively large and retractible. Single row of tiny hooks near tip of extended rostellum. Neck extends for about 1 mm posterior to scolex and proglottization gradual. Youngest proglottids trapezoid-shaped, mature rectangular, gravid ones almost threadlike.

Testes appear in full number in about 150th proglottid, divided into anterior and posterior fields by ovary and vitelline gland which lie just anterior to mid-region of proglottid. Cirrus sac (Fig. 5) extends medially just across prominent somewhat tortuous excretory canal; cirrus organ pyriform-shaped and spinose. In mature proglottids vas deferens uncoiled in cirrus sac but coiled in gravid ones (Fig. 6). Vagina opens externally adjacent to genital pore and in most proglottids with cirrus inserted (Figs. 5 and 6). This undoubtedly confused Yamaguti (1959) into describing terminal dilatation of vagina as spinose. Seminal receptacle a dilatation of vaginal canal near ootype in mature proglottids, reaching almost to inserted cirrus in gravid proglottids (Fig. 6). A blind pouch extends from ootype. Ovary bilobed and follicular lying slightly poral to median plane. Vitelline gland follicular and prominent lying posterior to ootype. Neither Mehlis' organ nor uterus apparent.

Egg capsules receive eggs and eventually fill

[1] From the Department of Zoology, University of Oklahoma, Norman, Oklahoma, supported by National Institute of Allergy and Infectious Diseases, Grant No. AI 05232, National Institutes of Health.



proglottids. Testes disappear as proglottids fill with egg capsules.

HOST: *Totanus flavipes* (Gmelin) 1789.

LOCATION: Small intestine.

LOCALITY: Cheyenne Bottoms Wildlife Management Area, Barton County, Kansas.

HOLOTYPE: U.S. National Museum Helm. Coll. No. 60955; Self No. F2101-4-1-(2), Mature Proglottids.

PARATYPES: U.S. National Museum Helm. Coll. No. 60955; Self No's. F2101-4-1-(3) Scolex, F2101-4-1-(2) Gravid Proglottids, F2101-4-1-(6) Armed Scolex, F2109-7-2 Hooks.

DISCUSSION: The genus *Kowalewskiella* was established and poorly described by Baczynska 1914. Burt (1940) corrected obvious errors in measurements given by Baczynska and listed *K. longiannulata* Baczynska as closely related to *Choanotaenia stagnatilidis* Burt, 1940, *C. glareolae* Burt, 1940, and *C. cingulifera* Krabbe, 1869, the first two of which he described as new species in the same paper. Burt retained *K. longiannulata* in its separate genus only by ". . . the generic character of a persistent uterus and small cirrus sac." In 1959 Baer and Gerber, following the ideas of Sandeman (1959) transferred *C. cingulifera* to the genus *Kowalewskiella* and listed *K. longiannulata*, *C. glareolae*, *C. stagnitilis* (= *C. stagnatilidis*), and *C. hypolencia* Singh 1952 as synonyms. They pointed out similarity of hooks and the separation of the testes into two groups by the female genital complex. The hooks in all these are distinctly smaller than those in *Choanotaenia* and the testes in the latter genus are all located posterior to the female organs. Thus this seems a logical basis for separating these closely related genera. However, the descriptions of a "saclike uterus" and "spinose vagina" given by Yamaguti 1959 for *Kowalewskiella* are in error.

K. totani is most closely related to *K. longiannulata* which Baer and Gerber (1959) consider synonymous with *K. cingulifera*. It differs from both of these in having roughly twice the number of testes described for them. In all other characters it is much like the other species but much larger. While one might assume that the types of *K. longiannulata* and *K. cingulifera* were immature thus accounting for the differences in the number of testes, this does not appear to be true. Descriptions of gravid proglottids would indicate that the types on which descriptions were based were mature worms. From the above it seems best to follow the opinions of Sandeman 1959 and concurred in by Baer and Gerber 1959 thus leaving *K. cingulifera* as the only valid species of *Kowalewskiella* up to now. *Kowalewskiella totani* n. sp. becomes the second species in the genus.

SUMMARY

Kowalewskiella totani n. sp. is described from *Totanus flavipes* from Barton County, Kansas. It differs from *K. cingulifera* (Krabbe 1869) Sandeman 1959 in being much larger and having roughly twice as many testes as the latter species.

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← *Kowalewskiella totani* n. sp.

Fig. 1. Scolex with rostellum extended; Fig. 2. Hook detail; Fig. 3. Mature proglottid showing full complement of testes; Fig. 4. Female reproductive organs; Fig. 5. Cirrus and vagina in mature proglottid showing cirrus organ inserted into latter and noncoiled vas deferens; Fig. 6. Cirrus and vagina of gravid proglottid showing coiled vas deferens and enlarged seminal receptacle; Fig. 7. Gravid proglottid.

Abbreviations: C—cirrus organ; CS—cirrus sac; EC—egg capsule; ED—excretory duct; O—ovary; OT—ootype; SR—seminal receptacle; T—testes; V—vagina; VD—vas deferens.

Aphasmatylenchus nigeriensis n. gen., n. sp. (Aphasmatylenchinae n. subfam. : Tylenchoidea : Nematoda) from Nigerian Soil

S. A. SHER[1]

Numerous specimens of a proposed new taxa were encountered in a soil sample from around cocoa (*Theobroma cacao*) from western Nigeria supplied by F. E. Caveness. Although these specimens superficially appeared similar to the genus *Telotylenchus* Siddiqi, 1960, they differ in many morphological characters from the examined four nominal species in this genus (*T. indicus* Siddiqi, 1960; *T. ventralis*, Loof, 1963; *T. hastulatus* (Colbran, 1960) Jairajpuri, 1963; and *T. housei* Raski, Prasad, and Swarup, 1964).

Using the classification of Thorne (1961) these nematodes could best be placed in the subfamily Hoplolaiminae. Goodey's (1963) classification would place them in the family Hoplolaimidae, most closely related to Hoplolaminae. A comparative study of the genera of Tylenchoidea does not indicate to the author a close relationship to any other nominal genus. A new genus and subfamily is therefore proposed.

APHASMATYLENCHINAE n. subfam.

DIAGNOSIS: Hoplolaimidae. Lip region with well-developed cephalic framework. Amphid apertures elongated. Labial disc present. Esophageal glands overlap intestine ventrally. Phasmids and deirids absent.

TYPE GENUS: *Aphasmatylenchus* n. gen. (from the Greek a, phasma, tylos and enchos and is masculine in gender).

Aphasmatylenchinae is considered to be most closely related to Hoplolaiminae and can be distinguished from this taxa by the absence of phasmids, elongated amphid apertures, and the narrow ventral esophageal gland.

GENUS *Aphasmatylenchus* n. gen.

DIAGNOSIS: *Aphasmatylenchinae*. Lip region annulated, set off from body, cephalic framework well developed. Face view exhibits six lips, elongated amphid apertures, and large labial disc. Spear well developed, slender. Esophageal gland narrow, overlaps intestine ventrally. Male spear and esophagus not as well developed as female. Four lateral incisures, incompletely areolated. Phasmids and deirids absent. Ovaries paired, outstretched. Female tail length about one and a half times body diameter at anus, terminus hemispherical. Male tail length more than twice body diameter at cloaca. Caudal alae envelops male tail.

TYPE SPECIES: *Aphasmatylenchus nigeriensis* n. sp.

Aphasmatylenchus nigeriensis n. sp. (Figs. 1–2)

MEASUREMENTS: Twenty female paratypes: L = 1.01–1.46 mm; a = 25–34; b = 7.2–9.1; b^1 = 5.4–7.4; c = 20–27; V = 50–57; spear = 29–32 μ; m* = 46–54. Ten male paratypes: L = 0.82–0.96 mm; a = 29–35; b = 6.3–7.2; b^1 = 4.8–5.8; c = 15–19; spear = 24–27 μ; m = 48–51; gubernaculum = 11–15 μ; spicules = 31–36 μ.

FEMALE (holotype): L = 1.23 mm; a = 32; b = 7.9; b^1 = 6.8; c = 24; V = 56; spear = 30 μ; m = 48. Body C-shape. Lip region almost hemispherical, distinctly set off, eight annules. Anterior surface of spear knobs sloping posteriorly distally. Dorsal esophageal gland opening 8 μ behind spear base. Excretory pore posterior to level of inconspicuous esophago-

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* m = Anterior part of the spear divided by the spear length.

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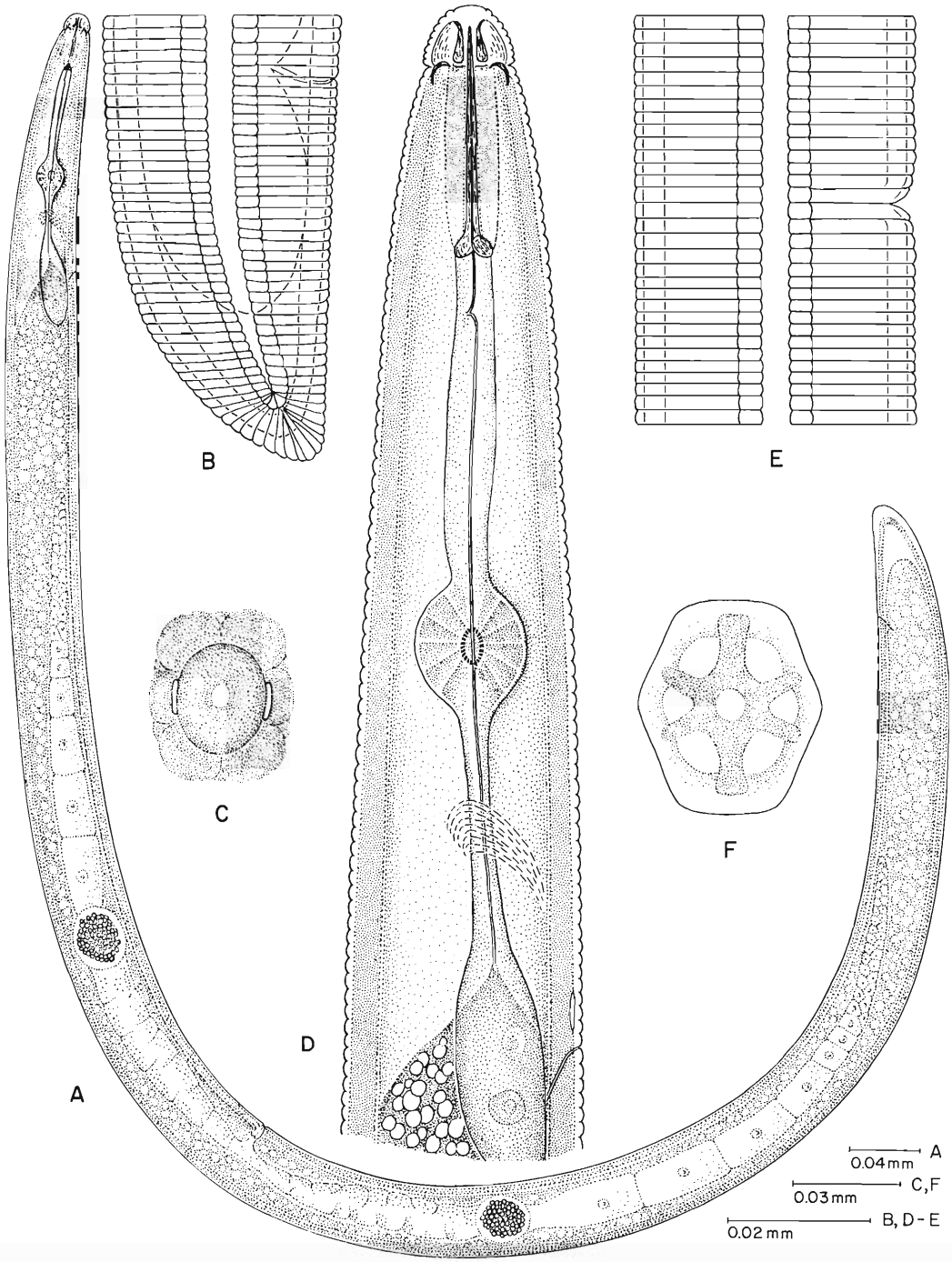
Fig. 1. *Aphasmatylenchus nigeriensis* n. gen., n. sp. Female. A. Entire body, lateral view. B. Tail. C. Face view. D. Anterior end. E. Surface view at vulva. F. Cross section through basal annule of lip region.



intestinal valve. Hemizonid one annule anterior to excretory pore. Esophageal glands overlap intestine slightly more than one body width at esophago-intestinal valve. Spermatheca ellipsoidal, filled with small, round sperm. Lateral field with four incisures, outer band incompletely areolated. Intestine overlaps rectum into tail. Tail length 1.75 anal–body widths long, tapering, more curved dorsally, terminus hemispherical, striated.

MALE (allotype): L = 0.93 mm; a = 34; b = 7.9; b^1 = 6.2; c = 16; spear = 25 μ; m = 52; gubernaculum = 14 μ; spicules = 32 μ. Body slightly curved ventrally. Lip region almost hemispherical, distinctly set off, eight annules. Spear and esophagus not as well developed as in female. Tail three body widths long at cloaca. Caudal alae slender. Gubernaculum with titillae.

In face view the amphid apertures are seen on the lateral lips at the edge of the labial disc (Figs. 1B and 2B). The lip region has seven or eight annules. Areolation of the lateral field is usually confined to the outer bands but some specimens exhibit a few irregular lines of the inner band. The tail is 1.3 to 1.8 anal–body widths long in the female and 2.5 to 3.3 cloaca–body widths long in the male. The small titillae present on the gubernaculum are best seen in a ventral view (Fig. 2F).

HOLOTYPE: Female collected by F. E. Caveness, 17 June 1961, catalog number 630, University of California Survey Collection, Davis, U.S.A.

ALLOTYPE: Male. Same data as holotype, catalogue number 631, University of California Survey Collection, Davis, U.S.A.

PARATYPES: 122 ♀♀, 50 ♂♂, 64 juveniles, same data as above, distributed as follows: 8 ♀♀, 2 ♂♂, 4 juveniles, Dept. of Nematology, Davis, California; 87 ♀♀, 37 ♂♂, 29 juveniles, Dept. of Nematology, Riverside, California; 7 ♀♀, 3 ♂♂, 11 juveniles, USDA Nematode Collection, Nematology Investigations, Beltsville, Maryland; 6 ♀♀, 2 ♂♂, 5 juveniles, Dept. of Nematology, Rothamsted Experimental Station, Harpenden, England; 5 ♀♀, 3 ♂♂, 3 juveniles, Plantenziektenkundige Dienst, Wageningen, The Netherlands; 4 ♀♀, 1♂, 8 juveniles, Canadian National Collection, Ottawa, Canada; and 5 ♀♀, 2 ♂♂, 1 juvenile, Nematode Laboratory, I.D.E.R.T., Abidjan, Ivory Coast.

TYPE HABITAT AND LOCALITY: Soil around cocoa (*Theobroma cacoa*), Ihumbo Village, Abeokuta Province, Nigeria.

Specimens of *Aphasmatylenchus nigeriensis* have also been identified from soil around *Hevea braziliensis*, Amai-Nge Village, Benin Province, Nigeria.

DISCUSSION

The resemblance of *Aphasmatylenchus* to *Telotylenchus* at low magnifications is invalidated by the following important morphological characters of *Aphasmatylenchus*: lip region with well-developed cephalic framework; sexual dimorphism in the anterior part of the body; the absence of phasmids; and a large labial disc and elongated amphid apertures.

Elongated amphid apertures are also seen in *Psilenchus* de Man, 1921; *Macrotrophurus* Loof, 1958; *Heterodera* Schmidt, 1871 (illustrated in Raski, 1950); and *Meloidogyne* Goeldi, 1887 (illustrated in Allen, 1952). These genera are not considered closely related to *Aphasmatylenchus*. *Psilenchus* and *Macrotrophurus* lack a well-developed cephalic framework, labial disc, sexual dimorphism of the anterior part of the body, overlapping esophageal glands, and have different type tails. *Heterodera* and *Meloidogyne* have sessile spherical females producing a gelatinous matrix and males with a short tail, hemispherical terminus, and lacking a caudal alae. In addition these genera have phasmids.

Although the family Hoplolaimidae (Chitwood, 1958; Goodey, 1963) is not considered to be well defined at present there is no difficulty in placing these Nigerian specimens in this taxa. The sexual dimorphism of the anterior portion of the body, high lip region with well-developed cephalic framework, and a labial disc readily suggest an affinity to Hoplolaiminae. A new subfamily is proposed, on the basis of the elongated amphid apertures and

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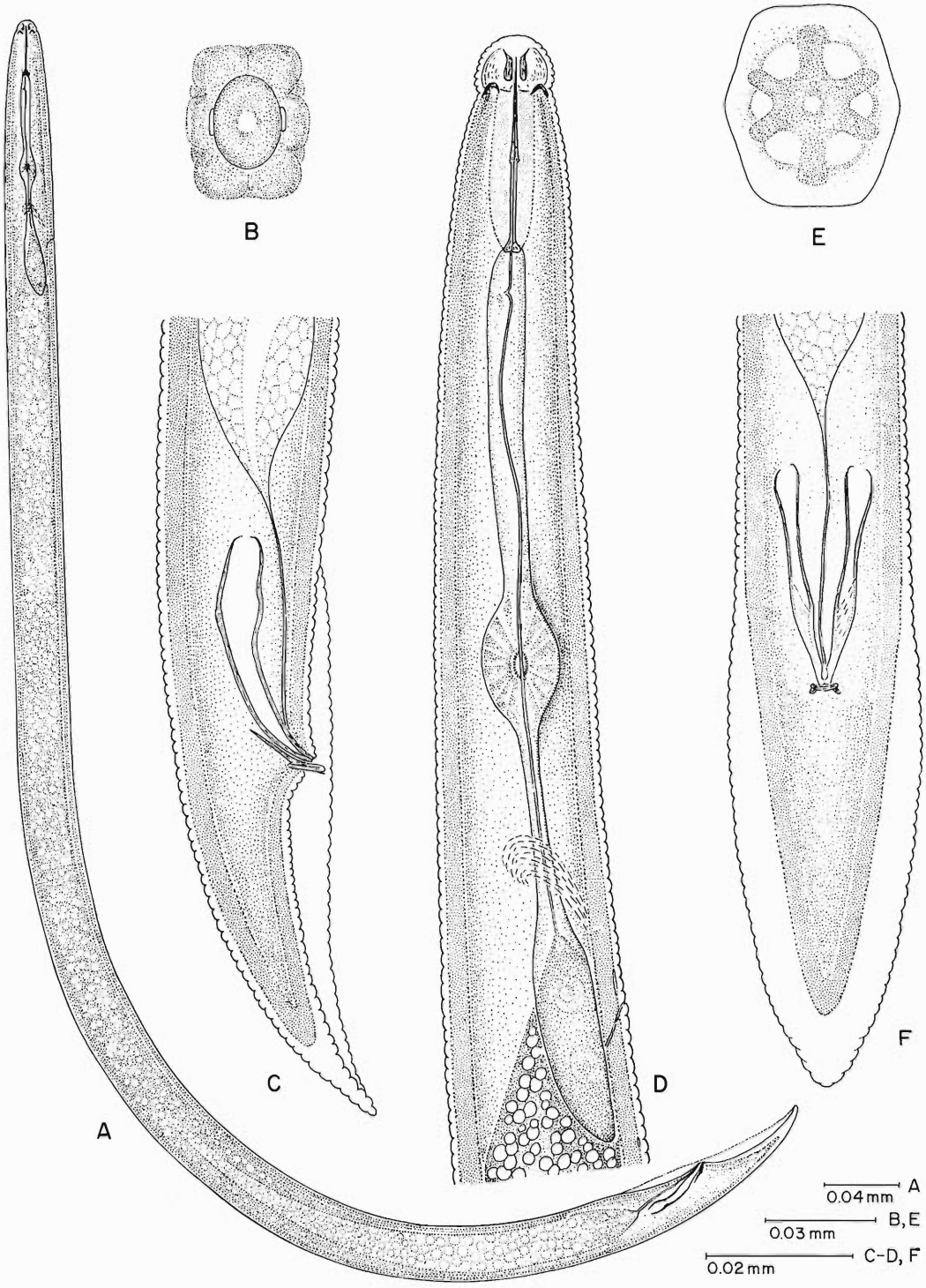
Fig. 2. *Aphasmatylenchus nigeriensis* n. gen., n. sp. Male. A. Entire body, lateral view. B. Face view. C. Tail, lateral view. D. Anterior end. E. Cross section through basal annule of lip region. F. Tail, ventral view.



absence of phasmids, in the Family Hoplolaimidae most closely related to the Subfamily Hoplolaiminae.

Although the author feels strongly concerning the publication of a single species in a paper, *Aphasmatylenchus* is considered a unique genus representing a new subfamily and enlarging the concept of the Family Hoplolaimidae. Paratypes are deposited in seven institutions in various parts of the world for further study and/or verification of the proposals in this paper.

The following assisted in the preparation of nematode slides, measurements, and the illustrations: A. H. Bell, K. W. Brown, and C. S. Papp.

The author is grateful to M. W. Allen and A. R. Maggenti for their comments and review.

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Two New Species of *Boleodorus* Thorne, 1941 (Nematoda : Neotylenchidae) From India[1]

S. ISRAR HUSAIN AND ABRAR M. KHAN

The authors encountered two populations of *Boleodorus* from the soil around the roots of *Mangifera indica* L. and *Pyrus communis* L. The close examination of the specimens revealed that the two populations differ from one another and also from all the known species of the genus, thus representing two new species. They are named as *B. hyderi*[2] n. sp. and *B. rafiqi*[3] n. sp.

Boleodorus hyderi n. sp. (Fig. 1A–F)

MEASUREMENTS: Fifteen females: L = 0.44–0.50 mm; a = 23–27; b = 4.3–5.0; c = 6.0–7.8; V = 63.6–68.5%; spear = 10–11 μ. One male: L = 0.38 mm; a = 22; b = 4.1; c = 7.0; spear = 10 μ; spicules = 12 μ; gubernaculum = 5 μ.

DESCRIPTION: Body tapering at both extremities, assuming C-shaped appearance when relaxed by gentle heat. Cuticle finely annulated. Lateral field marked by four incisures, occupying one-fourth body width near vulva. Dierids present slightly above the level of excretory pore. Phasmid situated just below the level of anus. Head continuous with the body contour, flat and cupolate. Stylet 9–11 μ long with basal flanges. Gland opening close to

[1] Contribution from the Section of Plant Pathology, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

The authors are greatly thankful to Dr. Gerald Thorne, Plant Pathology Department, State College, Brookings, South Dakota, U.S.A. for his help and valuable suggestions.

[2] Named after late Dr. Asghar Ali Hyder, ex-Head of the Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

[3] Named after Dr. Rafique Ahmad Khan, ex-Head of the Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

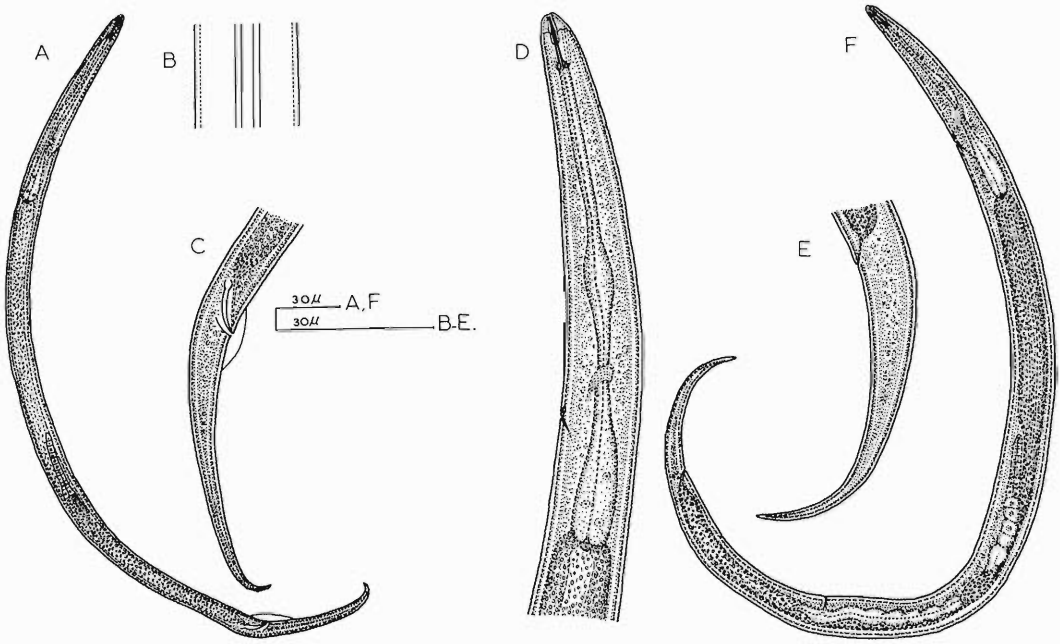

Fig. 1. A–F. *Boleodorus hyderi*. A. Male; B. Lateral field; C. Male tail; D. Head end of female; E. Female tail; F. Female.

spear base. Lip region one-third of the body width at neck base. Esophagus tylenchoid, consisting of a corpus with a posterior fusiform swelling, representing the valveless median bulb; isthmus long, encircled by nerve ring at 70 μ from the anterior end of the body. Basal bulb pyriform with three gland nuclei. Excretory duct prominent, opening through a cuticularized pore at 75–80 μ from the anterior end. Cardia small and rounded. Intestine packed with large refractive granules. Rectum about one-third anal–body width long. Ovary single, prodelphic, outstretched. Postuterine branch short, half the vulvar–body width long. Oocytes arranged in multiple rows. Spermatheca present. Vulva–anus distance greater than tail length. Tail elongate, conoid with rounded terminus.

HOLOTYPE: Female collected in February 1964, Slide No. 535, deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

ALLOTYPE: Male collected with the females; other data same as for holotype.

PARATYPES: Two females in the U.S. Department of Agriculture, Nematode Collection, Beltsville, Maryland, U.S.A. and six females with the authors.

TYPE HABITAT: Soil around the roots of *Mangifera indica* L.

TYPE LOCALITY: Dehra Dun, U.P., India.

DIAGNOSIS AND RELATIONSHIP: *B. hyderi* n. sp. comes closer to *B. innuptus* Andrassy, 1961; *B. volutus* Lima and Siddiqi, 1963 and *B. similis* Khan and Basir, 1963 but differs from:

(1) *B. innuptus* in having continuous head and presence of males;

(2) *B. volutus* in the size of the spear, tail length, and in the position of vulva;

(3) *B. similis* in body size, position of phasmid, and in the lateral field occupying less than one-fourth body width.

Boleodorus rafiqi[3] n. sp. (Fig. 2A–D)

MEASUREMENTS: Ten females: L = 0.5–0.6 mm; a = 22–35; b = 4.7–5.0; c = 7.0–10.5; V = 65–68%; spear = 8–11 μ.

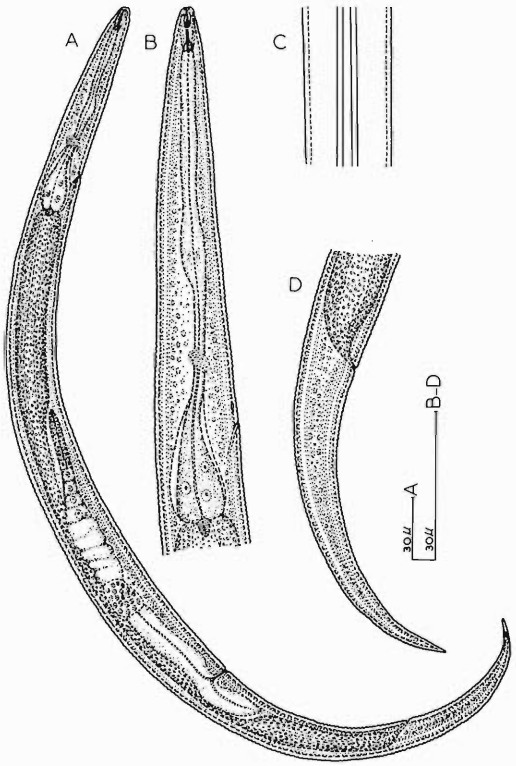

Fig. 2. A–D. *Boleodorus rafiqi*. A. Female; B. Head end; C. Lateral field; D. Tail end.

DESCRIPTION: Body C-shaped on death, tapering on both extremities. Cuticle finely annulated. Lateral field marked by four incisures, occupying less than one-fourth body width at mid-body. Deirids and phasmids not seen. Hemizonid three annules anterior to the excretory pore. Excretory pore 80–90 μ apart from the anterior end of the body. Head continuous with the body contour, flat and cupolate. Lip region unstriated, two-fifths of the body width at neck base. Spear 8–11 μ long with basal flanges. Gland opening close to spear base. Esophagus tylenchoid, consisting of a corpus with a posterior fusiform swelling representing the valveless median bulb; isthmus encircled by nerve ring. Basal bulb pyriform with three prominent gland nuclei, enclosed in a distinct chamber, a unique character in this genus. The distance from the anterior end of the body to the center of the median bulb slightly less than the distance from the latter to the end of the basal bulb. Cardia distinct, conoid. Intestine packed with large refractive granules. Rectum about one-third anal–body width long. Ovary single, prodelphic, outstretched. Elongate pouch-like spermatheca present. Postuterine branch short, nearly the vulvar–body width long. Vulva–anus distance greater than tail length. Tail elongate, ventrally arcuate, not hooked, with nearly rounded terminus; tail length six to seven times the anal–body width.

MALE: Not found.

HOLOTYPE: Female collected in March 1964, Slide No. 536, deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

TYPE HABITAT: Soil around the roots of *Pyrus communis* L.

TYPE LOCALITY: Srinagar (Kashmir), India.

DIAGNOSIS AND RELATIONSHIP: *B. rafiqi* n. sp. comes closer to *B. pakistanensis* Siddiqi, 1963 but differs in the presence of a distinct chamber surrounding the basal bulb and in the position of the dorsal esophageal gland opening. It can be differentiated from *B. thylactus* Thorne, 1941 in possessing more posteriorly located vulva and a distinct chamber surrounding the basal esophageal bulb.

SUMMARY

Two new species of *Boleodorus* Thorne, 1941, *B. hyderi*, and *B. rafiqi* are described from around the roots of *Mangifera indica* L. and *Pyrus communis* L. from Dehra Dun and Srinagar, respectively. *B. hyderi* n. sp. is characterized by possessing the phasmid just below the level of anus and lateral field occupying less than one-fourth of the body width near mid-body; and *B. rafiqi* n. sp. in possessing a distinct chamber surrounding the basal esophageal bulb.

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Seinura nagini n. sp. (Nematoda : Aphelenchoididae) from North India[1]

S. ISRAR HUSAIN AND ABRAR M. KHAN

The authors encountered one male and several female specimens of *Seinura* Fuchs, 1931 from the soil around the roots of *Saccharum officinarum* L. from Nagina, District Bijnor, U.P., India. The close and careful examination of the specimens revealed that it differs from all the known species in some important taxonomic characters. It is named as *Seinura nagini* n. sp. The specimens were relaxed by gentle heat, fixed in TAF, processed through lactophenol, and mounted in pure glycerine. The worm is described below.

Seinura nagini n. sp. (Fig. 1A–E)

MEASUREMENTS: Fifteen females: L = 0.32–0.40 mm; a = 28–31; b = 3.0–4.0; c = 6.0–8.0; V = 60–64%; spear = 12–15 μ. One male: L = 0.35 mm; a = 25.0; b = 3.5; c = 10.0; spear = 13 μ; spicules = 18 μ.

DESCRIPTION: Body cylindrical, ventrally curved on death, tapering on both extremities, finely annulated. Lateral field marked by four incisures. Lip region with three to four annules, distinctly set off by a constriction, without refractive oral armature, cap-like measuring 5 × 3 μ. Cephalic framework obscure. Spear 12–15 μ long with small but distinct basal knobs and broad lumen. Small spear guide present just above the middle of spear. Corpus a slender tube ending in a distinctly longer than wide median bulb with well-developed valve plates. Excretory pore distinct at the level of nerve ring, situated 45–52 μ apart from the anterior end of the body. Hemizonid not observed. Esophageal glands forming long lobes. Intestinal lumen broad and distinct, intestine packed with food granules. Anus distinct. Vulva prominent, ovary single, prodelphic, outstretched. Oocytes arranged in two rows. Rounded spermatheca present. Post-uterine sac slightly more than the vulvar–body width long. Vulva–anus distance more than tail length. Tail long and filiform with acute terminus six to seven times anal–body width long, terminal tail portion hooked, lacking a mucron.

Males similar to females in appearance. Testis single, outstretched. Spermatocytes serially arranged. Spicules 18 μ long, the proximal end of the transverse bar prolonged with the dorsal limb in a prominent apex and a prominent rostrum at the other end of the transverse bar. Supplements consisting of an adanal pair and two pairs postanal papillae. Tail shorter than females', conoid, ventrally curved, ending in a fine pointed flagellum-like terminus.

HOLOTYPE: Female collected in October 1964, deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

ALLOTYPE: Male collected with the females; other data same as for holotype.

PARATYPES: Two females, slide No. 641 deposited with Nematology Investigation, Plant Industry Station, Beltsville, Maryland, U.S.A. and one female at Rothamsted Experimental Station, Harpenden, Herts., U.K.

TYPE HABITAT: Soil around the roots of *Saccharum officinarum* L.

TYPE LOCALITY: Nagina Agriculture Farm, Nagina, District Bijnor, U.P., India.

DIAGNOSIS AND RELATIONSHIP: *Seinura nagini* n. sp. differs from all the known species by having smaller body being smallest amongst the species so far described. In the position of vulva too it differs from all the known species except S. *filicaudata* (Christei, 1939) Goodey, 1960, but differs from it in body measurements and other characters.

[1] Contribution from the Section of Plant Pathology, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India. The authors are greatly thankful to Dr. J. B. Goodey for his help and valuable suggestions.

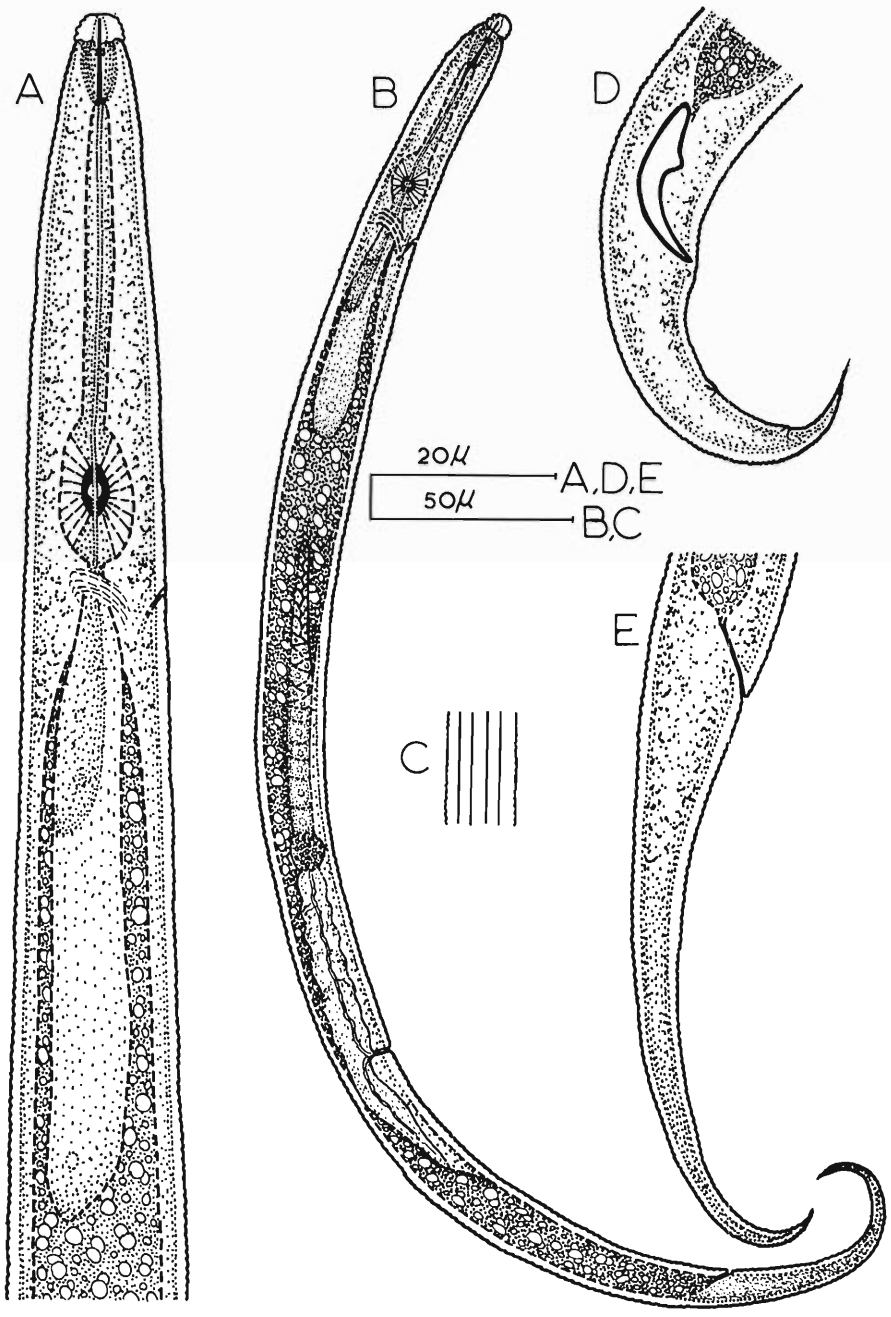

Fig. 1. A–E. *Seinura nagini*. A. Head end of female; B. Female; C. Lateral field; D. Tail end of male; E. Tail end of female.

SUMMARY

A new species of *Seinura* Fuchs, 1931 is described and figured. It is characterized by its smaller body (L = 0.32–0.40 mm); spear with small but distinct basal knobs; spermatheca rounded, postuterine branch one vulvar–body width long and the males having one adanal pair and two pairs of postanal papillae.

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Two New Species of *Chronogaster* Cobb, 1913 (Nematoda : Plectidae)

P. A. A. LOOF AND M. SHAMIM JAIRAJPURI[1]

Two new species af *Chronogaster* are described, one from India and one from The Netherlands, for which the names *C. andrássyi* and *C. tenuis* are proposed. A few morphological and taxonomic notes upon the genus are given. Measurements were taken from specimens mounted in glycerin.

Chronogaster andrássyi n. sp.[2] (Fig. 1)

FEMALES (7): L = 1.25–1.37 mm; a = 48–54; b = 4.4–4.7; c = 5.5–6.4; V = $^{7-10}$49–52.

HOLOTYPE: L = 1.25 mm; a = 54; b = 4.6; c = 6.0; V = ^{8}51.

MALE, ALLOTYPE: L = 1.29 mm; a = 53; b = 4.2; c = 8.2.

DESCRIPTION: Body slender, tapering more posteriorly than anteriorly; curved into a wide spiral or a circle in death. Lateral field not marked outwardly; lateral chord indistinct, seen only in the posterior part of the body; wide, one-third of body diameter, composed of three cell rows; apparently no epidermal glands, at least there are no lateral pores. Transverse annulation of cuticle coarse and distinct; width of annules 2.4 μ near vulva, narrowing posteriorly to 1.5 μ on middle of tail, widening anteriorly to 2.7 μ at base of oesophagus, then narrowing again to 2.2 μ near lip region; here the grooves between the annules are distinctly deeper than elsewhere on the body. First annule behind lip region narrower than succeeding ones. Anastomoses occur in small numbers all over the body; the incomplete annules may lie either on the ventral or on the dorsal side. No longitudinal striae. No crystalloids in the body cavity.

Lip region dome-shaped in most females, conoid in the male and in one female, perhaps due to collapse; 4 μ high and 7.5–8 μ wide, its width equal to 33–38% of maximum body diameter. *En face* view shows that the lip region bears about 16 longitudinal striae; from a lateral view these were not visible. There are no transverse striae on the lip region. Lips and labial papillae not distinguishable either from *en face* or from lateral view, but probably the lips are not wholly fused.

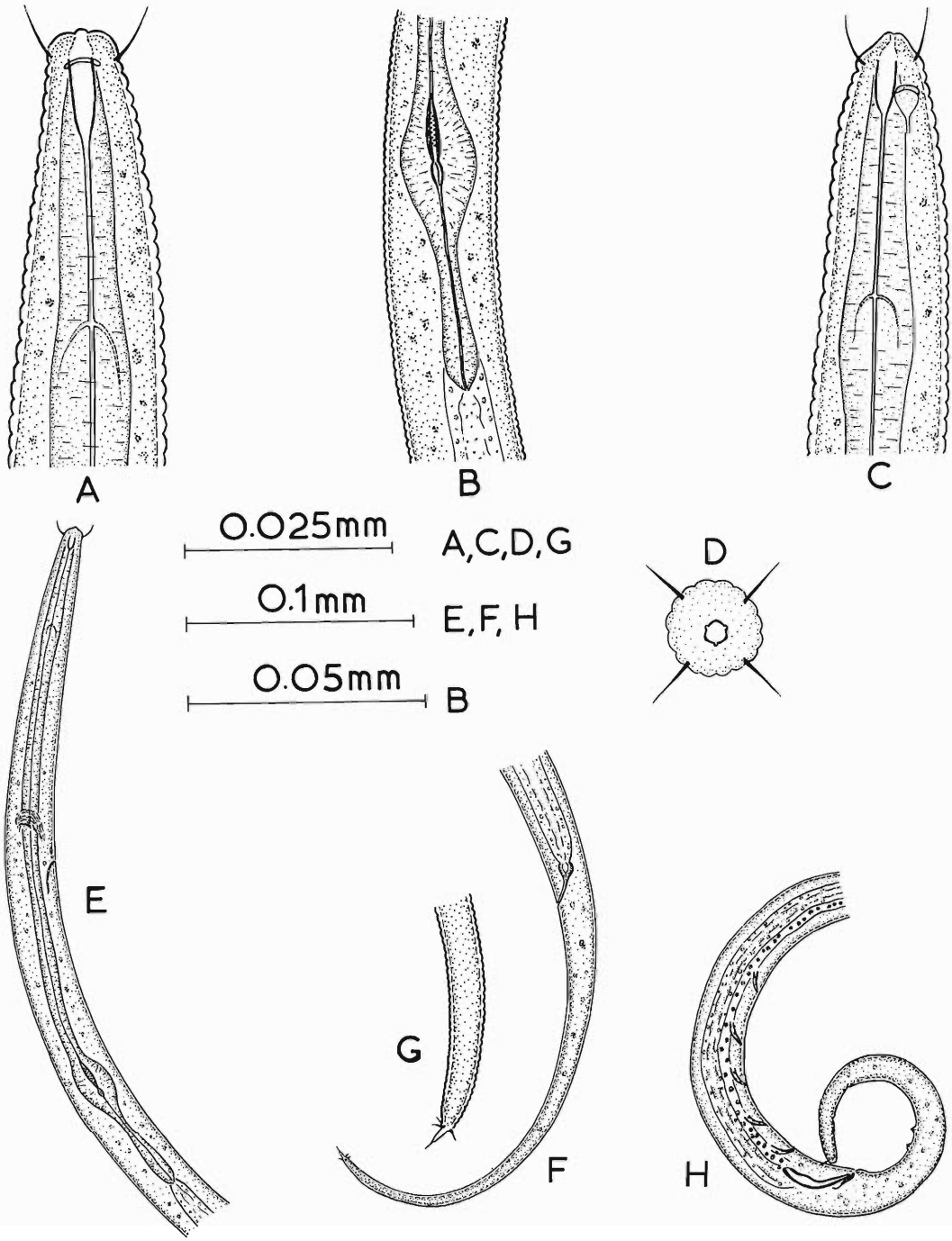
Cephalic setae four, slender, curved slightly forward, 8–9 μ long, i.e., slightly more than width of lip region. Amphid stirrup-shaped, aperture a curved transverse slit, located in the females on the first, in the male on the second annule behind the lip region.

Mouth cavity in two parts. The anterior one is subcylindrical, 9–9.5 × 2.5 μ in size; with three narrow expansions (two dorsosublateral, one ventral) visible only in *en face* view. On transverse section this part is strikingly like the mouth cavity of *Plectus parietinus* as illustrated by Maggenti (1961, Fig. 1 B). The posterior part is narrow, about 24 μ long, separated from the oesophageal lumen by an expansion. In the female the amphid aperture lies at the level of the anterior end, in the male at the level of the middle of the anterior part of the mouth cavity.

Oesophagus cylindrical until the oval bulbus, which is 20–22 μ long and 16–17 μ wide (20 × 12 μ in the male). Its lumen is in two sections, the anterior one serrate, bearing about 3 × 7 denticles. The postbulbar prolongation of the

[1] Landbouwhogeschool, Wageningen, Netherlands; second author on leave from Aligarh Muslim University, Aligarh, India.

[2] Named after Dr. I. Andrassy, Budapest, Hungary, who has contributed greatly to our knowledge of this genus.



oesophagus is about 1.5 times as long as the bulbus (33 μ). Nerve ring surrounds oesophagus at 42–45% of its length from head end. There is a distinct excretory pore at 47–50% of neck length, about 5–7 annules behind the nerve ring. Distal part of excretory canal cuticularized. Hemizonid distinct, 1–2 annules long, located 1–2 annules anterior to excretory pore.

FEMALE: Vulva an inconspicuous transverse slit, 5 μ long, depressed in most specimens. Vagina weakly cuticularized, about one-third of body diameter long. Gonad single, prodelphic, reflexed, inconspicuous. A very short rudiment of the posterior gonad appears to be present. Rectum slightly longer than anal–body width, separated from the intestine by a distinct sphincter. The anal–body width is 60–70% of the maximum body width. Tail 11–15 anal–body widths long, curved to ventral side, tapering; its tip provided with one large mucro (5 μ), the base of which is surrounded by four minute spines. Caudal glands and spinneret absent.

MALE: Testes two, opposed, the anterior one outstretched, the posterior one reflexed. Spicules 33 μ long, curved, cephalated proximally, pointed distally. Gubernaculum of complex shape (Fig. 1, H). Five tubular preanal supplements; between the posterior one and the anus there is a short ventral seta. Tail distinctly shorter than in the female, 8 anal–body widths long, curved strongly to ventral side; tip smooth, blunt, without mucro. Two ventral mammiform papillae as illustrated; on the distal part of the tail there are two more slight irregularities in the annulation on the ventral side. No caudal glands or spinneret.

HOLOTYPE: Female on slide WT 508. ALLOTYPE: Male on slide WT 509. PARATYPES: Seven females (one with *en face* view, and ventral view of vulva) on slides WT 509–515. Types in the Nematode Collection of the Plantenziektenkundige Dienst, Wageningen, Netherlands; paratype in the Zoology Museum, Aligarh Muslim University, Aligarh, India.

TYPE HABITAT AND LOCALITY: Soil around roots of orange (*Citrus* spec.), hills near Nainital, U.P., India. Elevation about 6,300 ft above sea level.

DISCUSSION: *C. andrássyi* is characterized by its sexual dimorphism (position of amphid, shape and length of tail), by the well-developed excretory pore and duct, and hemizonid, and by the arrangement of mucros on the female tail tip. For differentiation from the other species of the genus we refer to the key.

Chronogaster tenuis n. sp. (Fig. 2)

FEMALES (4): L = 1.06–1.18 mm; a = 67–75; b = 4.2–4.4; c = 4.8–5.2; V = $^{5-7}$45–47.

HOLOTYPE: L = 1.06 mm; a = 67; b = 4.3; c = 5.2; V = ^{5}47.

MALE: Not found.

A very slender species. In death the posterior part of the body is curved into a spiral, whereas the anterior part is curved much less and may even be straight. Lateral field not marked externally; lateral chord obscure, apparently without glands. Transverse striation of cuticle moderately coarse, 1.7 μ; near the head end the annules become slightly narrower (1.3 μ), on the distal part of the tail they tend to become indistinct. No longitudinal striation. No crystalloids in the body cavity.

Lip region truncate, its width at base 6 μ or about 40% of the maximum body width; the lips apparently not amalgamated. Cephalic setae about 9 μ long, slender, curved somewhat anteriad. Amphid aperture a transverse slit, on the third annule behind the lip region, opposite the posterior end of the wide part of the stoma. Amphids themselves difficult to see. Anterior part of stoma cylindroid, 6 μ long and 1.5 μ wide; posterior part narrow, elongate, separated from the esophageal lumen by an expansion. Total length of mouth cavity about 23–26 μ. Oesophagus cylindrical until the bulbus which measures 16–18 $\mu \times 11$ μ; its lumen in two sections, the anterior one with serrate walls. The postbulbar prolongation of the oesophagus is 27–29 μ long. The nerve ring surrounds the oesophagus at about 41% of its length from head end. At 46% of neck length

←

Fig. 1. *Chronogaster andrássyi* n. sp. A: Anterior end of female, lateral view; B: Female, base of oesophagus; C: Anterior end of male, lateral view; D: Female, cross section through lip region at level of insertion of setae; E: Female, oesophageal region, lateral view; F: Female, tail, lateral view; G: Female, distal part of tail, enlarged; H: Male, posterior part of body, lateral view.

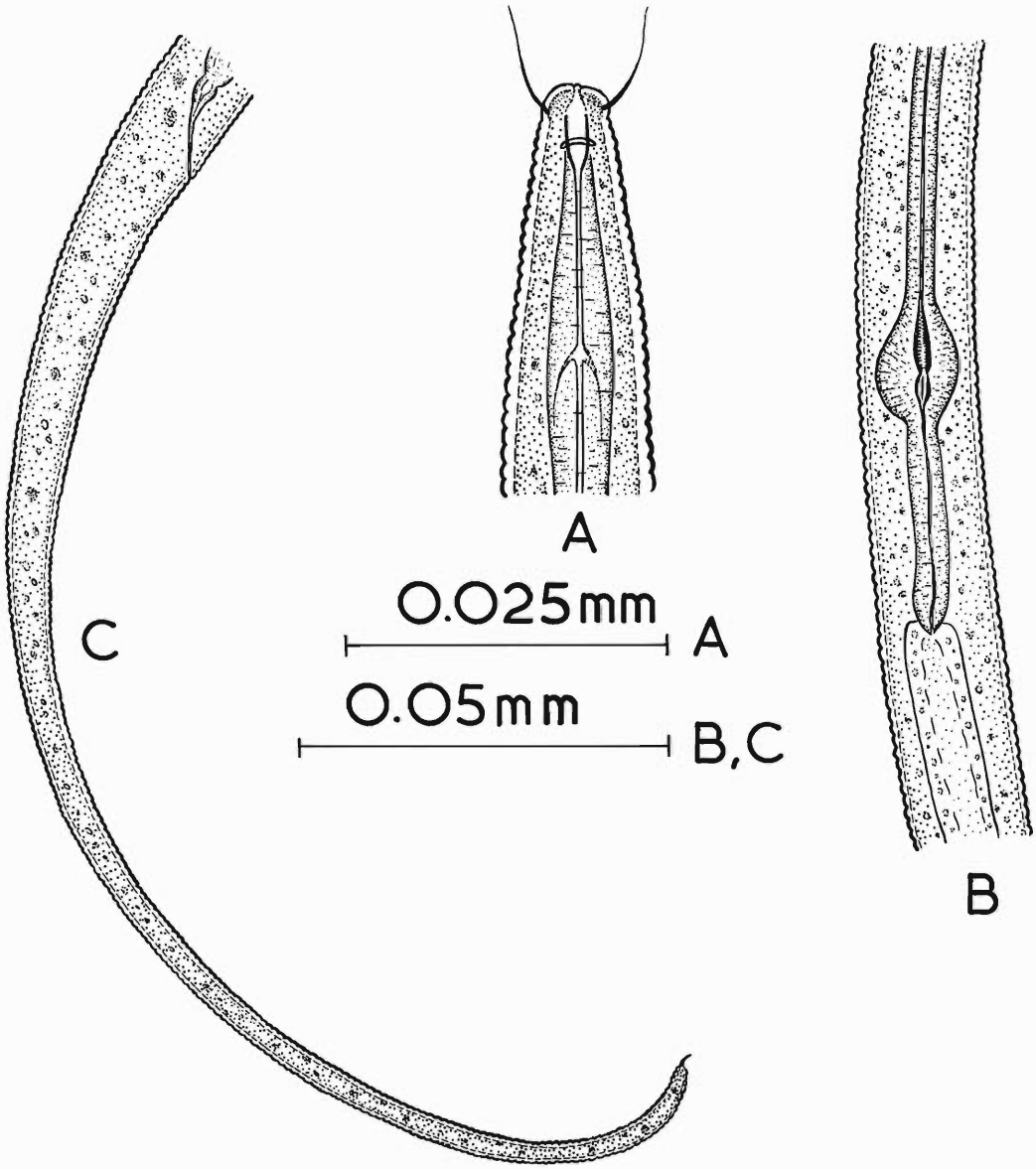


Fig. 2. *Chronogaster tenuis* n. sp. A: Anterior end of female, lateral view; B: Female, base of oesophagus; C: Female tail.

there is an obscure excretory pore. Hemizonid not seen.

Vulva more conspicuous than in the preceding species, transverse, with protruding lips. Vagina weakly cuticularized, about 40% of body diameter. Gonad single, prodelphic, reflexed; a very short (less than one-half body width) rudiment of the posterior gonad appears to be present. Rectum slightly longer than anal–body width, separated from the intestine

by a distinct sphincter. Tail elongate, 21–22 anal–body diameters long, slightly tapering proximally, then cylindroid to the narrow terminus which is provided with a single, ventral mucro of not quite 1 μ long.

HOLOTYPE: Female on slide WT 517. PARATYPES: Three females on slide WT 516. Types in the Nematode Collection of the Plantenziektenkundige Dienst, Wageningen, Netherlands.

TYPE HABITAT AND LOCALITY: Soil at the Municipal Park at Bergen-op-Zoom, Netherlands.

DISCUSSION: *C. tenuis* is close to *C. brasiliensis* Meyl, 1957, from which it differs by much slenderer body, much longer cephalic setae, and by the lumen of the bulbus being distinctly in two sections with serrate walls anteriorly.

GENERAL DISCUSSION

In the generic diagnosis given by Andrássy (1957) the excretory pore is said to be apparently absent. In *C. andrássyi*, however, a distinct and well-developed excretory pore and duct, and a hemizonid are present. The same condition was found by us in a female of *C. magnifica* Andrássy, 1956 from Nigeria. A less distinct, perhaps rudimentary excretory pore was found by us in *C. tenuis* and in specimens of *C. boettgeri* Kischke, 1956 from The Netherlands.

The generic diagnosis given by Goodey (1963) states: Gubernaculum absent. In *C. andrássyi*, however, a well-developed gubernaculum occurs.

So the generic diagnosis has to be emended on these two points, to include species with and without excretory pore, and with and without gubernaculum. (In *C. typica* (de Man, 1921) and *C. daoi* Loof, 1964 the excretory pore was not found.)

KEY TO THE SPECIES OF *Chronogaster*, BASED UPON FEMALES

1. Cuticle with longitudinal and transverse striation, dividing the surface outside the lateral fields into rectangles or squares 2
   Cuticle with transverse striation only 3
2. Longitudinal striae 18; amphid on 4th annule behind smooth lip region; body length about 1.5 mm; female tail without mucro ..... *alata* Gerlach, 1954
   Longitudinal striae 20–24; amphid on 2nd annule behind smooth lip region; body length about 1 mm; female tail with three mucros ..... *magnifica* Andrássy, 1956
3. Tail with four mucros of about equal size ..... *longicollis* (v. Daday, 1899)
   Tail with one mucro; if more, then one is distinctly larger than the other(s) 4
4. Body very slender (a about 100); oesophagus very short (b = 8); mouth cavity funnel-shaped ..... *subtilis* Andrássy, 1958
   Body less slender (a under 80); oesophagus of normal length (b under 5); mouth cavity cylindroid 5
5. Lateral glands large, conspicuous; body cavity with numerous crystalloids; tail with one mucro ..... *typica* (de Man, 1921)
   Lateral glands not conspicuous; body cavity without crystalloids 6
6. Amphid spiral, located behind wide part of mouth cavity; tail short (c over 10) ..... *boettgeri* Kischke, 1956
   Amphid not distinctly spiral, located about middle of wide part of mouth cavity; tail longer (c under 10) 7
7. Tail tip with one large mucro, its base surrounded by four minute ones ..... *andrássyi* n. sp.
   No minute spines at base of large mucro 8
8. Tail of moderate length (c = 6–8); tail tip with two mucros, the dorsal one being the larger one ..... *daoi* Loof, 1964
   Tail very long (c = 5.2 or less); tail tip with one mucro 9
9. Body moderately slender (a = 46–47); diameter of lip region one-quarter of maximum body width; length of cephalic setae 4.5 μ ..... *brasiliensis* Meyl, 1957
   Body very slender (a = 67–75); diameter of lip region one-third of maximum body width; length of cephalic setae 9 μ ..... *tenuis* n. sp.

Chronogaster multitubifera (Imamura, 1931) Maggenti, 1961 has not been included in this key. It differs from *Chronogaster* by the big spiral amphid, located far forward; by the shape of the mouth cavity, the anterior part of which is not widened; by the absence of valves in the bulbus (the "bulbular apparatus" was said to consist of two sets of rectangular plates) and by the paired ovaries. In all these characters, however, *C. multitubifera* fits the genus *Para-*

plectonema Strand, 1934. The illustration of the bulbus of *C. multitubifera* wholly agreed with a juvenile specimen of *P. pedunculatum* (Hofmänner, 1913) from the Netherlands, examined by us. Therefore we herewith transfer *C. multitubifera* to *Paraplectonema* which becomes *Paraplectonema multitubiferum* (Imamura, 1931) n. comb. Furthermore, in view of the great similarity between the descriptions of *P. pedunculatum* and *P. multitubiferum*, it is likely that the latter is synonym of *P. pedunculatum*.

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Four New Species of *Diphtherophora* de Man, 1880 (Nematoda : Diphtherophoridae) with a Key to the Species of the Genus[1]

S. ISRAR HUSAIN, ABRAR M. KHAN, AND J. J. S'JACOB

Among the numerous species of nematodes of the superfamily Dorylaimoidea collected by the authors from the soil around the roots of various plants at different places in India, four undescribed species of *Diphtherophora* de Man, 1880 are reported hereunder. The specimens were relaxed by gentle heat, fixed in TAF, processed through lactophenol, and mounted in dehydrated glycerine. Temporary water mounts were also examined. Measurements of the glycerine mounts are given.

Diphtherophora christenseni[2] n. sp. (Fig. 1D–G)

MEASUREMENTS: Twelve females: L = 0.31–0.34 mm; a = 14–18; b = 3.4–4.0; c = 16.5–21.0; V = 58.0–60.3%; spear = 16–20 μ. Five males: L = 0.31–0.38 mm; a = 15.7–23.7; b = 3.8–4.4; c = 15.7–16.5; spear = 15–19 μ; spicules = 14–16 μ; gubernaculum = 4–5 μ. Three larvae: L = 0.27–0.29 mm; a = 14.0–15.0; b = 3.4–4.0; c = 16.0–17.0; spear = 14–15 μ.

DESCRIPTION: Body small, robust, cylindrical with tapering ends, assuming slightly ventrally arcuate shape when relaxed by gentle heat. Cuticle thick and smooth, loosely fitted with the body except at head, vulva, and anus. Lip region distinctly set off from the body by a constriction, rounded, labial papillae slightly elevated. Amphidial pouches vase-shaped. Spear typical of the genus surrounded by protrudor muscles 16–20 μ long. Esophagus consisting of an anterior cylindrical tube and a posterior pyriform bulb, sometimes slightly overlapping ventrally. Nerve ring crossing the esophagus slightly behind its middle. Excretory pore situated at 70–80 μ apart from the anterior end of the body. Intestine packed with dense granules. Prerectum not definite. Rectum distinct, a little less than anal–body width long. Vulva not prominent, vagina considerably short, nearly one-fifth body width long, its walls not sclerotized. Ovaries paired, opposed, and reflexed. Tail dorsally convex–conoid, not digitate, 1½ times the anal–body width long.

[1] Contribution from the Section of Plant Pathology, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

[2] Named after late Prof. Jonas J. Christensen of the Department of Plant Pathology and Physiology, University of Minnesota, St. Paul, U.S.A.

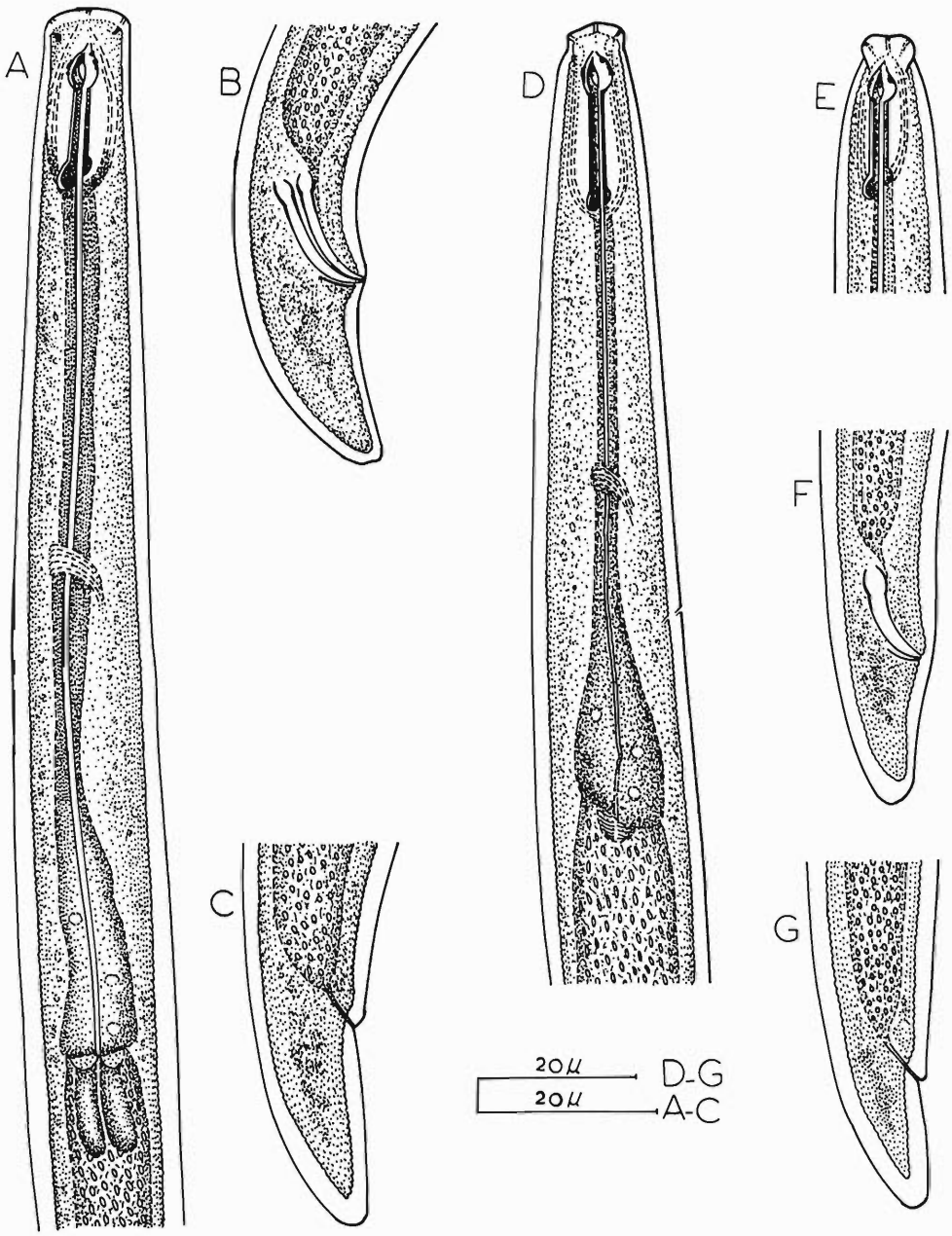

Fig. 1. A–C. *Diphtherophora tafazzuli.* A. Neck region of female; B. Tail end of male; C. Tail end of female; D–G. *Diphtherophora christenseni.* D. Neck region of female; E. Female head; F. Male tail; G. Female tail.

Males similar to females in general appearance, sometimes more curved and more slender. Testis single, spicules simple, slightly arcuate, nearly 14–16 μ long. Gubernaculum 4–5 μ long. Tail shape as in females or slightly ventrally curved. No supplements seen.

HOLOTYPE: Female collected on 15 December 1964, slide No. 711 deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

ALLOTYPE: Male collected with the females; other data same as for holotype.

PARATYPES: Two females and one male, slide No. 711 F & G deposited in the U.S.D.A. Nematode Collection, Beltsville, Maryland, U.S.A. Six females with the authors.

TYPE HABITAT: Soil around the roots of *Justicia gendarussa* Burm.

TYPE LOCALITY: University campus, Aligarh Muslim University, Aligarh.

DIAGNOSIS AND RELATIONSHIP: *D. christenseni* n. sp. comes closer to *D. parva* Siddiqi, 1964 and *D. minutus* Ivanova, 1958. It differs from *D. parva* in having set-off head against continuous head in *D. parva*, dorsally convex–conoid tail (digitate in *D. parva*) and in the presence of males. It can be distinguished from *D. minutus* in the smaller size of the body and in the position of vulva (V = 51–55% in *D. minutus*).

Diphtherophora tafazzuli[3] n. sp. (Fig. 1A–C)

MEASUREMENTS: Six females: L = 0.42–0.47 mm; a = 20–25; b = 3.7–4.5; c = 21–25; V = 62–64%; spear = 16–18 μ. One male: L = 0.4 mm; a = 30.7; b = 4.7; c = 20.0; spear = 15.0 μ; spicules = 18.0 μ; gubernaculum = 6 μ.

DESCRIPTION: Body cylindrical with gradually tapering ends slightly ventrally curved on death. Cuticle thick, smooth, and loosely fitted with the body except at head, vulva, and anus. Lip region continuous with the body, angular and flat; labial papillae distinctly elevated. Spear with anterior refractive irregular part and a posterior cylindrical extension with prominent basal knobs, nearly 16–18 μ long; spear guiding apparatus irregularly sclerotized, arch-like; well-developed protrudor muscles of the spear attached with the knobs. Esophagus with an anterior cylindrical tube crossed by nerve ring somewhere in the middle and a posterior bulbar region, pyriform in shape. After the cardia two glandular organs are seen. Intestine packed with refractive granules. Rectum distinct nearly one-half the vulvar–body width long. Prerectum not definite. Tail dorsally convex–conoid, not digitate, 1½ times anal–body width long. Ovaries paired, opposed, and reflexed. Vulva not prominent, vagina short, its walls not sclerotized.

Males similar to females in general shape, more slender than females. Tail nearly similar to females, slightly more conical at the terminus. Testis single; spicules simple, slightly arcuate, 18 μ long. Gubernaculum present, nearly 6 μ long. No supplements seen.

HOLOTYPE: Female, collected in January 1964, slide No. 712 deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

ALLOTYPE: Male, collected with the females; other data same as for holotype.

TYPE HABITAT: Soil around the roots of *Cestrum diurnum* L.

TYPE LOCALITY: University campus, Aligarh Muslim University, Aligarh.

DIAGNOSIS AND RELATIONSHIP: *D. tafazzuli* n. sp. comes closer to *D. parva* Siddiqi, 1964; *D. minutus* Ivanova, 1958; and *D. christenseni* n. sp. but differs from all in possessing two glandular organs at the base of esophagus, just after the cardia. It further differs: (1) from *D. parva* in the position of the vulva (V = 57–59% in *D. parva*), presence of an abnormal structure associated with the basal esophageal bulb, shape of the female tail, and in the presence of males; (2) from *D. minutus* in body width, tail length, position of vulva (V = 51–55% in *D. minutus*), and in the presence of males; (3) from *D. christenseni* n. sp. in the body size and width, position of vulva (V = 62–64% in *D. christenseni*), and in the continuous head (set off in *D. christenseni*).

Diphtherophora citri n. sp. (Fig. 2D and E)

MEASUREMENTS: Six females: L = 0.45–0.64 mm; a = 21.7–27.8; b = 4.2–4.5; c = 20.0–25.6; V = 60.0–64.0%; spear = 15.0–19.0 μ.

DESCRIPTION: Body cylindrical, tapering gradually on both extremities, slightly ventrally curved on death. Cuticle thick, smooth, and

[3] Named after S. Tafazzul Husain, the father of the senior author.

loosely fitted with the body except at head, vulva, and anus. Lip region continuous with the body contour. Labial papillae distinctly elevated. Amphidial pouches vase-shaped. Spear typical of the genus guided by well-developed protrudor muscles attached to the spear knobs. Esophagus consisting of an anterior cylindrical tube, encircled by nerve ring near its middle, and a posterior pyriform basal bulb. Intestine packed with dense granules. Prerectum not definite; rectum prominent, nearly three-fourths anal–body width long. Tail broadly convex–conoid, 1½ times the anal–body width long. Ovaries paired, opposed, and reflexed. Vulva not distinct, vagina short, its walls not sclerotized.

Males not found.

HOLOTYPE: Female, collected in May 1964, slide No. 713 deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

TYPE HABITAT: Soil around the roots of *Citrus medica* L.

TYPE LOCALITY: Dehra Dun, U.P., India.

DIAGNOSIS AND RELATIONSHIP: *D. citri* n. sp. is related to *D. kirjanovae* Ivanova, 1958; *D. pseudoperplexans* Van der Linde, 1938; *D. perplexans* Cobb, 1913; and *D. pellucidus* (Cobb, 1893) Thorne, 1939. It differs from the first in the position of vulva, body width, and tail length, and from the last three in the position of vulva and tail length.

Diphtherophora mangiferi n. sp.

(Fig. 2A–C and F)

MEASUREMENTS: Three females: L = 0.44–0.45 mm; a = 20–21; b =4.0–4.5; c = 21–23; V = 57.5–58.5%; spear = 21–22 μ. One male: L = 0.32 mm; a = 21.0; b = 4.7; c = 14.3; spear = 18.0 μ; spicules = 13 μ; gubernaculum = 4 μ.

DESCRIPTION: Body cylindrical, tapering at both extremities, slightly ventrally arcuate on death. Cuticle and subcuticle striated. Lip region narrower than front end of body, set off from the body contour. Labial papillae elevated. Amphibial pouches vase-shaped. Stylet typical of the genus. Corpus a cylindrical tube ending in a pyriform basal bulb. Cardia rounded. Intestine packed with granules. Prerectum not definite, rectum distinct nearly one-half the vulvar–body width long. Tail nearly round, 1½ times the anal–body width long.

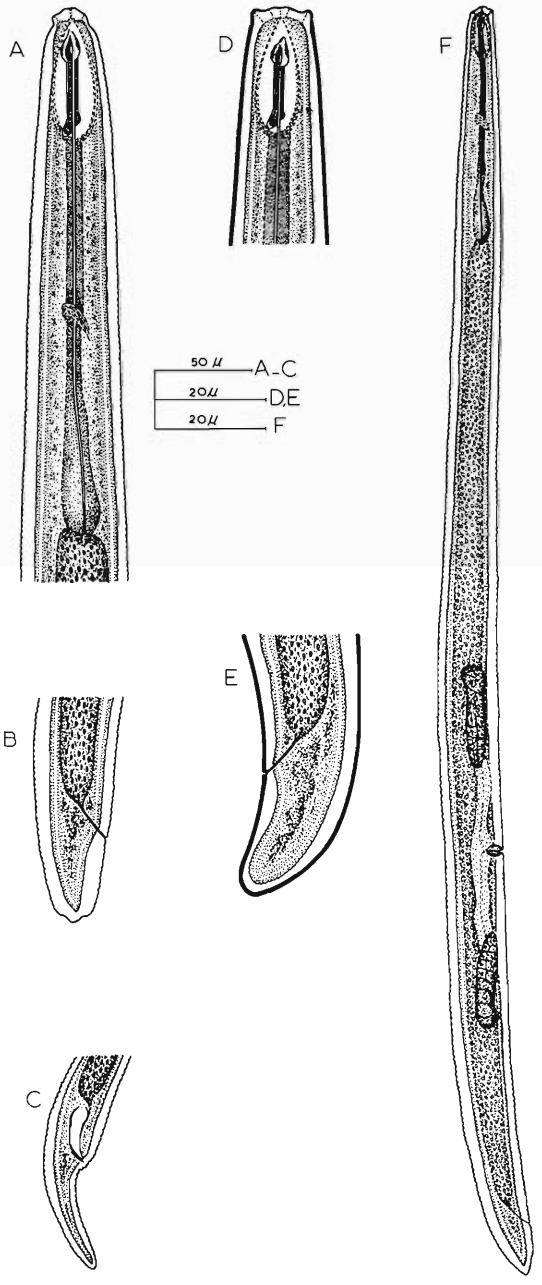

Fig. 2. A–C and F. *Diphtherophora mangiferi*. A. Neck region of female; B. Female tail; C. Male tail; F. Entire female; D–E. *Diphtherophora citri*; D. Head of female; E. Tail of female.

Ovaries paired, opposed, and reflexed. Vulva not prominent. Vagina short, one-fourth of the vulvar–body width; vaginal muscles forming a globular structure around it. Rounded spermathecae present with rod-shaped sperms.

Males similar to female with the tail shape entirely different, convex–conoid, tapering uniformly towards the posterior end, ending in a rounded terminus. Testis single; spicules simple, slightly arcuate, measuring 13 μ long. Gubernaculum 4 μ in length. No supplements seen.

HOLOTYPE: Female, collected in October 1964, slide No. 714 deposited with the Plant Pathology Section, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India.

ALLOTYPE: Male, collected with the females; other data same as for holotype.

TYPE HABITAT: Soil around the roots of *Mangifera indica* L.

TYPE LOCALITY: Ghazipur, U.P., India.

DIAGNOSIS AND RELATIONSHIP: *D. mangiferi* n. sp. comes closer to *D. parva* Siddiqi, 1964, *D. minutus* Ivanova, 1958, and *D. tafazzuli* n. sp. but differs from all the above three in possessing annulated body cuticle and subcuticle. It differs further: (1) from *D. parva* in the set-off head, shape of the female tail, larger spear, and in the presence of males; (2) from *D. minutus* in the position of vulva (V = 51–55% in *D. minutus*), body width, and tail length; and (3) from *D. tafazzuli* in the position of vulva and set-off head (head continuous in *D. tafazzuli*).

KEY TO THE SPECIES OF *Diphtherophora* DE MAN 1880 (Based on females only)

1. Average body length 500 μ or less 2
   Average body length 570 μ or more 7
2. Tail convex–conoid, digitate 3
   Tail convex–conoid to nearly rounded, not digitate 4
3. Body length 360–420 μ; amphids vase-shaped with flattened oval amphid apertures ..... *D. parva* Siddiqi, 1964
   Body length 490–520 μ; amphids oval, elongated vertically ..... *D. kirjanovae* Ivanova, 1958
4. V = 51–55% ..... *D. minutus* Ivanova, 1958
   V = 57.5–64% 5
5. Head continuous with the body contour; V = 62–64% ..... *D. tafazzuli* n. sp.
   Head set off from the body contour; V = 57.5–60.5% 6
6. Body length 310–340 μ; cuticle and subcuticle smooth ..... *D. christenseni* n. sp.
   Body length 440–460 μ; cuticle and subcuticle striated .. *D. mangiferi* n. sp.
7. Tail not bent dorsally, less than two times the anal–body width long, V = 50–64% 8
   Tail bent dorsally, more than two times the anal–body width long; V = 48–51% ..... *D. caudata* Ivanova, 1958
8. Esophageal enlargement subcylindrical to cylindroid ..... *D. vanoyei* De Conick, 1931
   Esophageal enlargement pyriform, elongate–conical, or rounded 9
9. Cuticle striated ..... *D. pseudoperplexans* V. d. Linde, 1938
   Cuticle smooth 10
10. Neck short, b = 6 or more; V = 54%; c = 33 ..... *D. brevicolle* Thorne, 1939
    Neck longer, b = 5 or less; V = 56–64%; c = 12.0–25.6 11
11. Tail length equal to anal–body width; a = 11 ..... *D. obesus* Thorne, 1939
    Tail length nearly twice or more than anal–body width; a = 21.3–27.8 12
12. Cuticle very thick, forming membrane-like folds ..... *D. pellucidus*, *D. perplexans* Cobb, 1893 and 1913
    Cuticle not forming membrane-like folds 13
13. L = 0.75 mm; c = 12–15; V = 56%, tail elongate–conoid, bent dorsally, males known ..... *D. communis* de Man, 1880
    L = 0.45–0.64 mm; c = 20.0–25.6; V = 60–64%; tail nearly rounded, not bent dorsally, males not known ..... *D. citri* n. sp.

SUMMARY

Four new species of *Diphtherophora* de Man, 1880 namely *D. christenseni* n. sp., *D. tafazzuli* n. sp., *D. citri* n. sp., and *D. mangiferi* n. sp. are described and figured. A key to the species of the genus is also presented.

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Tylencholaimellus cinctus n. sp. (Dorylaimoidea : Leptonchidae) from Kansas[1]

C. C. ORR AND O. J. DICKERSON

Nematodes were collected from the rhizosphere of native prairie plants in Kansas during 1961 and 1962. An undescribed species belonging to the family Leptonchidae was found. The description and diagnostic characters are presented here.

Tylencholaimellus cinctus n. sp. (Fig. 1A–E)

MEASUREMENTS: Females (25) (in glycerin): L = 0.7 mm (0.68–0.74); a = 18 (17.5–19.5); b = 6.5 (5.6–7.6); c = 33 (30–35); V = $^{7}34^{32}$ (34–35); stylet = 21 (20–22).

Males (7) (in glycerin): L = 0.62 mm; a = 19; b = 5.4; c = 35; T = 55.

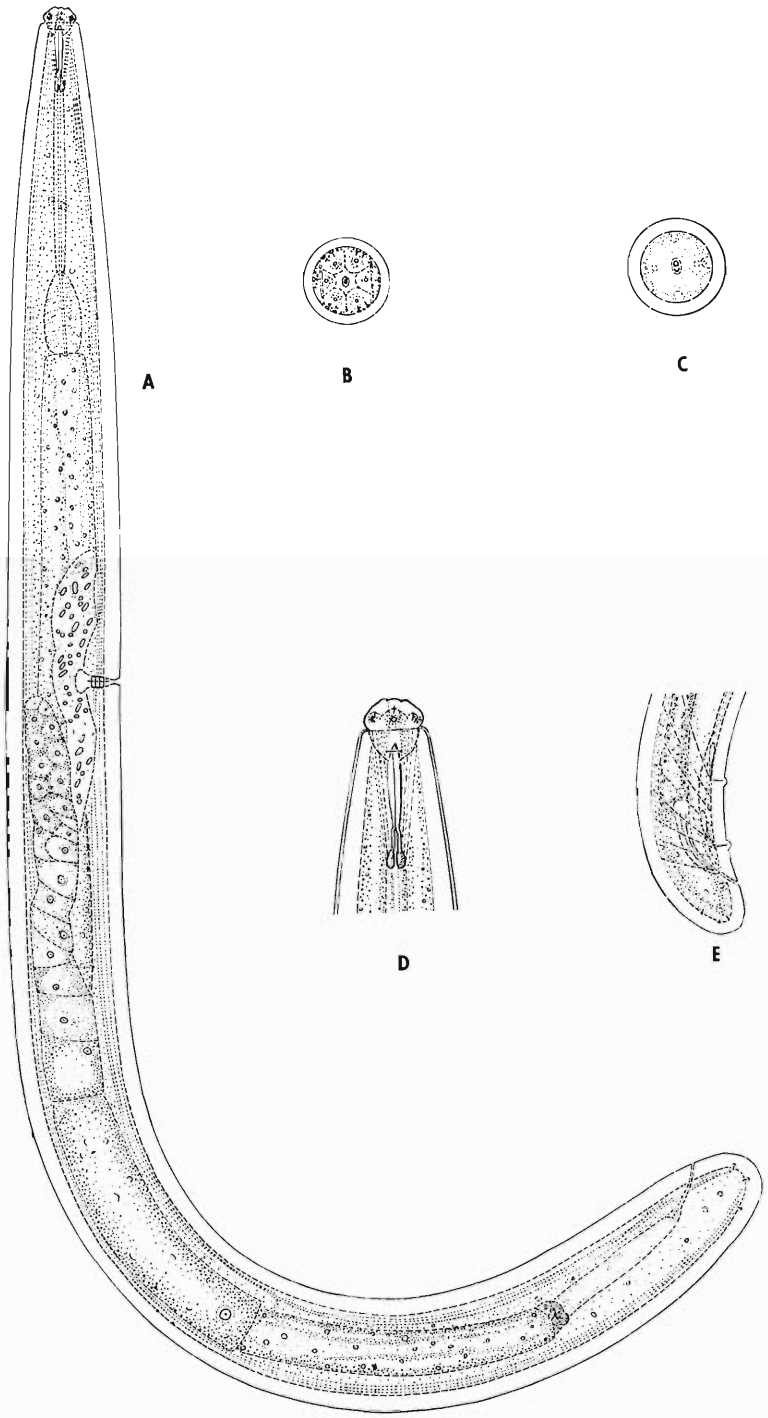
DESCRIPTION: Female body obese, slightly arcuate when killed by gentle heat. Neck tapering uniformly to head which is set off by a deep constriction. Lips low and rounded rising slightly above the contour of the head near the stoma. Lip region about one-third as wide as base of neck. The usual 16 lip papillae present. Amphids stirrup-shaped, almost as wide as head. Spear about 21 μ and consisting of 2 shafts, the main or ventral one being slightly asymmetrical in cross section and the supporting or dorsal one being round. Spear extensions strongly knobbed, about one-half as long as spear. Guiding ring simple. Esophagus slightly expanded anteriorly, then continuing as a slender tube until it reaches the basal bulb. The pyriform basal bulb set off by a constriction and four-fifths as long as body width at base of neck and about 2 times as long as wide. Cardia flat and obscure. Hemizonid located slightly posterior to level of nerve ring. Cuticle with transverse striae. Lateral cords one-fourth body width. Vulva transverse and far forward. Vagina extending about one-third of way across body. Anterior uterine branch a pouch about 1½ times body width and containing elongate spermatozoa. Posterior branch normal with ovary reflexed almost to vulva. Eggs twice as long as body width and 3 times as long as wide. Prerectum 2 times anal body diameter. Tail variable from hemispherical to slightly dorsally convex–conoid to a rounded terminus.

Male similar to female. Spicules dorylaimoid, 28 μ long. Lateral guiding piece of complex construction. Supplements an adanal pair unusually close together and a ventromedian one. Supplement glands lie just anterior to pores. Males were not as prevalent as females but were present in all collections containing the species.

DIAGNOSIS: Small (0.7 mm) *Tylencholaimellus* with head set off by deep constriction. Ovary reflexed almost to vulva. Cardia flat and obscure. Amphid about as wide as head. Most closely resembles *T. affinis* (Brakenhoff) Thorne and *T. polonicus* Szczygeil, but can be readily distinguished by smaller size, constricted head, longer ovary, and smaller cardia.

TYPE SPECIMENS: Holotype, female, collected in prairie soil about roots of *Andropogon gerardi* Vitm. 6 November 1961, by the authors

[1] Contribution No. 666, Dept. of Botany and Plant Pathology, Kansas Agricultural Experiment Station, Manhattan. Botany Serial No. 832.



on slide *Tylencholaimellus* 4b Department Plant Pathology nematode collection, Kansas State University, Manhattan, Kansas, USA. Allotype, male, same data as holotype on slide *Tylencholaimellus* 4e. Paratypes on slides *Tylencholaimellus* 4a, 4c, and 4f.

TYPE HABITAT: Prairie pasture about the roots of big bluestem, *Andropogon gerardi* Vitm. Other plants about which *T. cinctus* was found were wild strawberry (*Fragaria virginiana* Duchesne), leadplant (*Amorpha canescens* Pursh), and grassleaf goldenrod (*Solidago graminifolia* (L) Salisbol). Specimens were found in four of 61 collections within the type locality.

TYPE LOCALITY: Section 19, Township 8 South, Range 8 East, Pottawatomie County, Kansas, USA.

DISCUSSION: The specific name *cinctus* is derived from Latin and suggests constriction; chosen because of deep head constriction which, with the small body size, is the best distinguishing character.

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Description of *Neocriconema adamsi* n. gen., n. sp. (Criconematidae : Nematoda) with a Key to the Species of *Neocriconema*[1]

K. A. DIAB AND W. R. JENKINS

The genus *Criconemoides* was erected by Taylor (1936) who separated it from *Criconema* Hofmanner and Menzel (1917) on the basis of an absence of spines or scales on the cuticle of adult females. Numerous species, however, have been observed that have crenations along the posterior edge of their annules with the result that some confusion has developed as to whether they belong in *Criconema* or *Criconemoides*.

Luc (1959) described *Criconema limitaneum* as having crenated posterior edges on the annules and Baker (1962) listed this species under both genera. *Criconemoides goodeyi* de Guiran (1963) has similar crenations, and de Grisse (1964) named a species having the same character as *Criconema microdorum*.

Since cuticle formations are an important character in the separation of members of this group, a new genus is proposed to accommodate those species having crenations along the posterior edges of annules in the adult female leaving those with smooth edges in the genus *Criconemoides* and those with scales and spines in *Criconema*. Ten previously described species and a new species discussed below are placed in this new genus. A key to these ten species is presented.

Specimens of an unidentified nematode, fixed in 3% formaldehyde, were obtained from a pasture in West Virginia. These specimens were transferred into glycerin by Seinhorst's method (1959). For cuticle structure studies, some specimens were mounted in Berlese fluid after the method of Reed *et al.* (1957). A phase-contrast microscope was used to examine these mounts.

THE GENUS *Neocriconema* n. gen.

DIAGNOSIS: Criconematinae. (Females). Body stout, usually fusiform, round, and from 0.20 to 0.70 mm long. Cuticle thick with retrorse annules varying in width from 2 μ to

[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey.

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Fig. 1. *Tylencholaimellus cinctus*. A, Adult, female. B, Face view. C, Cross section in head region. D, Lateral view of head. E, Male tail.

8 μ. Posterior edge of annules on adult females crenate either on part or all of body. Annules range in number from 50 to about 200. Lip region composed of two more or less modified annules. Cephalic framework heavily or lightly sclerotized, sometimes extending back through three or four annules. Four sublateral lobes, varying in shape, size, and arrangement about the labial disc, may or may not be present. Amphid apertures elongate, located at lateral margins of labial disc. Spear strongly developed, varying in length from less than 30 μ to over 80 μ, with anteriorly concave basal knobs. Esophageal valve usually distinct. Isthmus reduced, often obscure, and continuous with small basal bulb. Nerve ring surrounds the isthmus. Excretory pore usually located opposite junction of esophagus and intestine. Anus sometimes obscure. Tail short, conical, with a rounded or pointed end. Vulva conspicuous, slit-like, with or without vulval flaps, located posteriorly at about 90% of the body length. Spermatheca may or may not be present. Ovaries single, prodelphic, outstretched or doubly reflexed. (Males). Rare, except in *N. oostenbrinkii* Loof, 1964. Annulations coarse, not retrorse. Spear lacking, esophagus degenerate. Spicules sharply pointed, straight to slightly arcuate; a short gubernaculum present. Bursa rather narrow, enveloping most of tail. Lateral field with four incisures, extending to the end of tail.

RELATIONSHIPS: Differs from *Criconema* in the absence of spines or scales on the annules in the adult female and from *Criconemoides* by the presence of crenations on the posterior edges of the annules of the adult females.

TYPE SPECIES: *Neocriconema limitaneum* (Luc, 1959) n. comb., syn. *Criconema limitaneum* Luc, 1959.

OTHER SPECIES: *N. crenatus* (Loof, 1964) n. comb., syn. *Criconemoides crenatus* Loof, 1964; *N. goodeyi* (de Guiran, 1963) n. comb., syn. *Criconemoides goodeyi* de Guiran, 1963; *N. kirjanovae* (Andrassy, 1963) n. comb., syn. *Criconemoides kirjanovae* Andrassy, 1963; *N. microdorum* (de Grisse, 1964) n. comb., syn. *Criconema microdorum* de Grisse, 1964; *N. oostenbrinkii* (Loof, 1964) n. comb., syn. *Criconemoides oostenbrinkii* Loof, 1964; *N. pseudohercyniensis* (de Grisse, 1964) n. comb., syn. *Criconemoides pseudohercyniensis* de Grisse, 1964; *N. pseudosolivagum* (de Grisse, 1965) n. comb., syn. *Criconemoides pseudosolivagum* de Grisse, 1965; *N. raskiense* (de Grisse, 1965) n. comb., syn. *Criconemoides raskiense* de Grisse, 1965; *N. solivagum* (Andrassy, 1963) n. comb., syn. *Criconemoides solivagum* Andrassy, 1963.

KEY TO SPECIES OF *Neocriconema*

1. First body annule wider than second ..... *limitaneum*
   First body annule smaller than second 2
2. Body annules more than 100 3
   Body annules less than 100 6
3. Annule anastomosis on mid-body absent ..... *goodeyi*
   Annule anastomosis on mid-body present 4
4. Body length more than 0.40, body annules 108–133 ..... *pseudohercyniensis*
   Body length less than 0.40 mm, body annules 140 5
5. Body annules 170–194, stylet 40–52 μ ..... *adamsi*
   Body annules 145–170, stylet 41–48 μ ..... *crenatus*
6. Stylet length less than 30 μ ..... *microdorum*
   Stylet length more than 30 μ 7
7. Dorsolateral as well as ventrolateral lobes, almost completely fused ..... *oostenbrinkii*
   Sublateral lobes separated or entirely absent 8
8. Sublateral lobes entirely absent ..... *solivagum*
   Sublateral lobes present 9
9. Body annules less than 60, tail not pointed ..... *pseudosolivagum*
   Body annules more than 60, tail pointed 10
10. Lateral plates present, anastomosis of annules absent ..... *kirjanovae*
    Lateral plates absent, anastomosis of annules present ..... *raskiense*

Neocriconema adamsi n. sp. (Fig. 1)[2]

MEASUREMENTS: Females (12): Length 0.282 mm (0.270–0.300 mm); a = 13.1 (12.0–15.0); b = 3.4 (3.1–3.8); c = 28.6 (27–32); V = 90.8% (90–92%); stylet = 48 μ (40–52); annules = 186 (170–194).

[2] Named in recognition of Dr. R. E. Adams, West Virginia University, who discovered this species.

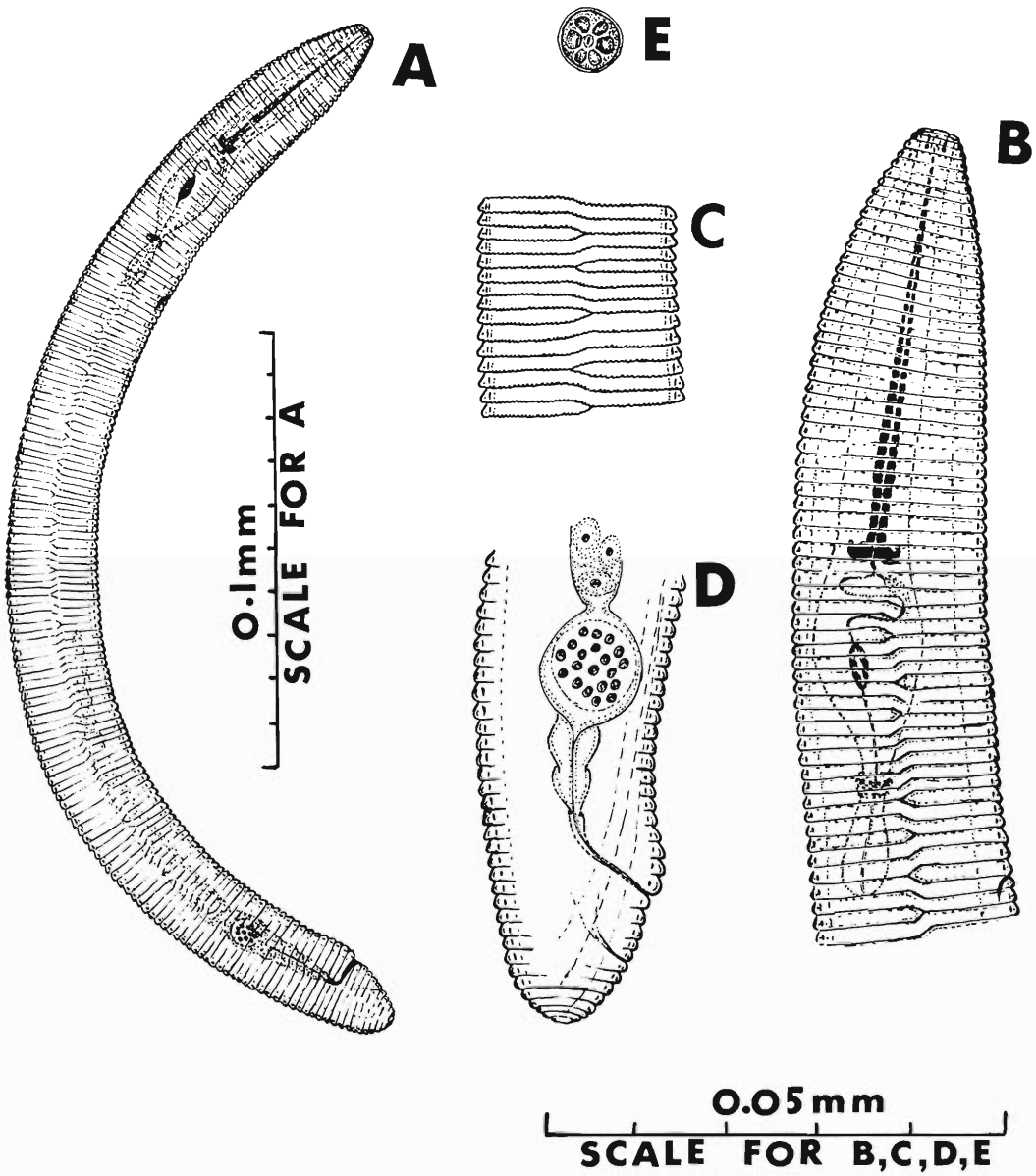

Fig. 1. A–E. Drawings of *Neocriconema adamsi* n. sp., n. gen. A, Lateral view of adult female. B, Esophageal region of female. C, Portion of adult female cuticle showing anastomosis of annules and crenation on posterior edge of annules. D, Tail region of female. E, *En face* view of female.

MALE: Unknown.

HOLOTYPE (female): L = 0.29 mm; a = 13.4; b = 3.4; c = 29; V = 90.4%; stylet = 48 μ; annules = 187.

DESCRIPTION: FEMALE (Fig. 1A–E): Body (Fig. 1A) cylindrical, gradualy tapering anteriorly to a flattened head and posteriorly to a more or less rounded tail. The *en face* view (Fig. 1E) shows six small lips; mouth a slit-like opening; two slit-like amphidial openings. Sublateral lobes absent; labial disc indistinct; and hexaradiate cephalic framework visible under the head annule. Two of the six arms of the cephalic framework and the oral vestibule are easily visible in lateral view. The first body annule separated from succeeding annules by a constriction.

Stylet length measures 40 to 52 μ with the conical part averaging 36 μ and the base 12 μ. Basal knobs 7 μ across and project anteriorly. Anteriorly the spear muscles are attached to the cephalic framework. The esophagus which is typical for the Criconematidae is 84 μ long and extends through 60 body annules. Dorsal esophageal gland duct orifice located 4 μ from base of stylet knobs. Nerve ring surrounds the isthmus. Excretory pore opening located on the 60th–68th body annule. Hemizonid not observed.

Body composed of 170–194 annules, averaging about 2 μ wide. The lateral line begins in the vicinity of the stylet knobs and appears as a break in striations (Fig. 1A, B, C). Posterior edge of the annules crenated.

Tail more or less rounded (Fig. 1D). Anus located on the 6th to 9th annule and vulva on the 10th to 14th annule from the terminus. The spermatheca which was present in all specimens, is situated at the proximal end of the uterus.

LARVAE: The lateral line, anastomoses, and crenations of the annules the same as in adult females, but with body more slender.

TYPE SPECIMENS: Holotype, slide no. 00-1 and paratypes, slides no. 00-2 to 10. *En face* views on slides 00-11 and 12, Rutgers University collection.

TYPE HABITAT: Mixed pasture grasses.

TYPE LOCALITY: Abandoned pasture about 50 yards from the Buckhannon River, Upshur Co., on the property of E. H. Hunter approximately 10 miles northeast of Buckhannon, West Virginia, U.S.A.

DIAGNOSIS: This species is different from all other *Neocriconema* species in its large number of body annules (170–194). It closely resembles *N. crenatus*, but differs in its larger number of body annules (170–194) compared to *N. crenatus* (145–170), and in the absence of sublateral lobes in *N. adamsi*.

SUMMARY

A new nematode genus, *Neocriconema*, was described and illustrated. This genus is characterized by crenations on the posterior margins of body annules of the adult female. It is closely related to *Criconema* and *Criconemoides*, differing from the former in that *Criconema* bears spines or scales, and from the latter in that *Criconemoides* has plain annules. A new species, *N. adamsi*, is described and illustrated from pasture grass in West Virginia. Ten species are transferred to *Neocriconema* and a key to all 11 species prepared.

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MINUTES

Four Hundred Fifth—Through Four Hundred Twelfth Meetings

405th Meeting: Dart Auditorium, Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington, D.C., October 21, 1964. Fifty-fourth Anniversary Meeting. The 1964 Anniversary Award of the Helminthological Society of Washington was presented to Dr. J. R. Christie. Papers presented: Geographical pathology, by H. C. Hopps; Pneumocystosis, by D. H. Winslow; Buruli ulcer, by D. H. Connor; Cutaneous leishmaniasis, by E. F. Chaffee.

406th Meeting: Log Lodge, Agricultural Research Center, Beltsville, Maryland, 20 November 1964. Officers elected: L. A. Jachowski, President, D. L. Price, Vice-President, F. W. Douvres, Recording Secretary; E. Buhrer, Corresponding Secretary-Treasurer; M. M. Farr, Assistant Secretary-Treasurer (new office). Papers presented: Survival of oocysts of chicken and turkey coccidia under various conditions, by M. M. Farr; The significance of earthworm transmission of *Heterakis* and *Histomonas*, by E. E. Lund; Electrophoresis of swine kidney worm antigens, by L. A. Baisden; *Babesia caballi* in the erythrocyte, by P. A. Madden and A. A. Holbrook; A preliminary trial on immunization against beef measles by oral vaccination with X-irradiated *Taenia saginata* eggs, by J. T. Lucker and H. H. Vegors.

407th Meeting: Student Union Building, University of Maryland, College Park, Maryland, December 16, 1964. Appointments made: Members-at-large of the Executive Committee, W. B. DeWitt and D. B. McMullen; Representative to Washington Academy of Sciences, M. Farr; Librarian, J. Humphrey; Archivist, J. T. Lucker; Representative to the A.S.P., C. G. Durbin. Program informal, consisting of papers, notes, and comments from assembled members and guests.

408th Meeting: Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, D.C., 20 January 1965. Appointments made: Auditors, F. G. Tromba and D. K. McLoughlin. M. Farr, the Representative to the Washington Academy of Sciences, resigned from this position and was replaced by A. O. Foster. Papers presented: Malaria research at Walter Reed Army Institute of Research, by W. D. Tigertt; Magnetic field columa concentration of *P. berghei* infected red cells, by D. Pollack; Electron microscopy in malaria research, by P. Macomber; Artificial feeding of mosquitos through membranes, by R. Ward; Report on WHO Expert Committee Meeting in immunology of parasitic diseases held in Ibadan, Nigeria, by E. H. Sadun.

409th Meeting: Naval Medical Research Institute, Bethesda, Maryland, 17 February 1965. Auditor's report was read and approved. M. M. Farr resigned from the position of Assistant Secretary-Treasurer; appointed in her place was H. H. Vegors. Papers presented: Use of the multipurpose chamber-dialysis membrane technique in parasitological research, by D. Jensen; Lung mites in subhuman primates, by W. B. Hull; Derangements in lipid metabolism, by J. Gutierrez; Relation of weight to egg production in *Aedes aegypti*, by L. A. Terzian; Fine structure of exoerythrocytic phase of *Plasmodium fallax*, by P. K. Hepler; Fine structure of erythrocytic phase of *Plasmodium fallax*, by M. Aikawa.

410th Meeting: National Institutes of Health, Bethesda, Maryland, 17 March 1965.

The Society gave permission to the Corresponding Secretary-Treasurer to transfer the Society's savings account from the American Security Trust Bank to Riggs National Bank. Papers presented: Glycerol absorption by *Taenia taeniaeformis*, by T. von Brand; The use of silicone rubber implants for the sustained release of antimalarial and antischistosomal agents, by K. G. Powers; Disk electrophoresis of *Plasmodium berghei*, by W. Sodeman and J. H. E. T. Meuwissen; Axenic cultivation of *Entamoeba histolytica* in clear liquid media, by L. S. Diamond and I. L. Bartgis; Cultivation at 25 C and behavior in hypotonic media of strains of *Entamoeba histolytica*, by C. S. Richards, M. Goldman, and L. T. Cannon; Intrapulmonary localization of *Angiostrongylus cantonensis* in the rat, by T. M. Sodeman, C. S. Richards, and W. A. Sodeman, Jr.

411th Meeting: Patuxent Wildlife Research Center, Laurel, Maryland, 21 April 1965. Via correspondence, L. Schubert, President, Washington Academy of Sciences, asked the Society and other area scientific societies to consider the possibility of holding "some appropriate" joint ceremony in the fall of 1965, to celebrate the Mendel Centennial. The Society approved consideration of this possibility or presentation of a program of papers on the genetics of parasites and hosts at one of the fall meetings, as a commemorative to Mendel. A. O. Foster, the Society's representative to the Washington Academy of Sciences, F. W. Douvres, and D. Price were appointed as a committee to consider these matters. Papers presented: Preliminary electron microscope studies on *Sarcocystis*, by V. H. Zeve; Notes on black flies (Simuliidae) by I. B. Tarshis; The age composition of a natural population of *Anopheles quadrimaculatus* at the Patuxent Wildlife Research Center, by J. Hitchcock; Studies on a new *Cryptobia* (hemoflagellate) of fish, by R. Puty; Parasite problems in fish culture, by G. L. Hoffman; *Plasmodium* in Canada geese (read by title only), by C. M. Herman.

412th Meeting: Beltsville Parasitological Laboratory, Agricultural Research Center, Beltsville, Maryland, 22 May 1965. Annual Picnic Meeting.

Motions were made and approved by the Society to pay for expenses incurred for the picnic and to send our annual contribution of $25.00 to the Joint Board on Science Education, Washington, D.C. A. O. Foster, chairman of the committee appointed to consider a program commemorating the Mendel Centennial, gave the following report: The committee proposes that the Society's Anniversary Meeting, held annually in October, be selected for the presentation of a program commemorating the Mendel Centennial sponsored by, and held at, the Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington, D.C. This program to consist of 3 guest speakers who will present papers on the work and influence of Mendel and on the genetics of helminths and protozoa. The program will be preceded by a short business meeting and is to be followed by refreshments and a buffet dinner. The Society approved the committee's proposals and authorized it to carry out any action required to arrange the program.

The following were elected to membership at the meetings indicated: **405th**—B. Y. Endo, J. R. Lichtenfels, T. E. Amerault, R. P. Dodds, Jr., J. Philis, E. D. Besch, A. K. Sen; **406th**—L. A. Baisden, J. E. Rose, R. S. Dorney, E. Kahn, A. A. Cedeno, R. B. Holliman, J. E. Ubelaker; **408th**—D. Moore; **409th**—J. S. Mackiewiez, H. G. Wiseman; **410th**—F. Vande Vusse, A. Coomans, S. Garson, D. Farooqi, T. Palmer, G. Poinar, Jr.; **411th**—H. H. Bailey, S. Ratanaworabhan, B. Ford, A. A. Holbrook; **412th**—M. A. Hart, T. L. Wellborn, Jr., A. H. Tomerlin, V. C. L. C. Wilson.

FRANK W. DOUVRES
Recording Secretary

Report of the Brayton H. Ransom Memorial Trust Fund

FUNDS ON HAND, January 1, 1964	$2,238.36
RECEIPTS: Interest rec'd in 1964	92.76
DISBURSEMENT: Grant to Helminthological Society of Washington ..	10.00
BALANCE ON HAND, Dec. 31, 1964 ..	$2,321.12

A. O. FOSTER
Secretary-Treasurer

Hemiurid Trematodes of Formosan Marine Fishes. II. Subfamily Lecithochiriinae

WILLIS A. REID,[1, 3] WILLIAM H. COIL,[1] AND ROBERT E. KUNTZ[2]

The present paper is based upon a study of trematodes collected by the third author from marine fishes while he was a member of the Parasitology Department of Naval Medical Research Unit No. 2, Taipei, Taiwan. This is the third in a series of papers on fish parasites, and is part of an extensive project concerned with a study of host–parasite and zoogeographic relationships of helminths of vertebrates taken on Taiwan (Formosa) and its offshore islands.

Upon the examination of four species of marine fishes (*Gymnothorax melanospilus*, *G. kidako*, *Saurus* sp., and *Saurida filamentosa*) three species of hemiurid trematodes belonging to the subfamily Lecithochiriinae were recovered. One of these, a species of *Sterrhurus*, is described below as new, and previously reported species of *Lecithochirium* and *Separogermiductus* are also recorded. A new genus, *Magniscyphus*, is proposed for *Sterrhurus taboganus* Sodandares-Bernal, 1959. Keys to the species of *Separogermiductus* and *Sterrhurus* are included.

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[3] From a dissertation submitted in partial fulfillment of the requirements for the Master of Arts degree.

The authors are indebted to a number of persons who have made this study possible as a result of their various contributions and services. Dr. Ernest A. Lachner, Associate Curator, Division of Fishes, U.S. National Museum and Robert H. Kanazawa of the same division have provided the final identification for the fish hosts. Dr. Yunsheng Liang, Curator of Fishes, The Taiwan Museum, Taipei (Taiwan) has also given assistance in the identification of fishes. Special acknowledgment is due to Captain Robert A. Phillips, MC USN, Commanding Officer, NAMRU No. 2 and to members of the staff of the Parasitology Department who have given extensive support for these overall studies. We are also grateful to Dr. Willard W. Becklund, Animal Disease and Parasite Research Division, A.R.S.-U.S.D.A., Beltsville, Maryland, for making available specimens deposited in the U.S. National Museum Helminthological Collection, and to Dr. Reinard Harkema, Department of Zoology, North Carolina State University at Raleigh for cooperation in the examination of his collection from Beaufort, North Carolina.

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MATERIALS AND METHODS

Standard techniques were used to remove the trematodes from the host. The parasites were killed by quick immersion into hot water and were then transferred to stender dishes with FAA (formalin–acetic acid–alcohol) for fixation. After 5 to 15 hours they were transferred to vials with 70 per cent alcohol plus 2 per cent glycerine. Whole mounts were stained progressively with Harris' hematoxylin and eosin, cleared in xylene, and mounted in piccolyte.

Some specimens of each of the three species reported were sectioned sagittally. Sections were cut at thicknesses of 10, 12, or 15 microns, depending upon the size of the specimen. Sections were likewise stained with Harris' hematoxylin and eosin, cleared in xylene and mounted in piccolyte.

All material was examined with phase contrast and ordinary light microscopy. Figures were drawn with the aid of a microprojector and details were added freehand. All measurements are in millimeters.

Sterrhurus concavovesiculus n. sp. (Figs. 1, 2)

DIAGNOSIS: Based on eight mature specimens with characters of genus. Body fusiform, smooth, 1.78–3.38 long (excluding ecsoma) by 0.553–0.917 wide at ovarian level; ecsoma partially or completely retracted or fully extended; fully extended ecsoma measuring 1.326; preoral lobe present; oral sucker subterminal, lacking papillae-like projections into oral cavity, 0.209–0.356 long by 0.185–0.336 wide; prepharynx absent; pharynx globular, 0.103–0.226 long by 0.074–0.226 wide; esophagus very short or absent; ceca simple, extending into ecsoma for approximately one-half its length; preacetabular pit absent; acetabulum preequatorial, circular, 0.349–0.579 in diameter; testes oval, symmetrical, well separated, situated immediately posterior to or slightly overlapping posterior margin of acetabulum; right testis measuring 0.226–0.394 long by 0.205–0.299 wide, left measuring 0.185–0.394 long by 0.135–0.328 wide; seminal vesicle dis-

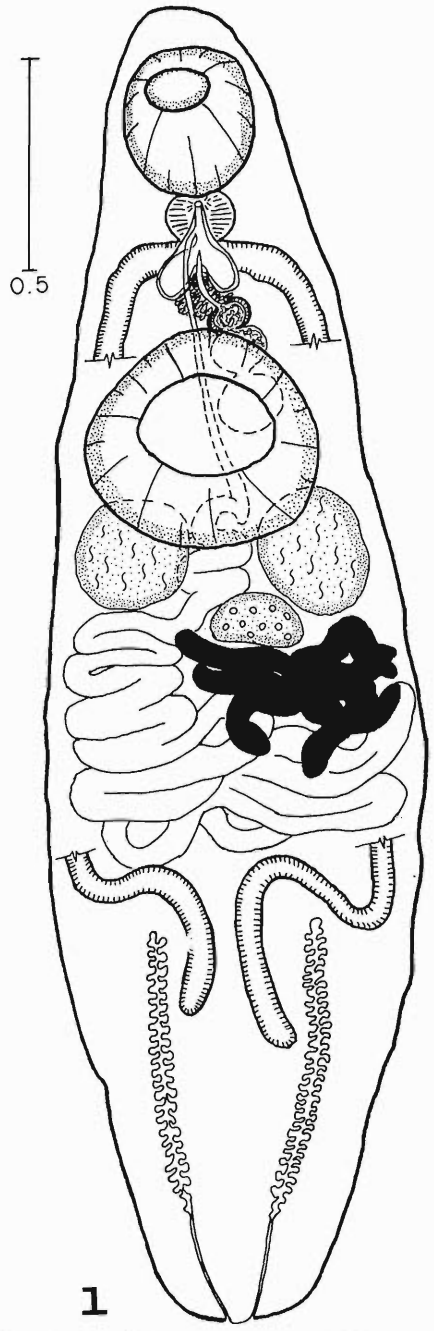

Fig. 1. *Sterrhurus concavovesiculus* n. sp., whole mount of the type specimen in ventral aspect.

tinctly tripartite, dorsal and anterodorsal to acetabulum, anterior lobe with thick muscular wall; duct between seminal vesicle and pars prostatica extremely short, distal end may be constricted before entering pars prostatica; pars prostatica short, provided with well-developed prostatic cells for entire length, entering sinus sac posteriorly at base of concave portion, piercing and projecting into ejaculatory vesicle in form of a nozzle-like structure provided with minute cilia-like projections; sinus sac U- or heart-shaped, well developed, situated ventral to intestinal bifurcation; vesicle U-shaped, noncellular, wall formed as a continuation of ejaculatory duct; ejaculatory duct short; hermaphroditic duct relatively long, well developed; genital pore ventral to pharynx; ovary reniform, ventral, submedian, almost contiguous with left testis, 0.089–0.287 long by 0.031–0.205 wide; vitellaria divided into two distinct, postovarian masses, composed of 7–8 digitiform lobes; uterus primarily postovarian, not extending into ecsoma, passing to right of ovary and between testes, forming straight tube dorsal to acetabulum; metraterm long, straight, commencing at level of posterior lobe of seminal vesicle, entering sinus sac ventral to ejaculatory vesicle and uniting with ejaculatory duct a short distance anterior to vesicle; eggs small, numerous, elliptical, 0.015–0.018 long by 0.009–0.011 wide; excretory crura united dorsal to oral sucker.

HOSTS: *Gymnothorax melanospilus* (type host), *G. kidako*.

SITE OF INFECTION: Small intestine.

LOCALITY: Formosan waters.

HOLOTYPE: U.S. Nat. Mus. Helm. Coll. No. 61053.

PARATYPE (sections): U.S. Nat. Mus. Helm. Coll. No. 61054.

DISCUSSION: *Sterrhurus concavovesiculus* is easily distinguishable from all other species of the genus by the presence of the concave sinus sac and ejaculatory vesicle, from which the specific name is derived. Park (1936) described a nozzle-like projection of the pars prostatica into the ejaculatory vesicle of *Sterrhurus magnatestis*, but Manter and Pritchard (1960) placed this species in *Separogermiductus* on the basis of other criteria.

The taxonomy of the two largest genera of the subfamily Lecithochiriinae, *Lecithochirium* Lühe, 1901 and *Sterrhurus* Looss, 1907, is in a

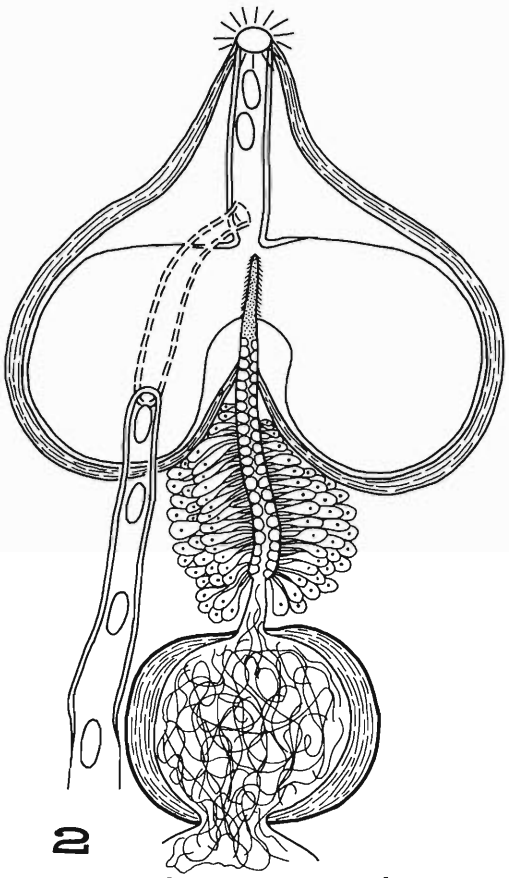

Fig. 2. *Sterrhurus concavovesiculus* n. sp., freehand drawing of the terminal genitalia in ventral aspect.

confused state. Essentially, the problem revolves around the lack of agreement on basic criteria to separate the two genera. Stunkard and Nigrelli (1934), Jones (1943), Crowcroft (1946), Manter (1947, 1954), Manter and Pritchard (1960), and others have reviewed the problem, but none have been successful in offering an acceptable solution. For the present, it seems that the presence (*Lecithochirium*) or absence (*Sterrhurus*) of a preacetabular pit is the only character by which the two genera can be distinguished.

Sterrhurus monticelli (Linton, 1898) Linton, 1910 has been reported from several localities: Woods Hole, Massachusetts (Linton, 1898, 1910, 1940), Beaufort, North Carolina (Manter, 1931), Puerto Rico (Siddiqi and Cable, 1960), and Costa Rica (Bravo-Hollis and Arroyo, 1962). The last authors placed it in *Lecithochirium* in accordance with Skrjabin and Guschanskaja (1954). Examination of the single specimen (39401) recovered by Siddiqi and Cable, and comparison of it with specimens (4855) deposited by Linton (1940), leads us to consider that the two are not conspecific. The vitellaria of the former are distinctly compact, while all other specimens of *S. monticelli* possess lobed or digitiform vitellaria. In addition, the testes of their specimens are symmetrical, as compared to diagonal or tandem of other specimens. The acquisition of additional specimens may well prove that the species of Siddiqi and Cable is new.

Velasquez (1962) incorrectly transferred *L. japonicum* Yamaguti, 1938 to *Sterrhurus*, stating that it lacked a preacetabular pit. Yamaguti's original description, however, clearly states: "ventral depression present between acetabulum and genital pore."

S. magnacetabulum Guiart, 1938 and *S. sihamai* Srivastava, 1937 are inadequately described and should be *species inquirenda*. *S. magnacetabulum* was "caractérisé par ses plus grandes dimensions (presque doubles de celles du *Sterrhurus fusiformis*), par le ventouse située en avant de l'abdomen et recouverte par le cou, enfin en raison de l'hôte, le *Synaphobranchus pinnatus*, qui est un Congridé des grandes profondeurs. Ici encore les vitellogenes en bananes faciliteront le diagnostic." The presence or absence of a preacetabular pit is not mentioned, and the measurements presented by Guiart (1938) do not serve to distinguish his species from other large members of the genus. *S. sihamai* was described in an abstract and Chauhan (1954) declared it *nomen nudum*. According to the International Code of Zoological Nomenclature, a species can be declared *nomen nudum* only if the original species description is not "accompanied by a statement that purports to give characters differentiating the taxon." Srivastava (1937) makes an attempt to differentiate his species.

An examination (W.A.R.) of the holotype (38874) of *S. taboganus* Sogandares-Bernal, 1959 confirmed the characters presented in the original diagnosis. The species is characterized, in part, by the possession of a distinct

cup- or bowl-shaped forebody, prostatic cells surrounding the hermaphroditic duct within the sinus sac, and the widest portion of the body being between the acetabulum and the oral sucker. The posterior rim of the cupped forebody is provided with specialized musculature. This musculature and the nature of the cup seem to indicate that the condition is of a permanent nature in this species (Sogandares-Bernal, 1959). *S. taboganus*, therefore, possesses a combination of characters which sets it apart not only from other species of the genus, but from all of the known genera of hemiurids as well. For this, we recommend a new genus, *Magniscyphus* (*magni* = large, *scyphus* = cup, bowl), with *M. taboganus* (Sogandares-Bernal, 1959) n. comb. as the type species.

Magniscyphus n. gen.

DIAGNOSIS: Hemiuridae. Distomes with ecsoma; cuticle smooth; maximum body width between oral sucker and acetabulum; oral sucker subterminal; preoral lobe present; pharynx oval; esophagus very short or lacking; ceca extending to base of ecsoma; acetabulum equatorial; forebody bowl- or cup-shaped, posterior rim of bowl with muscular groove; genital pore ventral, opposite pharynx; sinus sac moderately developed, enclosing prostatic vesicle and muscular hermaphroditic duct; latter surrounded by prostatic cells; testes two, symmetrical, immediately postacetabular; seminal vesicle bipartite, thin-walled, elongate; pars prostatica short, surrounded by cells only at anterior region; ovary posttesticular, smooth; vitellaria postovarian, distinctly lobed; uterus not entering ecsoma; metraterm simple; excretory crura not observed; eggs small, numerous.

TYPE SPECIES: *Magniscyphus taboganus* (Sogandares-Bernal, 1959) n. comb.

HOLOTYPE: U.S. Nat. Mus. Helm. Coll., No. 38874.

KEY TO THE SPECIES OF *Sterrhurus* Looss, 1907

1. Seminal vesicle bipartite, thin-walled .. 2
   Seminal vesicle bipartite, anterior lobe with muscular wall 15
   Seminal vesicle tripartite, thin-walled .. 6
   Seminal vesicle tripartite, anterior lobe with muscular wall 11
   Seminal vesicle tripartite, anterior and middle lobes with muscular wall .. 14
2. Sinus sac distinct, relatively well developed; vitelline lobes compact, stumpy 5
   Sinus sac ("cirrus bulb" of Linton) distinct; vitelline lobes digitiform ..... *S. monticelli* (Linton, 1898) Linton, 1910
   Sinus sac much reduced; metraterm uniting with male duct near pars prostatica; vitelline lobes digitiform ..... *S. praeclarus* Manter, 1930
3. Body length not exceeding 0.75; eggs bluntly oval (ratio of width to length 1 : 1.3–1.4) 4
   Body length 1.0 or longer; eggs relatively elongate (ratio of width to length 1 : 1.6–1.7) 5
4. Body abruptly attenuated anteriorly; ovary distinctly larger than testes ..... *S. latus* Viqueras, 1958
   Body rounded anteriorly; ovary smaller than, or same size as, testes ..... *S. ryptici* Viqueras, 1958
5. Sinus sac pyriform, extending far posterior to intestinal bifurcation; prostatic cells numerous; well developed ..... *S. musculus* Looss, 1907 (Syn. *S. floridensis* Manter, 1934)
   Sinus sac short, ovoid, not extending past intestinal bifurcation; prostatic cells few, weakly developed ..... *S. brevicirrus* Nicoll, 1915
6. "Gland stomach" absent 7
   Ceca provided with "gland stomach" immediately posterior to intestinal bifurcation, with sphincter muscles and pronounced ciliated epithelium posterior to sphincters ..... *S. fusiformis* (Lühe, 1901) Looss, 1907
7. Eggs large, elliptical; acetabulum distinctly preequatorial 8
   Eggs small, oval (0.010–0.012 × 0.007–0.009); acetabulum equatorial ..... *S. loossi* Viqueras, 1958
8. Ecsoma well developed; vitelline lobes digitiform 9
   Ecsoma extremely small and poorly developed; vitelline lobes broader than long ..... *S. microcercus* Manter, 1947
9. Sucker ratio approximately 1 : 2 10
   Sucker ratio approximately 1 : 3 ..... *S. imocavus* Looss, 1907
10. Acetabulum diameter large in relation to body size (one-fourth body

length) ..... S. *grandiporus* (Lühe, 1901) Looss, 1907

Acetabulum diameter smaller in relation to body size (one-sixth body length) ..... S. *branchialis* Stunkard and Nigrelli, 1934

11. Body small (not exceeding 3.5), not attenuated posteriorly 12

Body larger (6.0), attenuated posteriorly ..... S. *havanensis* Viqueras, 1958

12. Sinus sac and vesicle ovoid; vesicle wall a continuation of pars prostatica; nozzle-like projection of pars prostatica absent 13

Sinus sac and vesicle U-shaped; vesicle wall a continuation of ejaculatory duct; pars prostatica entering vesicle as a nozzle-like projection ..... S. *concavovesiculus* n. sp.

13. Duct betwen seminal vesicle and pars prostatica short, straight; prostatic vesicle dorsal to sinus sac; vitelline lobes digitiform; ceca entering ecsoma; genital pore highly muscular ..... S. *lotellae* Manter, 1954

Duct between seminal vesicle and pars prostatica long, S-shaped; pars prostatica enclosed by muscles of sinus sac; vitelline lobes bluntly rounded; ceca not entering ecsoma; genital pore normal ..... S. *cirrhiti* Manter and Pritchard, 1960

14. Body large (7.087); prostatic cells weakly developed, not distributed in sinus sac; ecsoma shorter than body ..... S. *amplus* Manter, 1961

Body smaller (1.550–2.530); prostatic cells well developed, distributed internally and externally to sinus sac; ecsoma longer than body ..... S. *magnicaudatus* Fischthal and Kuntz, 1963

15. Prostatic cells entering sinus sac; eggs 0.013–0.018 × 0.008–0.009; testes contiguous; sucker ratio 1 : 1.6–1.9 ..... S. *goslinei* Manter and Pritchard, 1960

Prostatic cells not entering sinus sac; eggs larger, 0.021–0.024 × 0.010–0.012; testes well separated by uterus; sucker ratio 1 : 2.4–3.0 ..... S. *pacificus* (Yamaguti, 1942) Yamaguti, 1958

Lecithochirium microstomum Chandler, 1935

HOST: *Saurus* sp.

SITE OF INFECTION: Small intestine.

LOCALITY: Formosan waters.

HOLOTYPE: U.S. Nat. Mus. Helm. Coll. No. 61061.

PARATYPE (sections): U.S. Nat. Mus. Helm. Coll. No. 61062.

DISCUSSION: Although slight variations occur among specimens from different localities, the internal and external prostatic vesicles, the muscular metraterm with a distinct sphincter separating it from the uterus, and the muscular preacetabular pit interspersed with gland cells serve to distinguish *L. microstomum* from other species of the genus. The preacetabular pit of our specimens seems to be more highly developed than those described in other published accounts.

The vitelline lobes were originally described by Chandler (1935) as "scarcely if any longer than wide." Manter and Pritchard (1960), however, state that these may be "about the same length as width or slightly longer, up to twice as long. . . ." The lengths of the lobes in the Formosan specimens are approximately one and one-half times the width. The range in egg size in our specimens (0.019–0.020 × 0.010–0.012) is close to that of Manter and Pritchard (1960) (0.019–0.024 × 0.011–0.013). They also consider *L. sinaloense* Bravo-Hollis, 1956 a synonym for *L. microstomum*.

Pertinent measurements on the Formosan specimens are (based on eight mature specimens): body length, 1.271–2.011; body width, 0.275–0.516; oral sucker diameter, 0.087–0.131; acetabulum diameter, 0.270–0.306; sucker ratio, 1 : 2.0–2.4; testes diameter, 0.091–0.166; ovary diameter, 0.087–0.191.

Separogermiductus magnus (Yamaguti, 1938) Skrjabin and Guschanskaja, 1955

HOSTS: *Saurida filamentosa*, *Saurus* sp.

SITE OF INFECTION: Small intestine.

LOCALITY: Formosan waters.

HOLOTYPE: U.S. Nat. Mus. Helm. Coll. No. 61059.

PARATYPE (sections): U.S. Nat. Mus. Helm. Coll. No. 61060.

DISCUSSION: Yamaguti (1938) reported *Sep. magnus* in *Saurida argyrophanes* from Japan. To our knowledge, however, no para-

sites of this genus have been reported from fish of the genus *Saurus*. All of the species of *Separogermiductus* have been reported only from the Pacific.

Manter (1961) suggests that the allocation of *Sep. magnus* to this genus may have been in error. He referred to it as *Sterrhurus magnus* when comparing it to *St. amplus*, and stated that further study of the terminal genitalia of *Sep. magnus* was needed to verify its taxonomic status. We (W.A.R.) have been able to do this on the specimens collected from Formosa. A study of sectioned material showed that the characters in this species are definitely those found in *Separogermiductus*, i.e., a large ejaculatory vesicle into which the pars prostatica opens far anteriorly and dorsally.

There have been nine species placed in *Separogermiductus*; all but one, *Sep. congeri* Manter and Pritchard, 1960, were originally described as species of either *Sterrhurus* (six species) or *Lecithochirium* (two species). These are *Sep. inimici* (Yamaguti, 1934) Skr. and Gusch., 1955; *Sep. musigarei* (Yamaguti, 1938) Skr. and Gusch., 1955; *Sep. magnus*; *Sep. pagrosomi* (Yamaguti, 1939) Skr. and Gusch., 1955; *Sep. macrorchis* (Crowcroft, 1946) Manter and Pritchard, 1960; *Sep. magnatestis* (Park, 1936) Manter and Pritchard, 1960; *Sep. exodicus* (McFarlane, 1936) Manter and Pritchard, 1960; *Sep. genypteri* (Manter, 1954) Manter and Pritchard, 1960. The first six were originally assigned to *Sterrhurus*, the last two to *Lecithochirium*. From published data, however, there appear to be only slight differences in measurements between *Sep. musigarei* and *Sep. exodicus*, and the two are here considered conspecific.

KEY TO THE SPECIES OF *Separogermiductus* SKRJABIN AND GUSCHANSKAJA, 1954

1. Seminal vesicle saccular, not distinctly divided, may be S-shaped, thin-walled 2
   Seminal vesicle bipartite, anterior lobe muscular ..... *Sep. macrorchis* (Crowcroft, 1946) Manter and Pritchard, 1960
   Seminal vesicle distinctly tripartite, thin-walled 4
   Seminal vesicle distinctly tripartite, anterior lobe muscular ..... *Sep. magnus* (Yamaguti, 1938) Skr. and Gusch., 1955
2. Preacetabular pit absent 3
   Preacetabular pit present ..... *Sep. exodicus* (McFarlane, 1936) Manter and Pritchard, 1960
3. Body equal in width throughout length; sucker ratio approximately 1 : 2 ..... *Sep. pagrosomi* (Yamaguti, 1939) Skr. and Gusch., 1955
   Forebody narrowed; acetabulum large; sucker ratio approximately 1 : 2.5 ..... *Sep. inimici* (Yamaguti, 1934) Skr. and Gusch., 1955
4. Testes postacetabular or overlapping posterior margin of acetabulum; ecsoma not reaching halfway to acetabulum; vitelline lobes blunt, as wide or wider than long 5
   Testes dorsal to acetabulum; ecsoma reaching halfway or more to acetabulum; vitelline lobes digitiform, much longer than wide ..... *Sep. congeri* Manter and Prichard, 1960
5. Preacetabular pit inconspicuous, represented only by "rudimentary genital sucker"; pars prostatica penetrating ejaculatory vesicle as a "cirrus covered with numerous minute spinules" ..... *Sep. magnatestis* (Park, 1936) Manter and Pritchard, 1960
   Preacetabular pit conspicuous; pars prostatica not penetrating ejaculatory vesicle as a "cirrus" ..... *Sep. genypteri* (Manter, 1954) Manter and Pritchard, 1960

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Taxonomy of the Genus *Seinura* (Nematoda : Aphelenchoididae), with Descriptions of *S. celeris* n. sp. and *S. steineri* n. sp.[1]

HELEN CAROL HECHLER AND D. P. TAYLOR[2]

The taxonomy of the genus *Seinura* Fuchs, 1931 has recently been reviewed by Hechler (1963). This paper contains a description of two new species of *Seinura*, the redescription of several others, and a key to the species. The authorship of the new species is Helen Carol Hechler.

MATERIALS AND METHODS

The sources of all species of *Seinura* studied are given in Table 1: a few were formalin-preserved specimens sent to the U.S. Department of Agriculture nematode collection by Christie and made available by A. M. Golden; however, most of the specimens were from laboratory cultures.

Many *Seinura* isolates were found during examination of nematodes recovered from soil. Others were located by mixing the nematodes from a soil sample with a suspension of *Aphe-*

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Thanks are extended to the following workers who kindly sent *Seinura* specimens: R. V. Anderson: S. *steineri;* A. M. Golden: S. *filicaudata,* S. *linfordi,* S. *oahuensis,* S. *oliveirae,* and S. *tenuicaudata* from Christie's material, S. *tenuicaudata* and S. *oliveirae* from Steiner's collection; J. B. Goodey: S. *tenuicaudata,* S. *winchesi*; Gerald Thorne: S. *filicaudata,* S. *linfordi,* S. *oahuensis,* S. *oliveirae,* S. *tenuicaudata,* S. *demani,* S. *oxura*; R. P. Esser: live specimens of S. *steineri.*

TABLE 1. Sources of specimens of *Seinura*.

Species	Locality	Source	Date
S. *celeris*	Joliet, Ill.	Soil from fallow cornfield, stored in jar 1 year.	December, 1957
S. *citri*	Danville, Ill.	Soil around roadside weed roots.	December, 1957
S. *filicaudata*		U.S.D.A. nematode collection.	
S. *linfordi*		U.S.D.A. nematode collection.	
S. *oahuensis*		U.S.D.A. nematode collection.	
S. *oliveirae*	Mt. Pulaski, Ill.	Soil from fallow cornfield.	June, 1958
	Mentor, Ohio	Soil around bluebell roots.	October, 1958
	Des Plaines, Ill.	Soil around greenhouse rose roots.	January, 1959
		U.S.D.A. nematode collection.*	
S. *oxura*	Sandoval, Ill.	Within *Pratylenchus* lesions on strawberry.	October, 1957
	Wabash Co., Ill.	Soil from clover field.	August, 1958
	St. Elmo, Ill.	Soil from greenhouse pansy pot.	January, 1960
	Savoy, Ill.	Soil from golf course green.	October, 1961
	Mt. Vernon, Ill.	Soil around tomato roots.	October, 1962
S. *steineri*	Dundee, Ill.	Soil around yew roots.	April, 1957
	Urbana, Ill.	Soil around glory-lily roots.	November, 1957
	Evanston, Ill.	Soil from greenhouse lily pot.	February, 1959
	Gainesville, Fla.	Soil around roots of flowering dogwood.**	November, 1964

* Measurement for neotype only.
** No specimens measured.

lenchus avenae Bastian, 1865 in water, concentrating them in a small drop by centrifugation, and placing them on 2% water agar. If *Seinura* specimens were present they would kill the other nematodes, reproduce, and their presence would become obvious.

A few *Seinura* were added with a nylon pick to one side of a petri dish containing an unidentified fungus, possibly a species of *Pyrenochaeta,* and *A. avenae.* After several days, when their progeny were located on the opposite side of the dish, a piece of agar from that side was transferred to a fresh culture. After three to five such transfers the nematodes were free of contaminants.

Seinura spp. were maintained in petri dish cultures of *A. avenae* and the unidentified fungus. Twenty ml of Difco potato dextrose agar was added to plastic petri dishes 9 cm in diameter. A piece of agar containing the fungus and about 100 *A. avenae* was transferred from a stock culture to the agar, and 2 weeks later sufficient progeny were available to feed one to two generations of *Seinura.* A piece of agar containing a few *Seinura* was transferred to the dish, and, depending on the *Seinura* species, the prey in the dish lasted 7 to 16 days. All cultures were maintained at room temperature.

Measurements of cultured specimens were made from camera lucida drawings of nematodes relaxed in water at 54 C, fixed in FAAGO (Chitwood and Allen, 1959) for 12 hours, dehydrated to glycerine according to the method of Baker (1953), and mounted in desiccated glycerine. Many details such as stylet length, position of hemizonid, number of incisures in lateral fields, and length of spicules were more clearly visible on specimens mounted live in water or cold 5% formalin. For greater accuracy, spicules, stylets, width of annules, and eggs were measured with an ocular micrometer.

DEFINITION AND DIAGNOSIS OF *Seinura*

DEFINITION: Aphelenchoididae. Labial framework very lightly sclerotized, no hexaradiate star surrounding oral aperture. Stylet plain, with basal swellings, or small knobs. Lateral field with two to five incisures, deirids and phasmids not seen. Hemizonid behind excretory pore. Metacorpus longer than wide, with the anterior ¼ to ⅖ alveolate and nonmuscular. Crescentic valve plates located behind middle of metacorpus except in a few rare

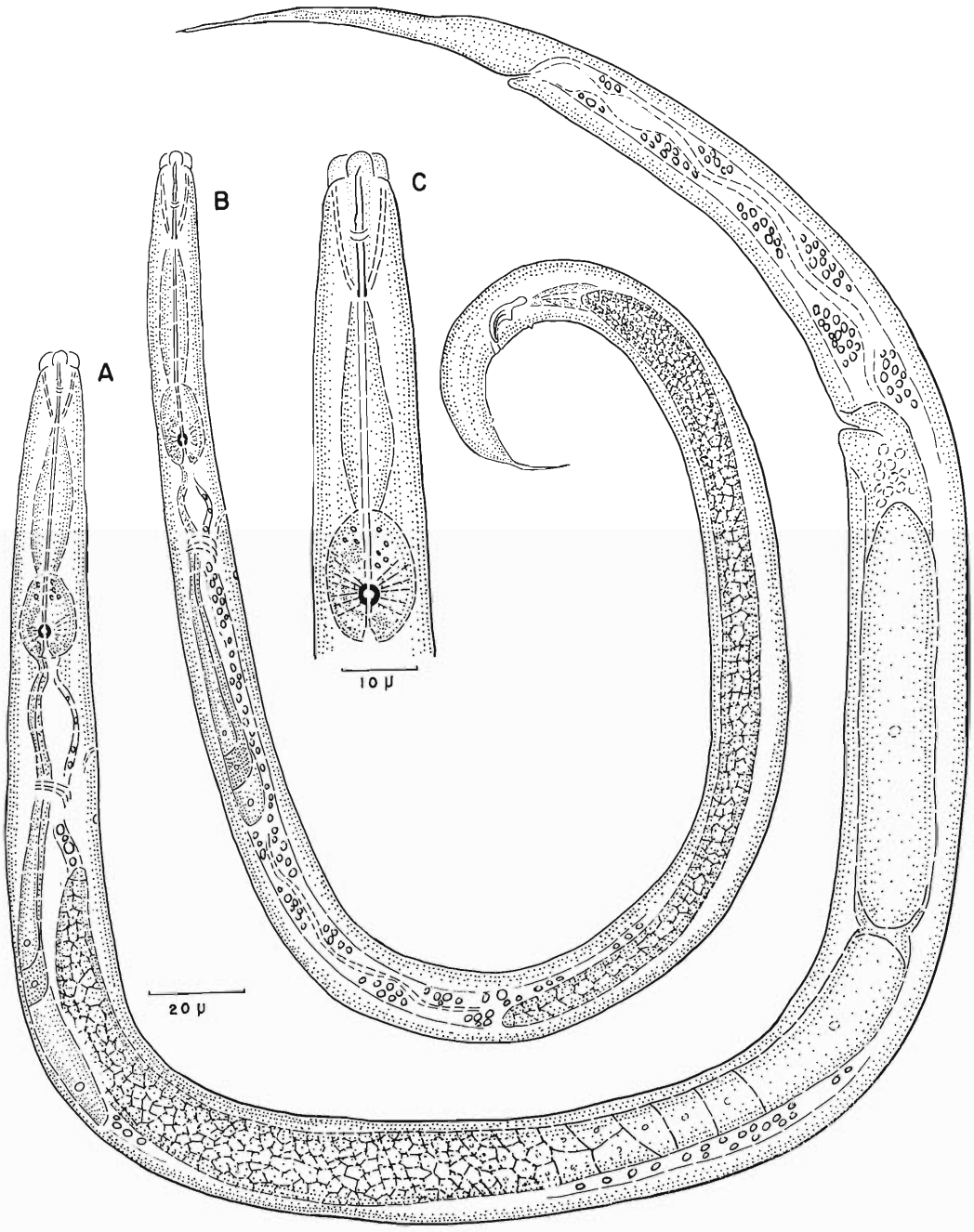

Fig. 1. *Seinura celeris*. A. Female; B. Male; C. Female head.

specimens. Esophageal gland lobe overlapping intestine dorsally. Ovary single, outstretched, with oogonia in one to five rows, a postvulvar sac present in many species. Ovary and uterus separated by a constriction, epithelium of ovary thin, epithelium of uterus thicker and much convoluted unless an egg is present. Lumen of uterus often wider at its anterior end, forming a round to oval spermatheca. Sperm cells stored throughout the length of uterus and in the postvulvar sac. Female tails elongate conoid to filiform. Male tail ventrally arcuate, conoid, elongate conoid, or tapering gradually or abruptly to a narrow spike which may have a mucronate or filiform terminus. Spicules paired with prominent anterior knob-like apex and ventral beak-like rostrum, distal end of ventral limb located almost as far posteriad as that of the dorsal limb. No gubernaculum present. One to four pairs of subventral papillae on male tail, or preanal papilla may be single and ventral. Reproduction bisexual or hermaphroditic.

DIAGNOSIS: The genera *Aphelenchoides* and *Paraseinura* closely resemble *Seinura*. Species of *Aphelenchoides* Fischer, 1894, differ from those of *Seinura* in the following characters: sclerotized hexaradiate labial framework present, stylet shorter, musculature farther forward in metacorpus, valve smaller, usually near middle of metacorpus, esophageal gland lobe shorter, female tail conoid, acute, or mucronate, never filiform, spicules with shorter apex, ventral limb of spicule may not reach as far posteriad as dorsal limb. *Paraseinura* Timm, 1961, differs by having a gubernaculum and the anterior part of the stylet in two sections.

DESCRIPTIONS

Members of the genus *Seinura* reproduce either bisexually or hermaphroditically, and many of the nematodes described below as females are technically hermaphrodites. However, to conform with convention, and because a hermaphroditic specimen would have the appearance of a female, only the terms "male" and "female" are used in the descriptions. Hermaphrodites can be recognized in early adulthood by the presence of sperm cells in the posterior part of the ovary, and this is mentioned in all descriptions of hermaphroditic species.

Seinura celeris n. sp.

DIMENSIONS: Females (n = 50): L = 490–790 (610)* μ; a = 25.8–40.0 (30.4); b** = 8.6–13.4 (10.9); c = 7.5–11.7 (9.5); V = 66.8–77.1 (72.9)%.

Males (n = 50): L = 380–430 (410) μ; a = 27.8–32.3 (30.3); b = 7.1–10.0 (7.9); c = 7.2–11.9 (10.4).

* Value given in parentheses is the mean.
** Length of esophagus was measured from the anterior end to the base of the metacorpus.

FEMALE (Fig. 1A, C): Body comparatively thick, six lips slightly offset from body. Cuticle finely striated, striations 0.8 μ apart, 3 incisures in lateral field. Stylet 14.0–17.5 μ long, with slight basal swellings. Metacorpus about 11 μ wide, 16 μ long, crescentic valve located at 60% of valve length from anterior end. Esophageal gland lobe about 90 μ long. Nerve ring about 25 μ posterior to bulb, excretory pore opposite or anterior to nerve ring, hemizonid one body width posterior to excretory pore. Ovary outstretched, anterior end reaching to nerve ring in well-fed specimens, narrow anteriorly, widened in middle with about five oogonia in a cross section, oocytes in a single row in growth region. No postvulvar sac present. Mature eggs 16 × 85 μ. Tail length about 60% of vulva–anus distance, terminus variable, may be elongate conoid, mucronate, or with an extremely short filiform portion.

MALE (Fig. 1B): Males much smaller than females. Stylet 11.0–15.5 μ long. Esophageal gland lobe 85 μ long. Testis straight or curved back, reaching up to 50% of body length from anterior end when straight. Testis very short in older males. Tail tapers very abruptly to a spikate terminus which is 30 to 35% as long as tail. One pair of papillae opposite rostrum, one pair about ⅗ the distance from anus to beginning of spike. Spicules comparatively narrow, 11 to 13 μ long.

DIAGNOSIS: The two closest species are *S. winchesi* (T. Goodey, 1927) J. B. Goodey, 1960 and *S. diversa* (Paesler, 1957) J. B. Goodey, 1960. The short spike on the male tail, shorter female tail, and the slight swellings on the stylet separate *S. celeris* from *S. winchesi*. The shorter female tail, which is shorter than vulva–anus distance, and excretory pore anterior to nerve ring separate it from *S. diversa*.

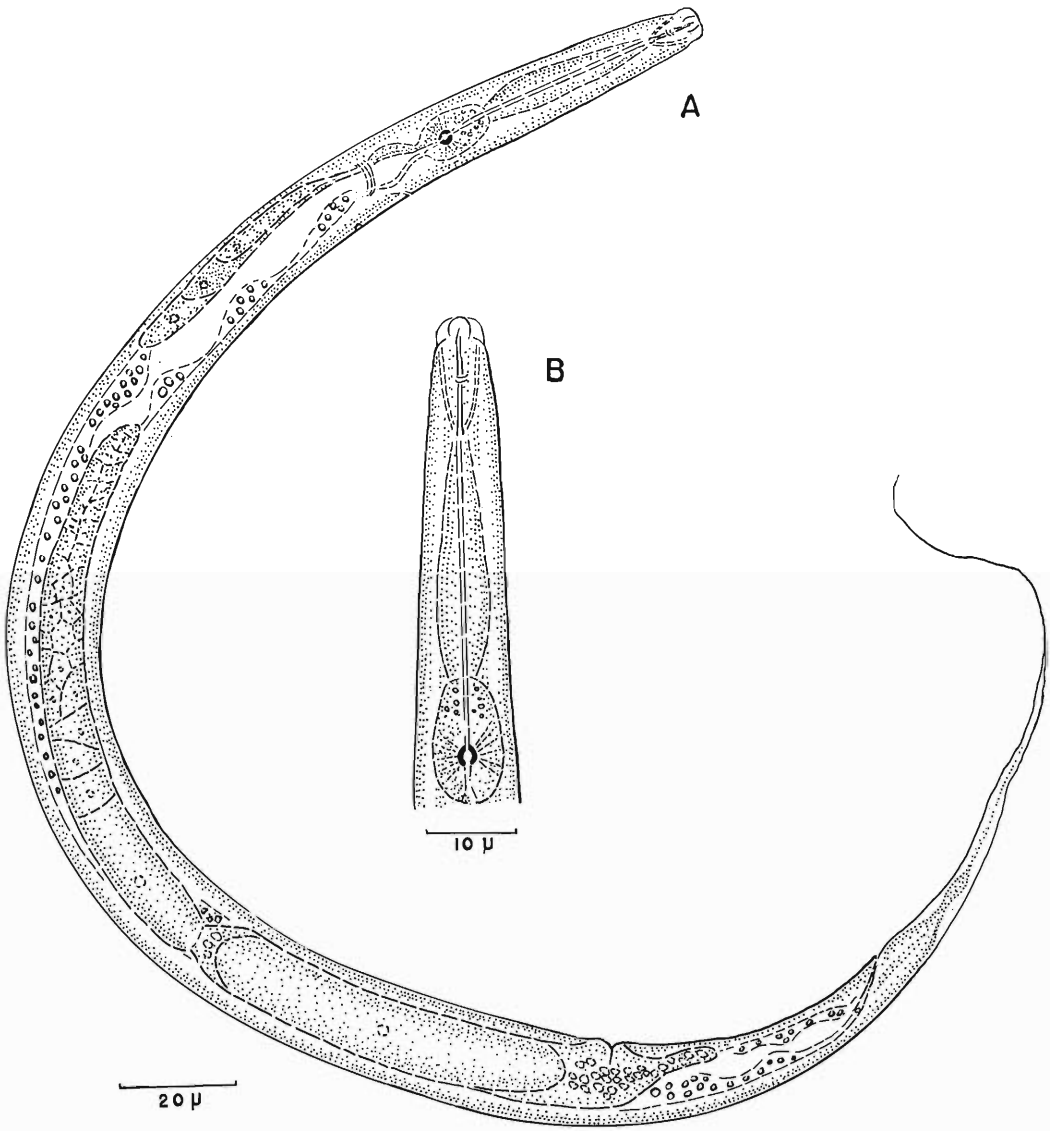

Fig. 2. *Seinura citri*. A. Female; B. Female head.

The life cycle of S. *celeris* is completed in the shortest period of time of all the *Seinura* species studied. Therefore, the specific name chosen was "*celeris*" which means "swift" in Latin.

HOLOTYPE: Female: L = 770 μ; a = 33.3; b = 12.3; c = 9.8; V = 74.8%. Slide T 58t in the U.S.D.A. nematode collection, Beltsville, Maryland.

TYPE LOCALITY: Joliet, Illinois (altitude 558 ft). Collected by Harlan L. Rhoades from a fallow cornfield, December, 1957.

Seinura citri (Andrassy, 1957) J. B. Goodey, 1960

DIMENSIONS: Females (n = 50): L = 410–600 (470) μ; a = 26.0–40.0 (33.5); b = 7.9–11.1 (9.9); c = 3.7–6.9 (4.5); V = 59.3–74.2 (65.1)%.

FEMALE (Fig. 2): Body small and slender; tail long, 1.7 to 2 times as long as vulva–anus distance, with extremely long filiform portion. Six lips barely offset from body. Stylet plain, 10 to 13 μ long. Cuticular striations extremely fine, three incisures seen in lateral field on one favorable specimen. Metacorpus 9 μ wide, 12 μ long, with the valve plates at 65% of its length from the anterior end. Gland lobe 72 to 95 μ long. Excretory pore opposite nerve ring, about 12 μ posterior to bulb, hemizonid about 15 μ posterior to pore. Ovary reaches to end of gland lobe, with 2 to 3 oogonia in cross section at the widest part, oocytes in a single row in growth region. Eggs 12 × 65 μ. Postvulvar sac only as long as corresponding body width. Males not seen.

DIAGNOSIS: *Seinura citri* most nearly resembles *S. longicaudata* (Cobb, 1893) J. B. Goodey, 1960. *S. longicaudata* is larger, females about 800 μ long, males are present, and the excretory pore is located opposite the valve in the metacorpus.

Seinura filicaudata (Christie, 1939) J. B. Goodey, 1960

DIMENSIONS: Females (n = 15): L = 620–820 (720) μ; a = 28.6–50.2 (38.8); b = 7.9–10.0 (8.9); c = 5.2–6.5 (5.8); V = 62.0–68.5 (66.0)%.

Males (n = 3): L = 540, 570, 550 μ; a = 45.0, 40.8, 34.2; b = 7.2, 7.1, 7.6; c = 7.4, 7.7, 7.6; T = 33.2, 36.8, 36.2%.

FEMALE: Head slightly offset, cuticle finely striated, three incisures in lateral field. Stylet 18 to 21 μ long, plain. Metacorpus 10 to 14 μ wide, 18 to 21 μ long, crescentic valve plates located 60 to 70% of bulb length from anterior end. Esophageal gland lobe 110 to 130 μ long. Excretory pore opposite anterior portion of bulb, hemizonid about 35 μ behind pore. Ovary straight, oogonia in a single row, sperm cells in posterior end of ovary in young nematodes. Postvulvar sac reaches ⅓ vulva–anus distance. Tail tapers gradually to a filiform terminus, length slightly longer than vulva–anus distance.

MALE (Fig. 3): Male not described previously. Males smaller than females, body slender, six lips slightly set off from body. Cuticle finely striated, three incisures faintly visible in lateral field. Stylet plain, 17 μ long. Metacorpus 9 μ wide, 16 μ long, crescentic valve located 60% of distance from anterior end. Gland lobe about 100 μ long. Nerve ring 15 μ behind metacorpus, excretory pore opposite middle of metacorpus, hemizonid about 25 μ behind pore. Testis outstretched or recurved, spermatogonia in a single row in anterior end. Tail tapers gradually to a spikate terminus which is 56 to 60% as long as tail. One pair of papillae opposite apex of spicule, two pairs about ⅔ distance from anus to beginning of spike. Spicules 14 μ long.

DIAGNOSIS: *S. filicaudata* is most similar to *S. elmiraensis* (van der Linde, 1938) J. B. Goodey, 1960, and *S. steineri* n. sp. It can be separated from *S. elmiraensis* by the position of the excretory pore opposite the anterior part of the bulb. Males of *S. filicaudata* can be separated from those of *S. steineri* by the longer spike on the male tail and the single pair of postanal papillae in *S. filicaudata*. However, except for the more offset lip region in *S. steineri*, it is very difficult to distinguish females of *S. filicaudata* and *S. steineri* from each other.

NEOTYPE: Female: L = 790 μ; a = 39.5; b = 8.9; c = 6.1; V = 67.0%. Slide T 379p in the U.S.D.A. nematode collection, Beltsville, Maryland.

Seinura linfordi (Christie, 1939) J. B. Goodey, 1960

DIMENSIONS: Females (n = 15): L =470–620 (550) μ; a = 27.3–34.3 (30.9); b = 7.2–9.2 (8.2); c = 7.0–10.2 (8.6); V = 70.0–74.5 (72.4)%.

FEMALE: Head barely offset, or continuous with body. Cuticle prominently striated except on lips, striations 1.8 to 2.0 μ apart at middle of body. Lateral field marked by two incisures just behind stylet, three at level of metacorpus, four at end of esophageal gland lobe, five at level of vulva, four at ½ vulva–anus distance, three at anus, two at ½ tail length, outer lines crenate. Stylet 15 to 18 μ long with small basal knobs. Metacorpus 9 to 11 μ wide, 14 to 18 μ long, crescentic valve located 60 to 80% of bulb length from anterior end. Excretory pore opposite nerve ring, hemizonid 8 to 10 μ behind pore. Esophageal gland

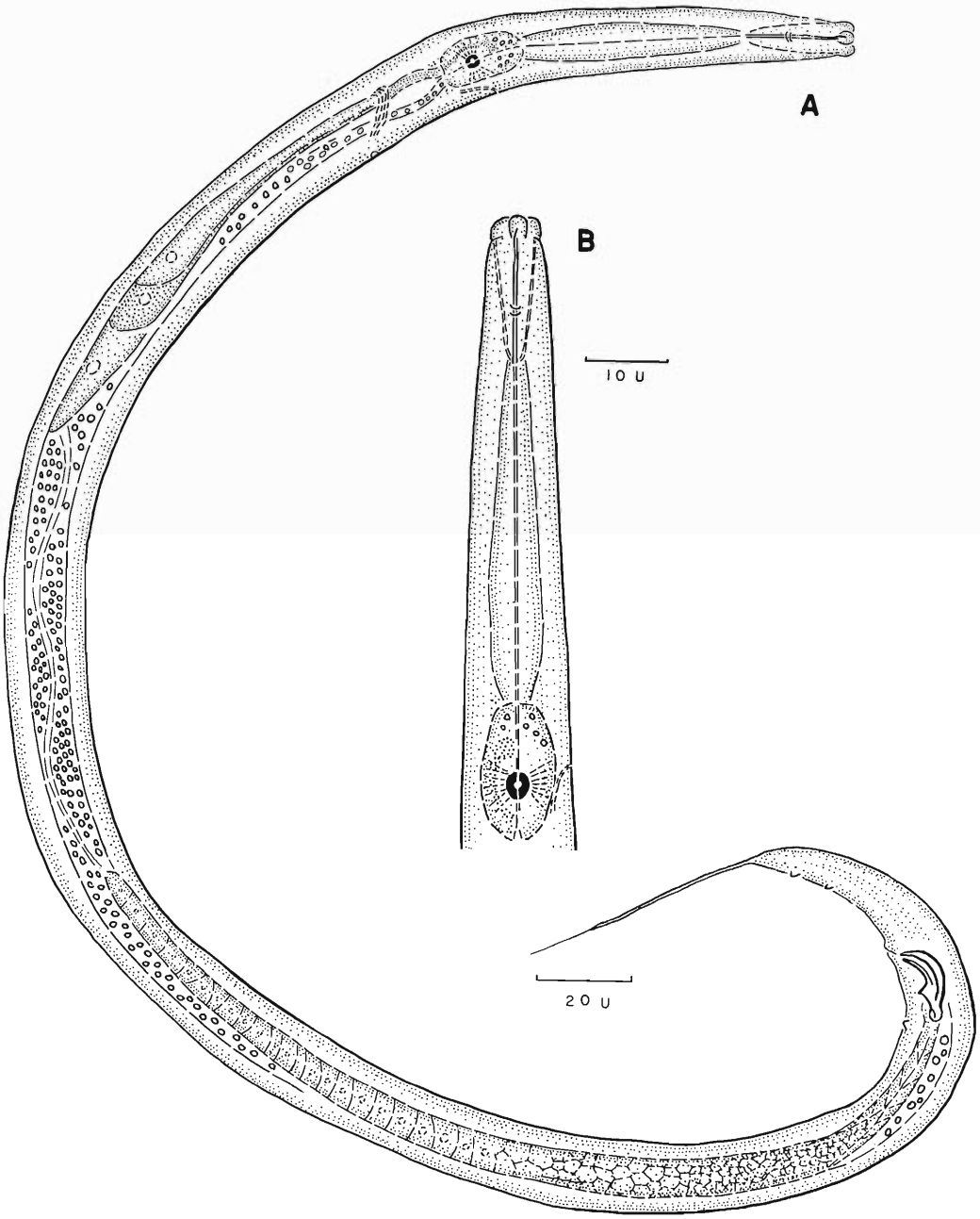

Fig. 3. *Seinura filicaudata*. A. Male; B. Male head.

lobe 70 to 90 μ long. Ovary straight, oogonia arranged in a single row, sperm cells packed in posterior portion of ovary in young nematodes. Postvulvar sac short, ⅛ to ⅓ vulva–anus distance. Tail often curved ventrally in relaxed specimens, tapering gradually to a short filiform terminus, length variable, 70 to 140% of vulva–anus distance.

DIAGNOSIS: *S. linfordi* can be separated from other species of *Seinura* by its coarse cuticular striation, with the annules more than 1.5 μ wide, and the prominent lateral field with up to five incisures.

NEOTYPE: Female: L = 620 μ; a = 28.1; b = 9.0; c = 8.9; V = 74.0%. Slide T 378p in the U.S.D.A. nematode collection, Beltsville, Maryland.

Seinura oahuensis (Christie, 1939) J. B. Goodey, 1960

DIMENSIONS: Females (n = 10): L = 510–820 (680) μ; a = 39.1–54.0 (44.3); b = 7.3–11.3 (9.7); c = 11.0–13.3 (11.9); V = 72.5–75.0 (74.0)%.

FEMALE: Head barely offset from body, cuticle finely striated, striations 0.6 to 0.7 μ apart, no lateral field seen. Stylet 14 to 17 μ long, knobbed. Metacorpus 8 to 9 μ wide, 14 to 17 μ long, crescentic valve located 50 to 64% of bulb length from anterior end. Esophageal gland lobe about 120 μ long. Excretory pore opposite nerve ring, hemizonid 8 to 10 μ behind pore. Ovary straight, with oogonia arranged in a single row. In young specimens sperm cells are present in the posterior end of the ovary. Postvulvar sac 40 to 60% as long as vulva–anus distance, with the lumen extending only ½ to ¾ of its length. At the end of the sac a row of two to eight small cells may be present. Tail tapering gradually to a short filiform terminus, length 60 to 80% of vulva–anus distance.

DIAGNOSIS: *S. demani* (T. Goodey, 1928) J. B. Goodey, 1960, *S. oliveirae* (Christie, 1939) J. B. Goodey, 1960, and *S. oahuensis* (Christie, 1939) J. B. Goodey, 1960, all have knobbed stylets. However, *S. oahuensis* may be easily separated from the other species by its postvulvar sac.

NEOTYPE: Female: L = 750 μ; a = 50.0; b = 11.0; c = 11.9; V = 72.5%. Slide T 377p of the U.S.D.A. nematode collection, Beltsville, Maryland.

Seinura oliveirae (Christie, 1939) J. B. Goodey, 1960

DIMENSIONS: Females (n = 50): L = 520–760 (590) μ; a = 26.5–36.0 (31.5); b = 7.7–11.3 (10.0); c = 5.6–9.7 (7.5); V = 64.8–77.0 (71.7)%.

Males (n = 50): L = 400–500 (460) μ; a = 27.5–34.6 (31.2); b = 7.9–8.7 (8.5); c = 7.4–11.8 (8.4).

FEMALE (Fig. 4A, C): Body moderately slender, lips slightly offset, tail length slightly less than vulva–anus distance, with long filiform portion. Cuticle finely striated, striations 0.8 μ apart, no lateral field seen. Stylet 15 to 16 μ long, knobbed. Metacorpus 14 to 16 μ long, 10 to 13 μ wide, valve at 61 to 65% of length from anterior end. Gland lobe 85 to 110 μ long. Nerve ring about 14 μ posterior to bulb. Excretory pore opposite or posterior to nerve ring, hemizonid about 9 annules posterior to excretory pore. Ovary straight, oogonia in three to five rows at widest part, sometimes anterior end level with nerve ring, then curved backward. No postvulvar sac present.

MALE (Fig. 4B): Males smaller than females. Testis straight or recurved. Spicules comparatively narrow, 12 to 14 μ long. Tail tapers gradually to a filiform terminus, only occasionally is the posterior spikate portion set off by a slight constriction. One pair of papillae located opposite rostrum, one pair at about 45% of tail length.

DIAGNOSIS: The two most similar species are *S. oahuensis* (Christie, 1939) J. B. Goodey, 1960 and *S. demani* (T. Goodey, 1928) J. B. Goodey, 1960. Absence of a postvulvar sac separates *S. oliveirae* from *S. oahuensis*, and the excretory pore behind the nerve ring and the evenly tapering male tail separates it from *S. demani*.

NEOTYPE: Female: L = 610 μ; a = 38.2; b = 9.2; c = 9.4; V = 72.5%. Slide T 376p in the U.S.D.A. nematode collection, Beltsville, Maryland. Neotype from vial of formalin-fixed nematodes sent by J. R. Christie to A. M. Golden.

Seinura oxura (Paesler, 1957) J. B. Goodey, 1960

DIMENSIONS: Females (n = 50): L = 500–900 (725) μ; a = 23.7–38.2 (29.5); b = 8.1–18.7 (13.0); c = 9.4–21.3 (14.5); V = 72.9–83.6 (78.5)%.

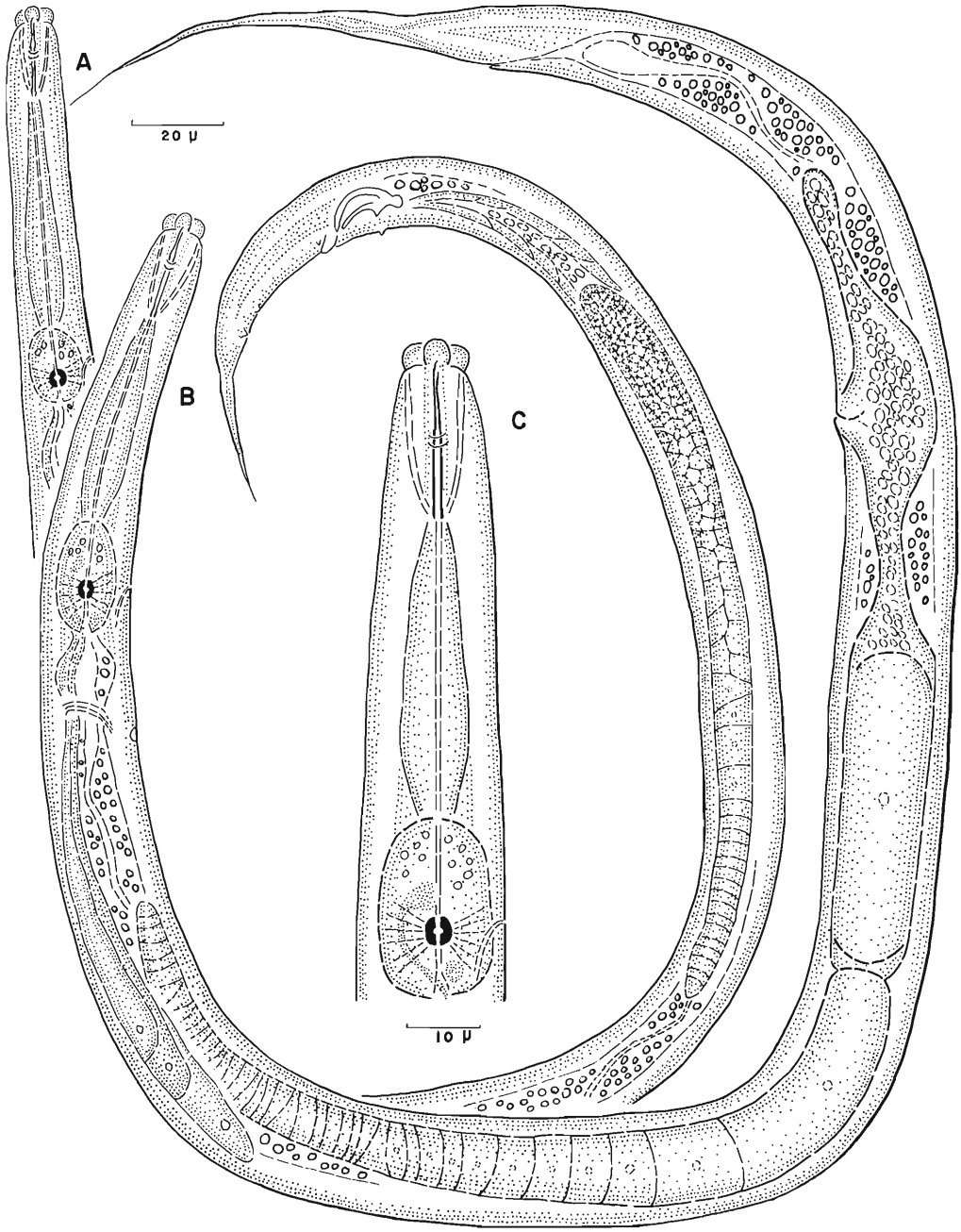

Fig. 4. *Seinura oliveirae.* A. Female; B. Male; C. Female head.

TABLE 2. Summary of characters of *Seinura tenuicaudata* reported by various authors compared to those of hermaphroditic isolates.

Author or isolate	Female:					
	Length (microns)	a	b	c	V %	Stylet length (microns)
de Man	950	35–36	9–9.5	7.8–8.7 rarely 10	70	24–27
Steiner	580–620	29–35	7.1	7.7–10	–	22–26
T. Goodey	670	32	7.4	8.0	66–75	22
Christie	930–1,000	31–39	10–11.2	9–10	70–74	16–19
Hechler	500–940	30–40.5	8.2–11.4	6.6–11.3 (8.5)	70–78	16–20
Hermaphroditic isolates	680–960	25–39	8.5–11.8	5.6–9.6(7.5)	60–75	20–23

Author or isolate	Female:		Male:	
	Position of excretory pore	Postvulvar sac as % of vulva–anus distance	Spike of tail as % of tail length	Length of spicules (microns)
de Man	behind bulb	60	33	18
Steiner	anterior half of bulb or opposite valve	–	no males	–
T. Goodey	opposite or slightly posterior to valve	"long"	45	–
Christie	base of bulb to ½ distance from base to valve	52	31	18–20
Hechler	base of bulb	42–64	29–37	15–16
Hermaphroditic isolates	opposite valve	40–50	40–50	15–18

Males (n = 11): L = 500–790 (700) μ; a = 27.2–37.6 (33.9); b = 8.5–11.6 (10.1); c = 17.6–22.7 (21.3).

FEMALE (Fig. 5B, C): Body comparatively wide, lips offset, tail short, elongate conoid, length ½ vulva–anus distance, with rounded, rarely mucronate or filiform terminus. Cuticle moderately finely striated, striations about 1.2 μ apart, three incisures in lateral field. Stylet 17.0 to 19.5 μ long, plain. Metacorpus 16 to 19 μ long, 11 to 14 μ wide, valve at 55 to 60% of bulb length from anterior end. Gland lobe 100 to 165 μ long. Excretory pore opposite base of bulb to about 10 μ posterior to it. Hemizonid about 25 μ posterior to pore. Nerve ring 25 μ posterior to bulb. Ovary straight, oogonia arranged in two rows at anterior end, in three to five rows at widest part, sperm cells in posterior section of ovary in young nematodes. Eggs 27 × 95 μ. No postvulvar sac present. Uterus filled with sperm cells except in senescent nematodes.

MALE (Fig. 5A): Male previously undescribed. Body only slightly smaller than females, testis straight, 270 to 300 μ long. Spicules wide, 15 to 16 μ long. Male tail short, tapering very rapidly to an acute point, occasionally mucronate, never spikate or filiform. One pair of papillae just anterior to anus, one pair at about ¾ tail length.

DIAGNOSIS: *Seinura oxura* is closest to *S. oswegoensis* (van der Linde, 1938) J. B. Goodey, 1960 in tail shape. Lack of a postvulvar sac separates *S. oxura* from *S. oswegoensis*.

Seinura steineri n. sp.

SYN: *Aphelenchus tenuicaudatus* de Man, 1895 of Steiner, 1927.

Five isolates of species of *Seinura* in culture were very similar morphologically; however,

two reproduced bisexually (Hechler, 1963), and three were hermaphroditic with males rare. All isolates had plain stylets, long postvulvar sacs, oogonia in one to two rows, female tails moderately long and filiform, male tails with a single preanal papilla, one pair of adanal and two pairs of postanal papillae. The hermaphroditic and bisexual isolates differ as follows: the hermaphroditic isolates with a longer spike on the male tail, slightly longer female tail, longer stylet, and shorter postvulvar sac; the excretory pore is opposite the valve in the hermaphrodites, opposite the base of the bulb in the bisexual isolates. Both groups are very close to *S. tenuicaudata*, but it is difficult to determine which one is *S. tenuicaudata* and which is another form.

Nematodes have been described as what is now considered to be *S. tenuicaudata* by de Man (1895), Steiner (1927), T. Goodey (1928), Schuurmans-Stekhoven (1936), Christie (1939), and Hechler (1963). Schuurmans-Stekhoven mentioned a small postvulvar sac and rounded terminus in his specimens; therefore, his material is not closely related to these isolates. Characters of the nematodes described by the other authors are compared with those of the hermaphroditic isolates in Table 2.

Differences in measurements reported by the various authors are not sufficiently consistent to use as a basis of separation of the species. However, the lack of males in Steiner's material, the longer spike on the male tail in T. Goodey's material, and the excretory pore opposite the metacorpus valve reported by both of these authors differentiate their material from that described by the others. The descriptions by Steiner and T. Goodey are apparently identical to the hermaphroditic isolates, while the descriptions of the other authors are like the bisexual isolates. Therefore, the bisexual isolates, as first described by de Man, are identified as *S. tenuicaudata*, whereas the hermaphroditic isolates are considered identical to the material first reported by Steiner and are here described as *Seinura steineri* n. sp. T. Goodey's material is also identified as *S. steineri*.

DIMENSIONS: Females (n = 50): L = 680–960 (790) μ; a = 25.5–39.8 (31.0); b = 8.5–11.8 (10.4); c = 5.6–9.6 (7.5); V = 60.4–75.0 (70.7)%.

Males (n = 5): L = 515–715 (625) μ; a = 32.6–34.3 (33.1); b = 7.0–9.5 (8.1); c = 8.6–13.1 (11.1).

FEMALE (Fig. 6B, C): Body moderately slender, lips offset, tail length less than vulva–anus distance, with long filiform portion. Cuticle finely striated, striations 0.8 μ apart, lateral field with three incisures at middle of body, two anterior to metacorpus. Stylet 20 to 23 μ long, plain. Metacorpus 18 to 22 μ long, 10 to 14 μ wide, valve located about ⅔ the distance from anterior end. Esophageal gland lobe 120 to 150 μ long. Excretory pore opposite valve in metacorpus, hemizonid about 4 annules wide, 25 μ behind pore. Nerve ring about 10 μ behind bulb. Ovary with one row of oogonia throughout most of its length, sometimes two rows for a short distance. Sperm cells in posterior part of ovary in young nematodes. Sperm cells present in uterus and postvulvar sac except in very young and very old specimens. Eggs measure 15 to 18 × 45 to 60 μ. Postvulvar sac 25 to 50 μ long, 40 to 50% of vulva–anus distance. Sac collapsed and not easily seen in older specimens with few sperm cells remaining.

MALE (Fig. 6A): Males rare, varying from 20 to less than 1 per 10,000 females, slightly smaller than females. Testis straight. Spicules wide, 15 to 17 μ long. Tail tapers gradually, then more abruptly, ending in a spike 40 to 50% of tail length. A single ventral papilla is opposite the rostrum, one pair of subventral papillae is just posterior to anus, and two pairs are located 70 to 80% of distance from anus to spike.

DIAGNOSIS: *S. steineri* closely resembles *S. tenuicaudata*, but differs from it by having a longer stylet, longer spike on the male tail, excretory pore more anterior, female tail slightly longer ("c" averages 7.5 in *S. steineri*, 8.5 in *S. tenuicaudata*), and males are rare. The females are very similar to females of *S. filicaudata*, but differ by having a more offset lip region.

HOLOTYPE: Female: L = 680 μ; a = 32.2; b = 9.1; c = 6.5; V = 69.2%. Slide T 70t in the U.S.D.A. nematode collection, Beltsville, Maryland.

TYPE LOCALITY: Dundee, Illinois (altitude 239 m). Collected by M. B. Linford from soil around yew roots, April, 1957.

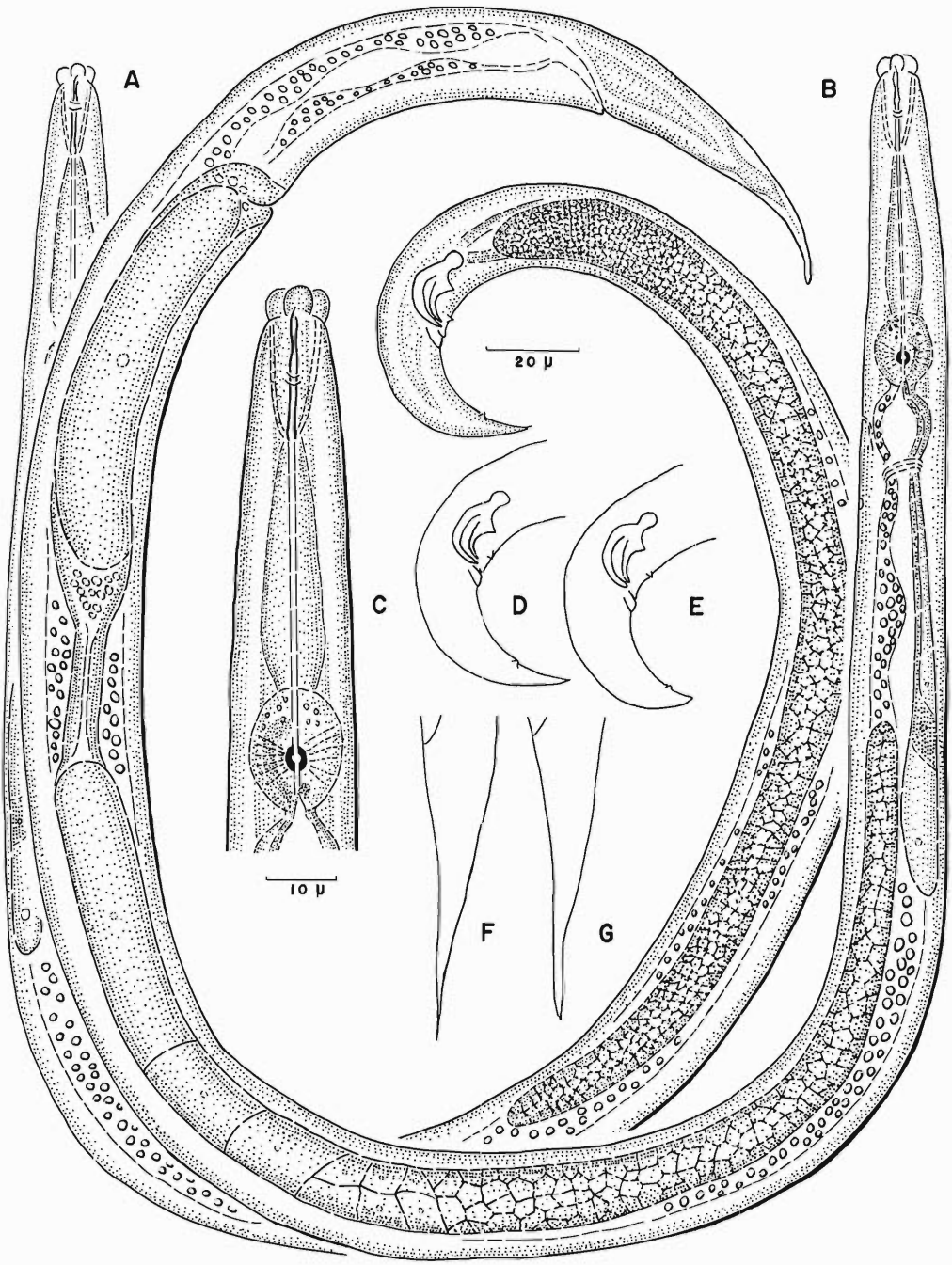

Fig. 5. *Seinura oxura*. A. Male; B. Female; C. Female head; D–E. Male tail variations; F–G. Female tail variations.

ON THE STATUS OF S. *hyerabadensis*, S. *mucronatus*, AND S. *speciosus*

S. *hyderabadensis* (Das, 1960) J. B. Goodey, 1960; S. *mucronatus* (Paesler, 1946) J. B. Goodey, 1960; and S. *speciosus* (Andrassy, 1958) J. B. Goodey, 1960 were considered by J. B. Goodey (1960) as "probably belonging to this genus." Descriptions of these species, all based on males only, are too inadequate to permit their inclusion in *Seinura*.

S. *hyderabadensis*, described from a single male, is very similar in tail shape to S. *celeris*. However, Das (1960) observed no papillae on the male tail, while papillae have been found on the tails of all males in *Seinura*. After discovery of the female, the taxonomic position of this species may be more certain.

The tail shape of S. *mucronatus*, which was described from two males, is similar to that of some *Seinura* males. However, the metacorpus is illustrated with musculature in the extreme anterior end, and the spicules are shown with a shorter rostrum and broader apex than is found in *Seinura* spp. No other useful details were given.

The shape of the tail of the single S. *speciosus* male described is similar to the male tail of S. *celeris*. However, the short, knobbed stylet and small apex of the spicule, only slightly set off, are closer to characters found in *Aphelenchoides*. Andrassy also illustrated four pairs of postanal subventral papillae and one pair of subdorsal papillae on the male tail, a combination not seen in *Seinura*.

For the above reasons these species are regarded by the authors as *species inquirendae* in the superfamily Aphelenchoidea, and their names and authorities should be:

Aphlenchoides hyderabadensis Das, 1960
Aphelenchoides mucronatus Paesler, 1946
Aphelenchoides speciosus Andrassy, 1958

KEY TO THE SPECIES OF *Seinura*

Most type material of *Seinura* spp. is either lost or difficult to acquire for study. The following key to the species therefore is based mainly on comparison of descriptions rather than on comparison of actual specimens. Female characters are used as much as possible, since males in several species are rare or unknown.

1. Stylet with knobs 2
1. Stylet plain or with small swellings 5
2. Cuticular annulation coarse, striae more than 1.5 μ apart ... *S. linfordi* (Christie, 1939) J. B. Goodey, 1960
2. Annulation fine 3
3. Postvulvar sac present ..... *S. oahuensis* (Christie, 1939) J. B. Goodey, 1960
3. Postvulvar sac absent 4
4. Excretory pore opposite or behind nerve ring, spike on male tail only faintly set off ..... *S. oliveirae* (Christie, 1939) J. B. Goodey, 1960
4. Excretory pore in front of nerve ring, spike on male tail definitely set off by a constriction ..... *S. demani* (Goodey, 1928) J. B. Goodey, 1960
5. Postvulvar sac present 6
5. Postvulvar sac absent 14
6. Female tail length 1½ times vulva–anus distance 7
6. Female tail less than 1½ times vulva–anus distance 8
7. Females large, over 700 μ, excretory pore opposite metacorpus, males present ..... *S. longicaudata* (Cobb, 1893) J. B. Goodey, 1960
7. Females small, less than 600 μ, excretory pore behind metacorpus, males rare ..... *S. citri* (Andrassy, 1957) J. B. Goodey, 1960
8. Postvulvar sac short, about one body width ..... *S. paratenuicaudata* Geraert, 1962
8. Postvulvar sac at least ⅓ vulva–anus distance 9
9. Female tail short, filiform portion, if present, 15 μ or less, c = 10 or more ..... *S. oswegoensis* (van der Linde, 1938) J. B. Goodey, 1960
9. Female tail long with long filiform portion, c less than 10 10
10. Postvulvar sac longer than ¾ vulva–anus distance, 1 pair postanal papillae in male tail ... *S. mali* Fuchs, 1931
10. Sac shorter than ⅔ vulva–anus distance, 2 pairs postanal papillae on male tail 11
11. Spike on male tail 60% of tail length, c less than 6.5 in female 12
11. Spike on male tail less than 60% of tail length, c usually more than 6.5 in female 13

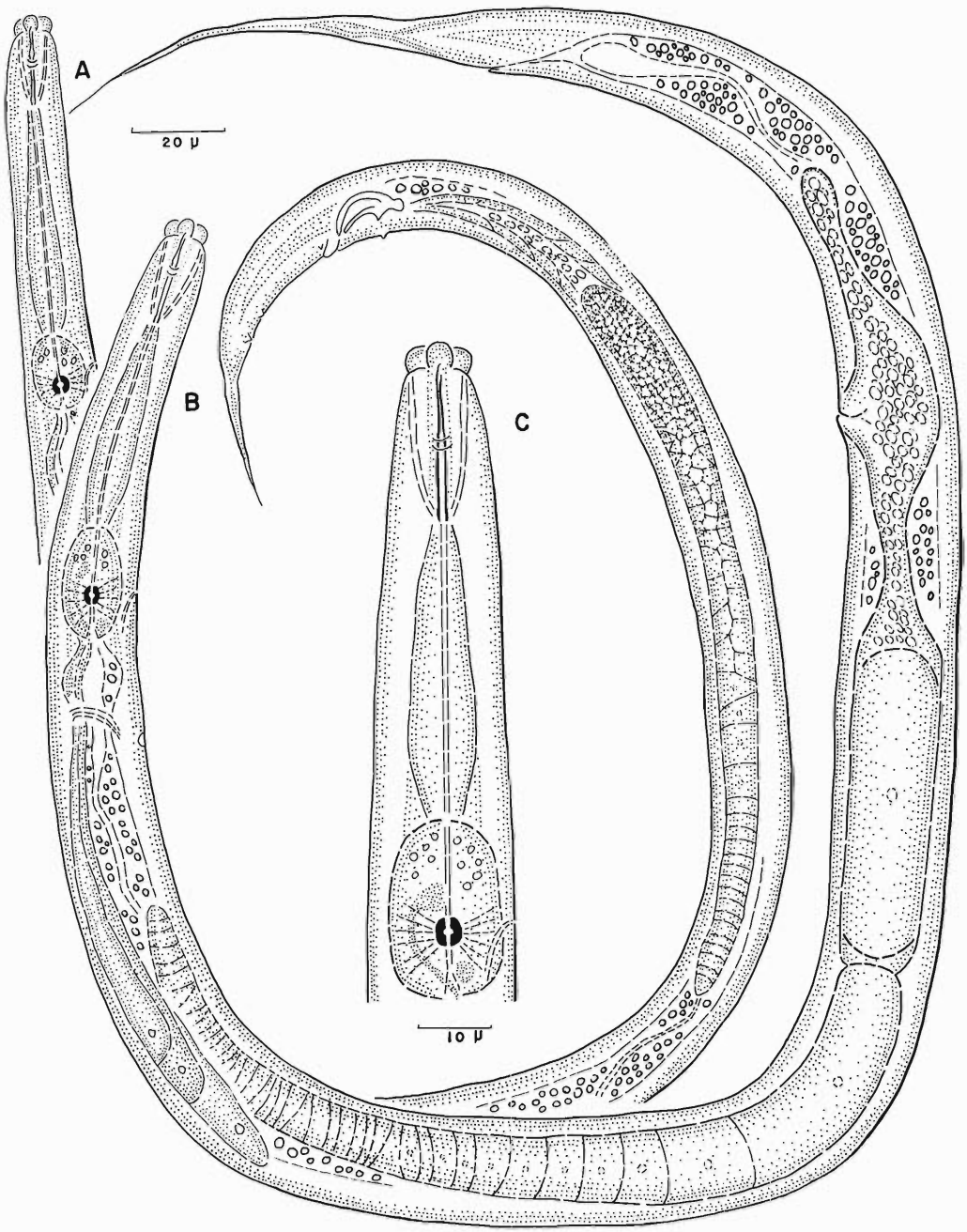

Fig. 6. *Seinura steineri*. A. Male; B. Female; C. Female head.

12. Head faintly set off, pore opposite valve in bulb, males rare ..... S. *filicaudata* (Christie, 1939) J. B. Goodey, 1960
12. Head distinctly set off, pore behind bulb, males abundant ..... S. *elmiraensis* (van der Linde, 1938) J. B. Goodey, 1960
13. Stylet over 20 μ long, pore opposite valve in bulb, spike on male tail 40 to 50% of tail length, males rare ..... S. *steineri* n. sp.
13. Stylet less than 20 μ long, pore opposite base of bulb, spike on male tail about ⅓ of tail length, males abundant ..... S. *tenuicaudata* (de Man, 1895) J. B. Goodey, 1960
14. Female tail very short, filiform portion, if present, less than 15 μ long, c greater than 10, no spike on male tail ..... S. *oxura* (Paesler, 1957) J. B. Goodey, 1960
14. Female tail elongate conoid or filiform, c less than 10, male tail with spike ... 15
15. Stylet plain, valve at middle of bulb, spike on male tail over ½ tail length ..... S. *winchesi* (Goodey, 1927) J. B. Goodey, 1960
15. Stylet with slight swellings, valve behind middle of bulb, spike on male tail less than ½ tail length 16
16. Female tail filiform, length 1⅓ vulva–anus distance, excretory pore opposite or behind nerve ring ... S. *diversa* (Paesler, 1957) J. B. Goodey, 1960
16. Female tail elongate conoid, length less to slightly longer than vulva–anus distance, pore opposite or anterior to nerve ring ..... S. *celeris* n. sp.

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Monogenetic Trematodes from the Southern Pacific Ocean. Part III. *Diplasiocotyle johnstoni* Sandars, 1944 from New Zealand and Australia, with a Description of a New Family[1]

WILLIAM J. HARGIS, JR. AND WILLIAM ARTHUR DILLON

Among the extensive collections made in New Zealand and Australia by Messrs. William Stanley Wilson and William Saunders of this institution, in connection with the Antarctic Research Program of the National Science Foundation, were two series of worms from the marine teleost, *Aldrichetta forsteri* (Cuv. and Val.). The series from New Zealand contained only four juveniles, while that from Australia yielded 13 more-advanced juveniles and 12 adults.

Examination and comparison of the specimens in our Australian collection with the description of Sandars (1944), who had at her disposal a fairly large collection of specimens, also from Australia, revealed them to be conspecific. Comparison of the juveniles from New Zealand with those from more comprehensive Australian collections confirmed their conspecificity. Sandars' (1944) description of the free-swimming larva, juveniles and adults, facilitated our comparative efforts.

Because our collections came from new localities as well as the type locality and because they present certain morphological differences, we have completely redescribed this species.

Morphological and taxonomic studies have necessitated removal of *Diplasiocotyle* Sandars, 1944 from the family Microcotylidae Taschenberg, 1879 and proposal of a new family. In turn, these changes have made a revision of the superfamily Diclidophoroidea Price, 1936 necessary.

METHODS AND MATERIALS

Trematodes were collected using a technique outlined by Hargis (1953). The gills, usually entire branchial baskets, were removed from the host to a saturated solution of Chloretone (Parke-Davis) prepared with filtered sea water and kept in this solution for 1 to 2 hours during which they were usually agitated to help free the relaxing monogeneids. The trematodes were then killed, fixed, and preserved in AFA or 10% formalin.

The parasites were removed from the branchial material with the aid of a stereomicroscope, and stored in vials containing a preservative solution of 5% glycerol (to prevent drying) in 70% ethanol.

For preparation of whole mounts the worms were removed from the preservative to 50% ethanol. The worms were then hydrated using a graded water–ethanol series. After hydration, the worms were colored with one or more of the various stains: Reynolds' double stain (Delafield's hematoxylin plus alum cochineal), alum cochineal, and Harris' hematoxylin. The worms were overstained and immediately destained. After dehydration, the specimens were cleared in deacidified beechwood creosote and mounted permanently in Piccolyte (Turtox).

Only the most completely relaxed specimens with clear taxonomic characters were used for identification and study. Adult individuals were used in making diagnoses and descriptions, sexual maturity being the criterion for adulthood. In this work, sexual maturity was determined by the presence of egg capsules or in individuals without egg capsules by attainment of a comparable body size and stage of development of the genital organs.

All measurements were made with the use of a filar micrometer and are given in millimeters. In indicating these measurements the mean is given, followed by the range in parentheses. The standard deviation (S), standard error ($S_{\bar{x}}$), and the interval estimate at the 95% level ($t_{0.05}S_{\bar{x}}$) follow the range. For convenience the alphabetical symbols SE and CL are established for the formal mathematical designations for standard error ($S_{\bar{x}}$) and confidence limits or interval estimate at the 95% level ($t_{0.05}S_{\bar{x}}$), respectively. The number of measurements used in the calculations appears in parentheses before these data. Measurements of curved structures were across the lines sub-

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tending the greatest arcs described by those structures.

In the measurements to follow, length—of the body, its appendages and most internal organs—refers to the distance along the anteroposterior axis except where otherwise noted. Width refers to a measurement made at right angles to the length, i.e., along the dextrosinistral axis. The lengths of cirri, accessory pieces, genital ducts, anchors, hooks, and spines are along the longest axis of those structures regardless of orientation.

Clamps, because of their differing shapes and variable orientation in relation to the anteroposterior axis of the body, present special problems. In these structures, the length is regarded as the greatest dimension of the sclerotized framework. Except in the cases of open, sucker-like clamps, e.g., as in Diclidophoridae, measurements are usually taken of the anterior or posterior valve *en face*. In most instances, except where diameter is used for circular, open, sucker-like clamps, the length of the clamp is measured at right angles to the center piece (more commonly) or (in fewer cases) parallel to the center piece. In either case the width of a clamp is taken as the greatest dimension at right angles to the length.

Camera lucida drawings were used to facilitate identification and in preparation of the plates. Morphological terminology employed is that of Hargis (1958).

In the locality descriptions given below, the nearest town or prominent geographic feature and its province are given first, followed by the approximate site of capture of the host. The place of capture is followed by the depth and bottom type in parentheses. Distance is in statute miles.

RESULTS AND DISCUSSION

SUBORDER Polyopisthocotylea Odhner, 1912: During earlier studies (Dillon and Hargis, in press), we decided to utilize the superfamily arrangement of Yamaguti (1963) on a tentative basis until we had an opportunity to consider the systematics of these higher taxa in the light of the extensive series of polyopisthocotyleids present in our collections but as yet unstudied. This practice is continued.

Superfamily Diclidophoroidea Price, 1936, *diag. emend.*

DIAGNOSIS: Polyopisthocotylea. Prohaptor a pair of buccal suckers (except in Pterinotrematidae); buccal suckers rarely armed. Adult posthaptor developed anterior or lateral to larval posthaptoral region. Posthaptor variable in shape and position; usually with several clamps in two symmetrical rows. Number of clamps small and regular on late juveniles and adults; rarely exceeding four on one side, sometimes eight. Clamps not gastrocotyloid in nature. Late larval stages or adults not permanently fused.

TYPE FAMILY: Diclidophoridae Cerfontaine, 1895.

DISCUSSION: These emendations are made to facilitate inclusion of the population encompassed in the genus *Diplasiocotyle* Sandars, 1944 which is clearly different from the microcotyloidids with which Yamaguti (1963), as well as other workers, has allied it.

It will be noted that in contrast to the families hitherto included in Diclidophoridea, which never possess more than four clamps on one side of the posthaptor, with the usual arrangement being four pairs, our population has eight pairs. We believe this departure is justified because Microcotyloidea, the only other superfamily grouping with which our animals can be clearly related, generally possess "numerous" and/or varying numbers of clamps. In microcotylids the clamp number is somewhat "indeterminate," that is, clamps are added over a longer period of the individual's life, while in diclidophorids the final number is attained early, or is somewhat "determinate." The clamp structure of *Diplasiocotyle johnstoni* also appears more diclidophoroidid or discocotylid than microcotylid in its skeletal structure and arrangement. Furthermore, the clamps are pedunculated as are those of many diclidophoroidid species. It is noteworthy that *Diplasiocotyle* has armed buccal suckers, a condition which is common in Microcotylidae but uncommon in Diclidophoroidea. It is possible that the tendency toward a larger number of clamps, in addition to the one pair of clamps which seem microcotylid in nature and the armed buccal suckers, indicates that this species is phylogenetically related to both groups. However, since the spectrum of characteristics enumerated suggests that the genus is more diclidophoroidid than microcotyloidid we place the diplasiocotylids in the superfamily Diclidophoroidea.

DIPLASIOCOTYLIDAE NEW FAMILY

DIAGNOSIS: Diclidophoroidea. Elongate, flattened. Prohaptor a pair of buccal suckers, armed with sclerotized, tooth-like papillae. Posthaptor bilaterally symmetrical, with eight pairs of pedunculated, diclidophoroidid-type clamps. Last clamp pair smaller and similar to microcotyloidid clamps in structure in at least one species, *D. johnstoni* Sandars, 1944. Genital atrium armed. Cirrus armed. Testes numerous, intercrural, postovarian. Crura ramified and joined posteriorly, extending into posthaptor as blind pouch. Vaginae paired, ventrolateral. Egg with one terminal filament.

TYPE GENUS: *Diplasiocotyle* Sandars, 1944.

DISCUSSION: The reasons for this action are presented above under the superfamily discussion.

GENUS *Diplasiocotyle* Sandars, 1944

DIAGNOSIS: Diplasiocotylidae. Elongate, flattened dorsoventrally. Prohaptor a pair of buccal suckers placed laterally in walls of buccal funnel; armed with sclerotized, tooth-like papillae. Posthaptor symmetrical, with eight pairs of pedunculated clamps; last pair (eighth), considerably smaller than other seven pairs, situated dorsal to seventh pair (numbering in anteroposterior succession). Clamps greatly dissimilar in size. Clamps with same number of elements but slightly different arrangement; first seven pairs of clamps discocotylid in nature; last pair apparently microcotylid. Genital atrium consisting of two laterally placed reniform muscular pieces, each armed with spines; cirrus bulbous, armed. Testes postovarian, between intestinal crura. Esophagus short, slightly branched. Gut bifurcated; crura ramified medially and laterally, extending into posthaptor; posterior ends of crura fusing short distance out on posthaptor to continue for short distance as blind caecum. Vitellaria coextensive with intestine. Two ventrolateral vaginal pores present, situated short distance posterior to genital atrium. Eggs fusiform to spherical, with one terminal filament.

TYPE SPECIES: *Diplasiocotyle johnstoni* Sandars, 1944.

Diplasiocotyle johnstoni Sandars, 1944
(Figs. 1 to 8)

HOST: *Aldrichetta forsteri* (Cuv. and Val.), yellow-eyed mullet; family Mugilidae.

LOCATION: Gills.

LOCALITY: (1) Timaru, Canterbury Province, New Zealand; Timaru Harbor (½ fathom; near pilings), (2) Adelaide, South Australia; 25 miles E Adelaide, near Androssan (1–2 fathoms; sand/weed), (3) Port Kenney, South Australia; 9 miles NW Port Kenney (1–2 fathoms; sand/rock), (4) Port Kenney, South Australia; Baird Bay (1 fathom; mud), and (5) Bunbury, Western Australia; Leschenault Inlet (1 fathom; weed/mud).

PREVIOUSLY REPORTED HOST AND LOCALITIES: From the gills of *Aldrichetta forsteri* (= *Agonostomus f.*) collected at Mandurah and Bunbury, Australia (Sandars, 1944).

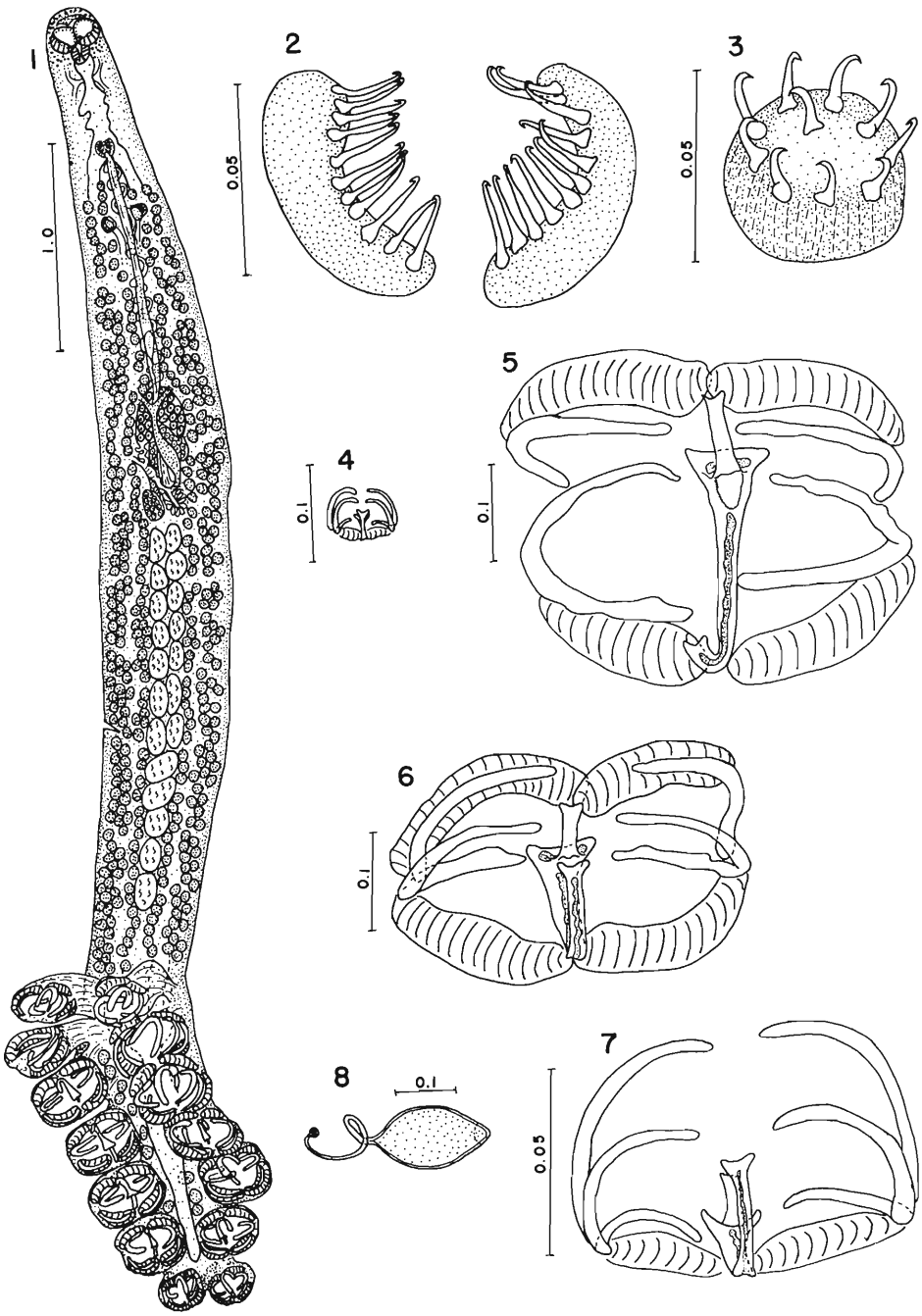
NUMBER STUDIED: 12 adults; 17 juveniles.

HOMOEOTYPE: U.S.N.M. Helm. Coll. No. 61090.

DESCRIPTION: Body elongate, (6) 6.69 (4.85–8.22), S = 1.429, SE = 0.5835, CL = 1.500 long by (6) 0.656 (0.433–0.796), S = 0.1412, SE = 0.0576, CL = 0.1481 wide. Cuticle thin and smooth. Glandular areas present on anterior extremity. Prohaptor a pair of buccal suckers, (6) 0.110 (0.097–0.127), S = 0.0119, SE = 0.0048, CL = 0.0123 long by (6) 0.111 (0.104–0.124), S = 0.0064, SE = 0.0026, CL = 0.0069 wide, placed ventrolaterally in walls of buccal funnel; rims of buccal suckers armed with single row of sclerotized, tooth-like papillae. Posthaptor a cotylophore, (6) 1.72 (1.31–2.09) long, armed with eight pairs of pedunculated clamps, with eighth pair of clamps situated dorsal to seventh pair (numbering in anteroposterior succession). Clamps dissimilar in size; anteriormost clamp pair (7) 0.318 (0.223–0.393), S = 0.0592, SE = 0.0224, CL = 0.0548 long by (7) 0.206 (0.128–0.265), S = 0.0490, SE = 0.0185, CL = 0.0453 wide; middle clamps (8) 0.343 (0.293–0.425), S = 0.0424, SE = 0.0150, CL = 0.0355 long by (8) 0.223 (0.183–0.293), S = 0.0332, SE =

→

Figs. 1. Whole mount, ventral view; 2. Genital atrium; 3. Cirrus; 4. Right clamp of the eighth pair (numbering in anteroposterior succession), ventral view. Drawn to same scale as Figs. 5–6; 5. Right clamp of the second pair (numbering in anteroposterior succession), ventral view; 6. Right clamp of the fourth pair (numbering in anteroposterior succession), ventral view; 7. Right clamp of the eighth pair (numbering in anteroposterior succession), ventral view; 8. Egg.



0.0117, CL = 0.0277 wide; posterior clamps (seventh pair) (8) 0.201 (0.167–0.291), S = 0.0388, SE = 0.0137, CL = 0.0342 long by (8) 0.147 (0.132–0.159), S = 0.0100, SE = 0.0035, CL = 0.0083 wide; eighth clamp pair (situated dorsal to seventh pair) (8) 0.081 (0.073–0.092), S = 0.0045, SE = 0.0016, CL = 0.0038 long by (8) 0.061 (0.055–0.070), S = 0.0045, SE = 0.0016, CL = 0.0038 wide. Clamps of first seven pairs heavily muscularized; clamps occurring (in mounted specimens) in open position, with proximal portion of center sclerite usually shorter than distal portion; sclerite shape and arrangement diclidophoroidid in nature. Clamps of posteriormost pair not heavily muscularized; appearing (in mounted specimens) in closed position, with proximal portion of center sclerite usually longer than distal portion; sclerite shape and arrangement microcotyloidid. Anchors absent in adults.

Mouth ventral, subterminal. Pharynx (6) 0.095 (0.080–0.111) long by (6) 0.090 (0.081–0.100) wide; esophagus relatively short, slightly branched. Gut bifurcating at level of genital atrium; crura ramified medially and laterally, extending into posthaptor; posterior ends of crura fusing short distance out on posthaptor to continue for short distance as a blind caecum.

Testes postovarian, 11–17 in number, located between intestinal crura; vas deferens extending anteriorly in midline to genital atrium. Genital atrium consisting of two (2) laterally placed reniform, muscular pads, each armed with 10–13 spines; atrial spines (8) 0.026 (0.023–0.031), S = 0.0032, SE = 0.0011, CL = 0.0026 long. Cirrus bulbous, armed with 9–13 spines, (7) 0.018 (0.016–0.021) long; cirrus spines usually arranged in circle.

Ovary folded, pretesticular; oviduct extending posteriorly from mature end of ovary, fusing with genitointestinal canal. Ootype dorsal to vitelline reservoir; uterus extending anteriorly in midline to genital atrium. Genitointestinal canal passing medially from right crus. Vaginal openings ventrolateral, unarmed (6) 0.410 (0.284–0.517) from genital atrium. Seminal receptacle not observed. Vitellaria follicular, coextensive with intestine; transverse vitelloducts fusing medially to form Y-shaped vitelline reservoir. Eggs in utero fusiform to spherical, with filament at one end; eggs (4) 0.193 (0.180–0.200) long by (4) 0.108 (0.092–0.115) wide (measurements exclusive of filament). Brain situated posterodorsally to pharynx.

DISCUSSION: Sandars (1944) described *D. johnstoni* from the gills of *Aldrichetta forsteri* from Western Australia. Included with her descriptions and figures of the adult morphology are descriptions and figures of the free-swimming larva (onchomiracidium) and the post-onchomiracidial stages. The above redescription is given because the original figures and description of the adult morphology were incomplete.

This study establishes new locality records for this species.

SUMMARY

Two separate populations of *Diplasiocotyle johnstoni* Sandars, 1944 from new localities in Australia and New Zealand were examined. Because earlier descriptions were not complete and we wished to correctly evaluate our populations, a redescription has been given.

The genus *Diplasiocotyle* Sandars, 1944 has been shown to have many characteristics in common with other species of Diclidophoroidea Price, 1936. As a result the genus has been removed from Microcotyloidea Unnithan, 1957 and placed, as the type genus of the new family Diplasiocotylidae, in Diclidophoroidea Price, 1936.

New locality records for this species are also established.

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Biacetabulum biloculoides n. sp. (Cestoidea : Caryophyllaeidae) from *Catostomus commersoni* (Lacépède) in North America[1]

JOHN S. MACKIEWICZ[2] AND ROBERT C. MCCRAE[3]

A new species of monozoic cestode found in *Catostomus commersoni* (Lacépède) in Colorado by McCrae (1960) and Central New York by Mackiewicz (1960) is described in this paper.

MATERIALS AND METHODS

A total of 733 white suckers, *C. commersoni* (Catostomidae), was examined. Localities and dates as well as techniques employed are similar to those reported in an earlier paper (Mackiewicz and McCrae, 1962).

Measurements are based on unflattened whole mounts of worms killed in hot fixative. Approximately 138 worms were observed, of which 40 gravid and 50 immature individuals were measured; 13 were sectioned. The diagnosis is based on Colorado and New York specimens. Measurements in mm unless otherwise indicated.

Biacetabulum biloculoides n. sp. (Figs. 1–15)

SYNONYMY: *Biacetabulum biloculoides* McCrae, 1961 [nomen nudum].

SPECIFIC DIAGNOSIS: (N = the sample observed or measured.) Gravid worms (N = 39) 3.7 to 11 long by 0.4 to 1.0 wide at the male gonopore. Immature worms (N = 50) 0.9 to 3.7 long. Scolex well defined, bulbous, with one pair of indistinct bothria. Neck long and narrow. Outer longitudinal muscles absent. Inner longitudinal muscles well developed. Testes numbering from 50 to 90, with a maximum diameter of 0.8 to 0.18 and not extending beyond first vitellarium. Cirrus pouch ovid, 0.14 to 0.24 in diameter, eversible. External seminal vesicle and seminal receptacle present. Vitellaria irregularly shaped, 0.08 to 0.17 in diameter, chiefly in two lateral rows but with numerous follicles dorsal and ventral to testes. Pre- and postovarian vitelline fields not connected. Ovary of compact lobes shaped like letter H; arms 0.2 to 0.5 long, connected by a thick commissure. Uterine glands present on pre- and postovarian uterine coils. Excretory canals number 8 to 12 in body region. Eggs operculate, shell smooth; size from hosts in Colorado as measured in utero (N = 35) 50 to 55 μ long by 27 to 30 μ wide; from hosts in New York as measured free in water (N = 50), 10 each from 5 worms) 57 to 72 μ long (mean = 64) by 35 μ wide. Unembryonated when laid (Fig. 11).

HABITATS: Small intestines and intestinal swelling ("stomach"); with scolex only in shallow pit.

LIFE CYCLE: Unknown.

HOLOTYPE AND PARATYPE: U.S.N.M. Helm. Coll. Nos. 39441, whole mounts from *C. commersoni* from Horsetooth Reservoir, Larimer Co., Colorado. Other specimens include U.S. N.M. Helm. Coll. Nos. 39282, 39283, and 39284 (17 slides from New York).

ICONOGRAPHY: Van Cleave, H. J. and J. F. Mueller (1934) plate 33, fig. 1. Meyer (1958) plate III, figs. 26, 31. Hugghins (1959) fig. 19 (photograph), the three smallest of the four pictured (the largest worm is *Glaridacris catostomi* Cooper).

HOSTS AND KNOWN DISTRIBUTION: *C. commersoni* (Lacépède): COLORADO: Boulder Co., Boulder Creek; Larimer Co., Horsetooth Reservoir and Cache la Poudre River. IOWA: Clay Co., Trumbull Lake (Meyer, 1958, det. as *G. catostomi*). NEW YORK: Oswego Co., Oneida Lake (Van Cleave and Mueller, 1934, det. as *G. catostomi*); Herkimer Co., Little Moose Lake; Tompkins Co., Fall Creek at Beebe Lake, Cornell University Campus. NORTH CAROLINA: Davidson Co., Tributary of Yadkin R. near Lexington; Lincoln Co., Tributary of Catawba R. near Lowesville. OHIO: Wayne Co., Salt Creek (Collection of Dr. R. V. Bangham). PENNSYLVANIA: Blair Co., Clover Creek; Crawford Co., Conneaut Creek. SOUTH CAROLINA: Cherokee Co., Little Thicketty Creek near Goffnery. SOUTH DAKOTA: Clark

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[1] Modified from doctoral dissertations at Cornell University, Ithaca, N.Y. (J.S.M.) and Colorado State University, Fort Collins, Colo. (R.C.M.).

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The senior author thanks Dr. Edward Raney for permission to examine hosts in the Cornell Fish Collection and Dr. R. Bangham and numerous workers for loan of their collections.

Co., Willow Lake (Hugghins, 1958, det. as *G. catostomi*).

MORPHOLOGY: The scolex (Fig. 1) bears two shallow depressions that lack the muscle septum (Fig. 14) and musculature characteristic of acetabular suckers. These transient depressions are somewhat like the median ones of *G. catostomi*; *in situ* (Fig. 10) they appear well developed. Although they may be observed on live and on some preserved specimens they are virtually impossible to detect on mounted preparations. These loculi are formed by the contraction of the cuticular and inner longitudinal muscles that insert in the region of the median pair of depressions (Fig. 9). Occasionally there are two smaller depressions each side of the larger median one (Fig. 1). Eight muscle fasciculi are present in the scolex and neck (Fig. 8). The latter structure is especially prominent on contracted specimens (Fig. 12b).

The reproductive and excretory systems are similar to those of *B. infrequens* Hunter (Figs. 5–7). Parasites (N = 7) from fish in Colorado had from 57 to 74 testes while those from New York (N = 13) had 50–90 with a mean of 61.

SYSTEMATIC POSITION: On the basis of the single gonopore, the coiling of the uterus anterior to the cirrus, and a pair of indistinct bothria on the scolex, this species is placed in the genus *Biacetabulum* Hunter, 1927. This species is the 5th in the genus to be described from North America.

Unlike *B. infrequens* Hunter, 1927, *B. giganteum* Hunter, 1927 and *B. macrocephalum* McCrae, 1962, the new species lacks a pair of well-developed, strongly muscled acetabula. It thus resembles *B. meridianum* Hunter, 1927, which, according to Hunter (1929, 1930), possesses suckers only weakly acetabular.

From this last species *B. biloculoides* differs in (1) the absence of acetabular suckers on a smaller scolex, (2) the presence of uterine glands on the preovarian portion of the uterus (in *B. meridianum* they are absent from this portion of the uterus), (3) the shorter length and different shape of the ovary, (4) the greater longitudinal extent of the uterus, and (5) the greater number of postovarian vitelline follicles.

If one accepts the generic status of *B. appendiculatum* (Mrázek) of Europe and *B. tandi* Johnston and Muirhead of Australia, then the new species can be readily distinguished from them. The absence of a well-developed neck, bulbous scolex, and the consistently smaller

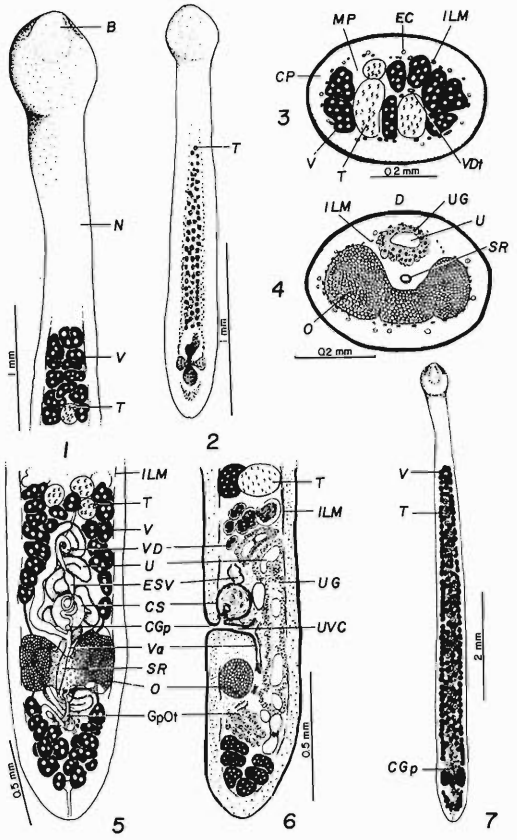

Plate 1, Figs. 1–7. *Biacetabulum biloculoides* n. sp. 1, Scolex. 2, Immature individual. 3, Section through testis. 4, Section through ovarian commissure. 5, Reproductive systems. 6, Mid-sagittal section of reproductive systems. 7, Gravid worm.

Abbreviations: A—acetabulum; AEC—ascending excretory canal; B—bothrium; CGp—common gonopore; CML—circular muscle layer; CP—cortical parenchyma; CS—cirrus sac; D—dorsal; E—epithelium; EC—excretory canal; ESV—external seminal vesicle; GpOT—Glandular portion of ootype; ILM—inner longitudinal muscles; LML—longitudinal muscle layer; MP—medulary parenchyma; MS—muscle septum; N—neck; O—ovary; Op—operculum; Ov—ovum; S—scolex; SE—subepithelium; SR—seminal receptacle; T—testis; U—uterus; UG—uterine glands; UVC—utero-vaginal canal; V—vitellarium; Va—vagina; VD—vas deferens; VDT—vitelline duct.

body size readily differentiates these two problematic species from *B. biloculoides*.

HOST–PARASITE RELATIONSHIPS: Both immature and gravid specimens occurred with the scolex buried in a small pit-like structure, (Figs. 13, 15) unlike that associated with any other species of *Biacetabulum*. These structures do not perforate the intestinal wall but appear as small, soft cysts on the serosal surface. A definite pit wall of fibrous tissue is absent. Sections of a pit containing five worms showed that some scolexes had a terminal introvert-like structure or were fan-shaped—two variations not found on live or preserved material (Fig. 15). Pits up to 3 mm in diameter and containing from one to six worms were most common in the "stomach." The mean number of worms per fish (N = 24) from New York was 5.8 (range 1–37); 50 percent of the infections involved one or two worms, however, one fish from North Carolina contained 46 individuals.

In New York gravid worms were found during July, August, October, and November, the only months collections were made. The only possible instance of host specificity occurred at Little Moose Lake (N.Y.) where three of 13 *C. commersoni* were infected but 27 *C. catostomus* (Forster) were not.

DISCUSSION

Restudy of slides OL 588-1 through 6, 594-1 and 601 of the Oneida Lake Fish Parasite Survey (Van Cleave and Mueller, 1934) by the senior author reveals the presence of whole or of parts of 18 specimens of *B. biloculoides* previously determined as *G. catostomi*. Similarly, the *G. catostomi* records of Hugghins (1958) and Meyer (1958) are redetermined as *B. biloculoides* on the basis of a restudy of original material.

Except for the scolex this species resembles the North American species of *Biacetabulum*. Study of the type specimens of the latter, however, reaffirms the presence of acetabular suckers which are absent on the new species. Because the systematic value of the scolex in the Caryophyllidae has not been satisfactorily appraised, this new species it now assigned to the genus *Biacetabulum*. Until more is known of *Biacetabulum* it seems best at this time not to erect a new genus or introduce a subgenus to contain *B. biloculoides*.

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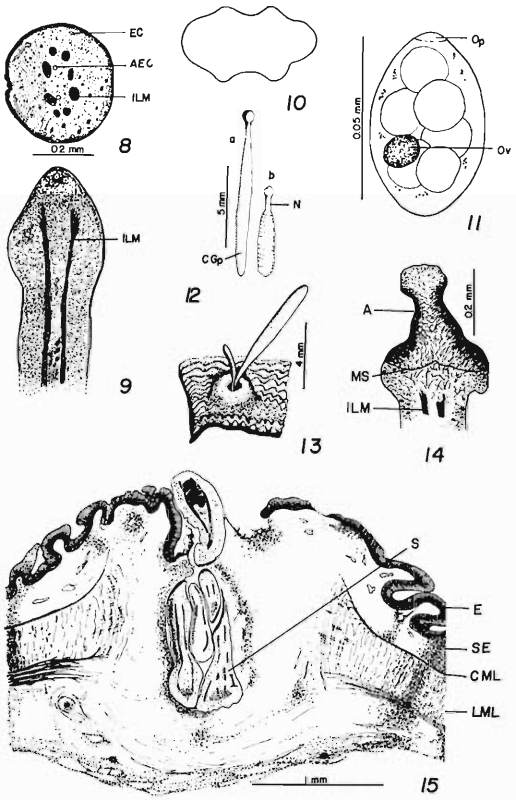

Plate 2, Figs. 8–15. *Biacetabulum biloculoides* n. sp. 8, Scolex, cross section. 9, Scolex, sagittal section. 10, Cross section outline of an *in situ* scolex showing maximum bothria development. 11, Egg. 12, Gravid worms illustrating the variation when (a) expanded, (b) contracted. 13, Cestodes *in situ*. 14, Scolex sagittal section of *Biacetabulum* sp. illustrating the muscle septum of the acetabular sucker. 15, Section of five worms *in situ*.

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Meloidogyne graminicola (Heteroderidae) a New Species of Root-knot Nematode from Grass

A. MORGAN GOLDEN AND WRAY BIRCHFIELD[1]

Late in 1963 a root-knot nematode was found in large numbers in the roots of barnyard grass, *Echinochloa colonum* L., growing in a field at Baton Rouge, Louisiana. Subsequent greenhouse and laboratory studies on host–parasite relationships by Birchfield (1964 and 1965) revealed, among other things, that this nematode readily attacked several grasses, including oats, but did not develop on a number of other common plants, including corn, cotton, pepper, tomato, and watermelon. Parallel morphological studies of specimens showed marked differences from other known root-knot forms; and this nematode is described herein as a new *Meloidogyne* species.

Meloidogyne graminicola, n. sp.

MEASUREMENTS: 20 females (Figs. 1 and 3) —Length 0.573 mm (0.445–0.765); width 0.419 mm (0.275–0.520); a = 1.37 (1.2–1.8); stylet 11.08 microns (10.64–11.20).

HOLOTYPE (female): Length 0.634 mm; width 0.515 mm; stylet 11.20.

Body pearly white, globular to pear-shaped with relatively small neck situated anteriorly on median plane with vulva. Body cuticle annulated, often with fine irregular punctation visible on some specimens. Head not distinctly

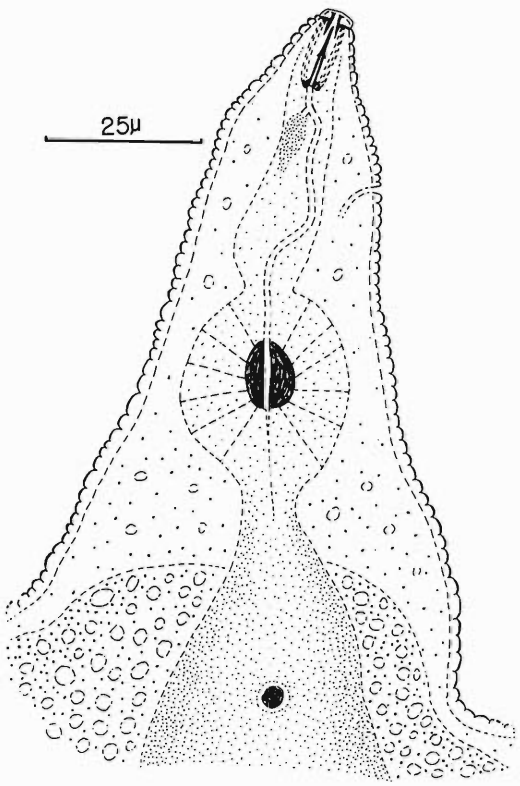

Fig. 1. Drawing of anterior portion of female of *M. graminicola*, n. sp.

[1] Nematologists, Nematology Investigations, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland and Baton Rouge, Louisiana, respectively.

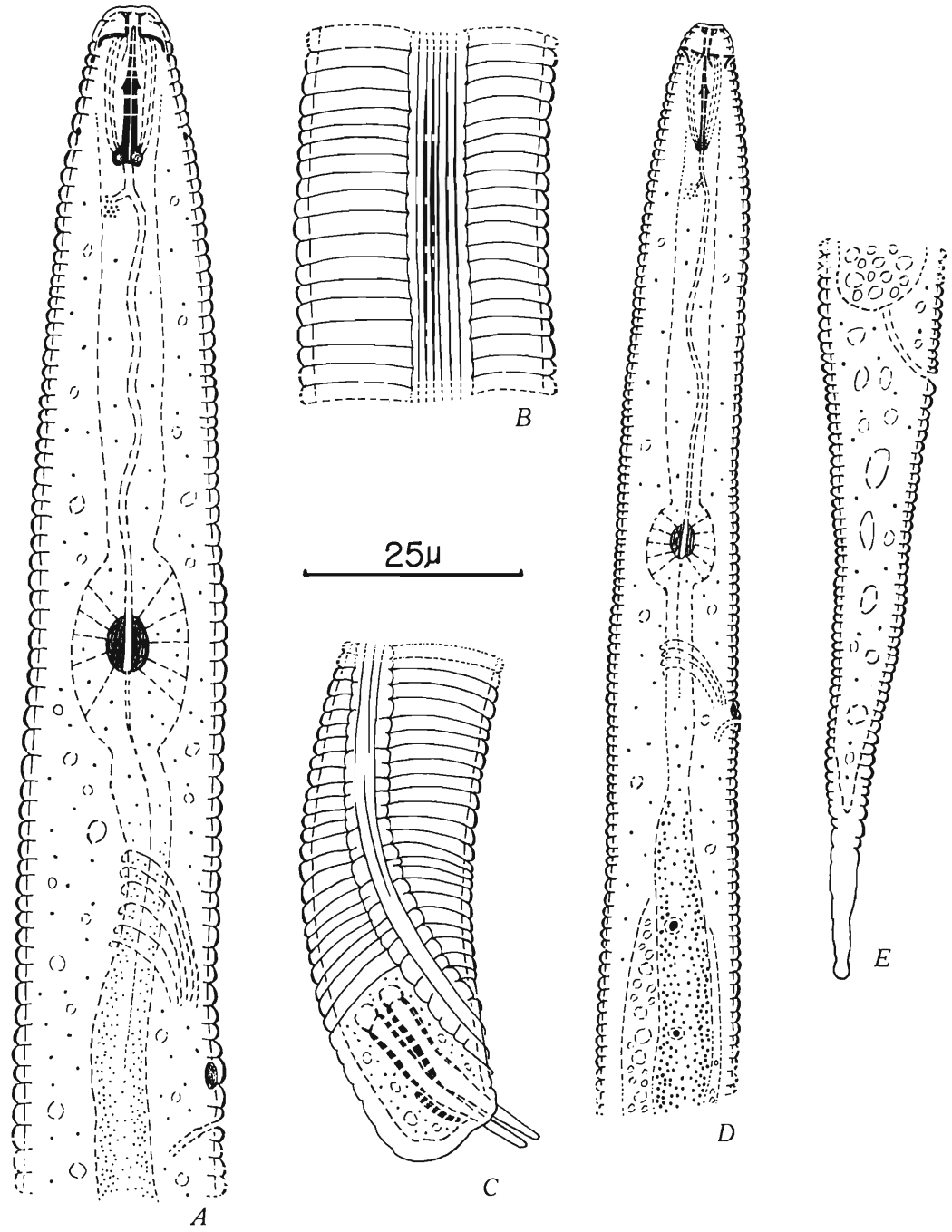

Fig. 2. Drawings of male and larva of *M. graminicola*, n. sp. A, B, and C—Anterior portion, lateral field and posterior portion of male. Dand E—Anterior and posterior portion of larva.

set off from neck and without annules. Cephalic framework present but not prominent. Cephalids not observed. Stylet small and delicate, with rounded knobs sloping posteriorly. Esophagus well developed with elongate, cylindrical procorpus and large, rounded metacorpus provided with heavily sclerotized valve. Three esophageal glands with a prominent nucleus each. Junction of esophagus and intestine obscure. Orifice of the dorsal esophageal gland 3.21 microns (2.80–3.92) posterior to base of stylet. Excretory pore very distinct, generally located about one and one-half stylet lengths or more from base of unprotruded stylet. Ovaries two, convoluted. Vulva and anus terminally located. Six large rectal glands with prominent nucleus in each. Perineal pattern prominent, somewhat egg-shaped, with distinct and characteristic striations as illustrated (Fig. 3). Eggs deposited in gelatinous matrix.

MEASUREMENTS: 20 males (Fig. 2A, B, C)—Length 1.222 mm (1.020–1.428); a = 117.4 (72.8–215.0); stylet 16.80 microns (16.24–17.36).

ALLOTYPE (male): Length 1.156 mm; stylet 16.80 microns; tail length 11.2 microns.

Body cylindroid, vermiform, tapering gradually at both ends. Body width 29.8 microns (24.0–34.7). Head not clearly offset from body, bearing a well-developed labial annule and a large postlabial annule without apparent annules. Cephalic framework prominent. Cuticular annulation very distinct, with annules approximately 2.2 microns wide in middle region of body. Lateral field 7.7 microns (6.2–9.5) wide, sometimes consisting of only four lines in small young specimens but often having about eight lines on large, older specimens at mid-body. The two outer lines generally crenate and the outer bands often areolated. Stylet stout, with rounded knobs appearing about as illustrated. Orifice of dorsal esophageal gland 3.30 microns (2.80–3.92) posterior to base of stylet.

Metacorpus elongate with well-developed, sclerotized valve. Length of esophagus (from anterior end to base of esophagus) 222.0 microns (196.0–250.0). Rather large and distinct nerve ring encircling isthmus just posterior to metacorpus. Cephalids located in anterior portion as illustrated. Hemizonid very distinct, located about two annules anterior to the excretory pore. Hemizonion indistinct but apparently situated a few annules posterior to excretory pore. Spicules arcuate, 28.14 microns (27.44–29.12) long. Testis 1, occasionally reflexed a short distance from its anterior end. Gubernaculum 6.06 microns (5.60–6.72) in length. Tail length 11.14 microns (6.16–15.12). Phasmids small, postanal, located about midway of tail.

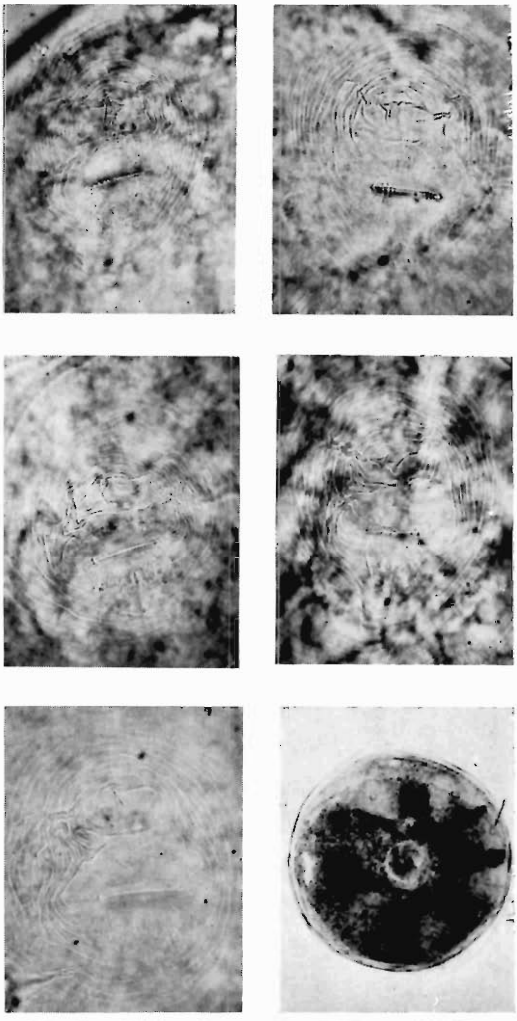

Fig. 3. Photomicrographs of *M. graminicola*, n. sp. Five perineal patterns and, lower right, posterior portion showing rectal glands (note large nuclei, one of which is at arrow).

MEASUREMENTS: 20 second stage larvae (Figs. 2D, E)—Length 0.441 mm (0.415–

0.484); a = 24.8 (22.3–27.3); b = 3.2 (2.9–4.0); c = 6.2 (5.5–6.7); stylet 11.38 microns (11.20–12.32).

Body cylindrical vermiform, tapering markedly toward posterior end. Average body width 17.8 microns. Head with slight cephalic framework, not offset from body and bearing three faint postlabial annules. Cuticular annulation distinct but fine, each annule measuring about one micron in width. Lateral field quite wide, being ¼ to ⅓ of body width and consisting of four lines on most of the body length. Stylet small and delicate with rounded knobs sloping posteriorly. Orifice of dorsal esophageal gland 2.83 microns (2.80–3.36) posterior to base of stylet. Metacorpus spherical with prominent sclerotized valve. Length of esophagus (from anterior to base of esophagus) 126 microns (112–140). Hemizonid located anterior and adjacent to well-defined excretory pore. Tail 70.9 microns (67.0–76.0) long. Hyaline tail terminal 17.9 microns (14.0–21.2) in length, usually without regular and distinct annulation. Caudal ratio A[1] 4.6 (4.0–5.0). Terminus rounded, often appearing slightly clavate as illustrated.

MEASUREMENTS: 20 eggs—Length 98.7 microns (95.6–101.4); width 44.1 microns (42.0–47.2); length/width ratio = 2.2. Eggshell hyaline, without visible markings.

DIAGNOSIS: *Meloidogyne* differing from the most closely related described species (*M. hapla* Chitwood, 1949) especially by: (1) Distinctive and characteristic perineal pattern as illustrated in Fig. 3; (2) Short, delicate female stylet (about 11 microns as compared to approximately 13 for *M. hapla*); (3) Outlet of dorsal esophageal gland closer (3.21 microns) to base of stylet than in *M. hapla* (5–6 microns); (4) Males with crenate and usually areolated lateral field (on the two outer bands) and often with about eight lines as compared with four lines in the lateral field of *M. hapla*.

HOLOTYPE—Female: Collected by Wray Birchfield on September 17, 1964 at Baton Rouge, Louisiana. Slide T-56t, United States Department of Agriculture Nematode Collection, Beltsville, Maryland.

ALLOTYPE—Male: Same data as holotype. Slide T-57t, United States Department of Agriculture Nematode Collection, Beltsville, Maryland.

PARATYPES: Males, females, and larvae: United States Department of Agriculture Nematode Collection, Beltsville, Maryland; and California Nematode Survey Collection, Davis, California.

TYPE HABITAT: Host and locality; Soil and roots of *Echinocloa colonum* L. in a field at Baton Rouge, Louisiana.

[1] Calculated by dividing the length of the hyaline portion of the tail by its width beginning anteriorly (Golden and Cobb, 1963).

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Acrobeloides uberrinus n. sp., with a Note on Morphologic Variation within Soil and Bacteria-Reared Populations

R. V. ANDERSON[1]

Males and females of a new species of *Acrobeloides* (herein described) were obtained in relatively large numbers from a sample of field soil. The description is based on studies of over 100 fixed and living nemas from soil. Measurements were made of adults in permanent glycerine mounts. Temporary water mounts of recently heat-relaxed or living nemas were helpful in clarifying details of structure.

Within the soil population, certain specimens varied in size and shape of the cephalic and labial probolae, and tail termini. Thorne (1937, 1961) has reported similar aberrants within species of the Acrobelinae; apparently due to nutrition. In order to evaluate the nature and extent of variation within *A. uberrinus*, selected specimens representing typical and variant forms were reared under conditions favorable for maximum reproduction and growth for comparison with nemas from soil. For this purpose, 20 colonies established from single immatures were grown for about a month at 30–34 C in petri plates containing potato–dextrose agar and an unidentified yellow bacterium isolated from a soil–water suspension. Some populations reared on the bacterium were added to pots of autoclaved field soil maintained fallow in the laboratory for 2 months.

Acrobeloides uberrinus n. sp. (Fig. 1)

MEASUREMENTS: Female (10): L = 0.44 mm; a = 17 (15–19); b = 3.7 (3.5–3.9); c = 16 (15–19); V = $^{12}65\%^{15}$ (64–67); egg = 47–52 μ × 20–24 μ.

MALE (10): L = 0.43 mm; a = 19 (18–20); b = 3.9 (3.6–4.1); c = 12.6 (11.3–13.9); T = 49% (46–53); gubernaculum = 11 μ; spicules = 22 μ.

DESCRIPTION: Body cylindroid, cuticle marked by annulations 2 μ wide throughout most of length. Lateral field about one-fourth body diameter, marked by five incisures. Incisures beginning as three near middle of corpus, outer incisures divide at deirid and continue as five to about level of rectum. Outer incisures crenate, areolated. Lateral field continues beyond phasmid to tail terminus, marked by two to three incisures. Cephalic region acrobeloid. Lips (cephalic probolae) six, each bearing a setiform axillary projection about as high as cephalic axil depth; continuous with cephalic axils between subventral lips, and the right lateral–dorsal and left lateral–dorsal lips. Subdorsal and subventral lips each with two papillae, lateral lips each with a marginal slit-like amphid aperture and a papilla at lip apex. Probolae (labial) ovoid at base; inner walls extending from base of mouth cavity, outer walls from top level of buccal capsule. Labial probolae tapering rapidly to spikes about as long as thickened basal portion; curved slightly outward. Cheilorhabdions cylindrical, thick, forming a triangle about mouth. Prorhabdions sclerotized, slightly thickened at apices. Mesorhabdions and telorhabdions thin, lightly refractive. Dorsal metarhabdion a large pyriform tooth with apex extending into triquetrous lumen; opposing metarhabdions sclerotized concave plates. Corpus fusiform, the triquetrous lumen expanding rapidly from base of stoma; narrowing gradually toward base of corpus. Apices of lumen arms tubular to juncture of corpus with isthmus. Isthmus as long or slightly longer than neck width. Nerve ring encircling isthmus near middle. Excretory system visible in living specimens. Coiled excretory duct leads to a large ventral gland cell (renette) at base of isthmus from which paired lateral canals, usually crossing at base of esophagus to laterodorsal positions, extend posteriorly about one body width beyond basal bulb. Excretory pore opposite nerve ring; hemizonid immediately below, about two annules long. Deirids at level of basal bulb, often not opposite. Cardia conoid, surrounded by intestinal cells. Inner intestinal walls often protruding into lumen, cell nuclei large. Rectum about as long as anal body diameter, surrounded by three rectal glands near intestino-rectal valve.

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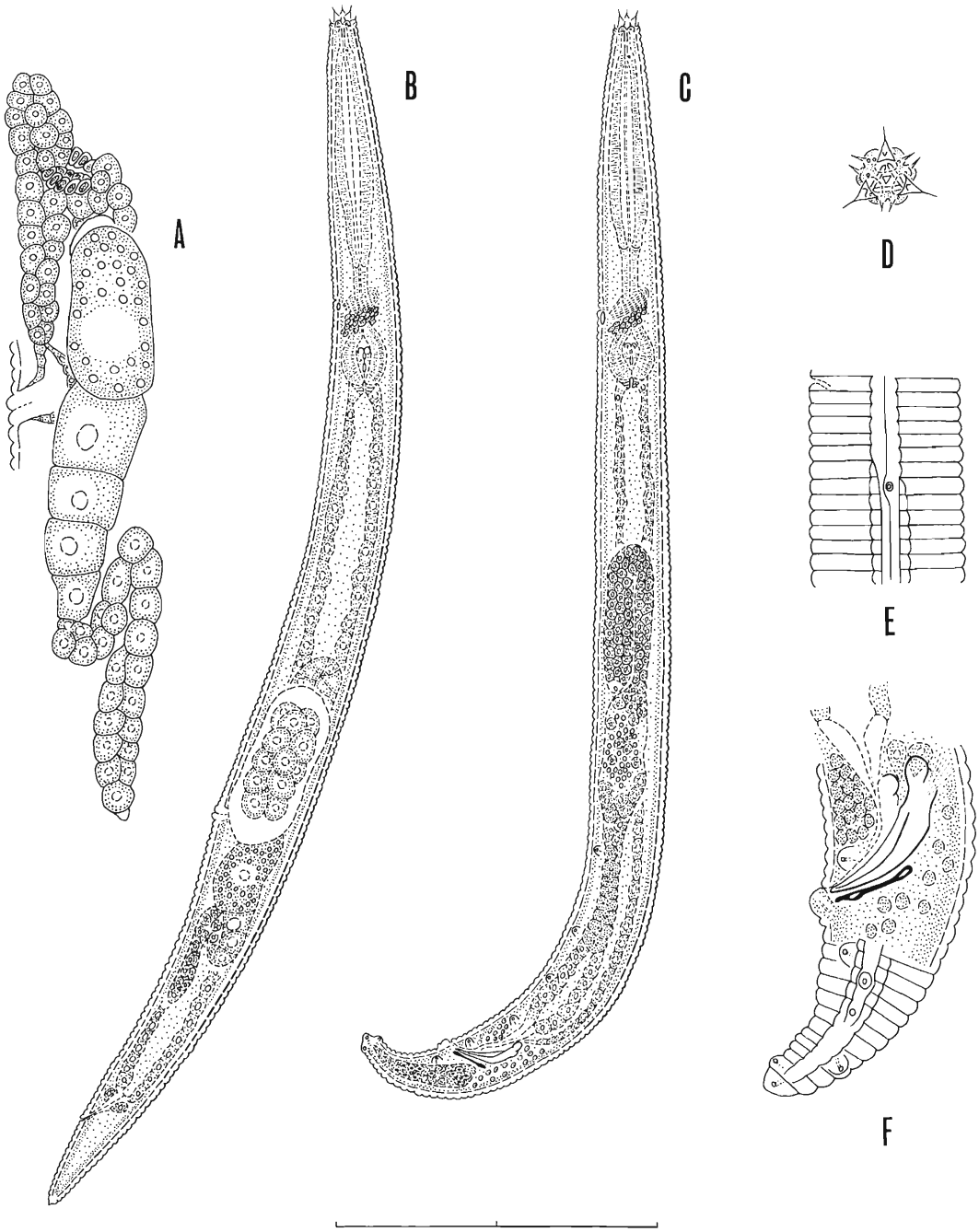

Fig. 1. *Acrobeloides uberrinus* n. sp. Scale: 100 μ ($\times$ 1,300). A. Female reproductive system ($\times$ 3,000). B. Female, adult. C. Male, adult. D. Face view. ($\times$ 3,000). E. Lateral field at base of neck ($\times$ 3,000). F. Male tail ($\times$ 3,000).

Vulval lips slightly protruberant. Oviduct entering dorsal side of uterus, its adjoining walls compressed and cells containing large nuclei. Oogonia arranged in double row, becoming tandem toward base of ovary. No postuterine branch. Never more than one egg observed within the uterus; found in all stages of cleavage and in gastrula stage, but not observed embryonated. Tail conoid, terminus rounded, sometimes mucronate. Anus 12–14 annules from tail terminus. Phasmids near middle of tail. Testis reflexed at anterior third, spermatogonia in multiple rows. Maturation zone expanded, containing numerous globules and free spermatids. Sperms in tandem and compressed in narrow seminal vesicle. Vas deferens expanded, cells large, nucleated. Spicules with ventral arcuate ridge extending from distal apex to manubrium. Gubernaculum straight, slightly expanded near rounded apicies; about half spicule length. Preanal supplements five pairs, spaced ventrally along lateral field beginning at proximal end of seminal vesicle and ending near anus. Tail ventrally arcuate with five pairs of genital papillae: one pair lateroventral near anterior portion of tail, one in lateral field at center of tail, one laterodorsal at tail terminus, one laterolateral, and one pair ventroterminal. Phasmids about two annules posterior to lateral papillae, generally not opposite.

DIAGNOSIS: (Acrobelinae): Resembles closely *A. tricornis* Thorne, 1925, from which it differs in tail length and number of incisures. The tail of *A. uberrinus* being about twice anal body diameter and has five incisures. The tail of *A. tricornis* is slightly longer than anal body diameter and has two incisures.

TYPE LOCALITY AND HABITAT: Terrestrial; common inhabitant in Minnesota soils.

COTYPES: Slide *Acrobeloides* 3, 3a, 3b, 3c, 3d. Personal nematode collection.

VARIATION: Topomorphs accounted for less than 10% of the soil population. Most common were specimens with lips bearing setiform axillary points as high as the cephalic axil depth and probolae with inwardly curved terminal spikes longer than the ovoid thickened basal portion (Fig. 2B). In other specimens, the lips bore bluntly rounded to knobbed axillary points that were shorter than the cephalic axil depth (Fig. 2C, D, E). In these specimens the terminal probolae spikes were shorter than the basal portion and the apices ranged from bluntly rounded to tapered points. Sometimes one or two probolae were typical in size and shape. Tails varied from conoid to slightly convex–conoid with termini ranging from bluntly rounded (Fig. 2G) to conical (Fig. 2F), and often mucronate (Fig. 2H, J). In only one case were differences in internal structure noted. The ovary of one nematode, though normal in structure and development, was found oriented anterior to the vulva; outstretched (Fig. 2A).

Colonies of *A. uberrinus* reared on bacteria attained numbers as high as 1 million per plate within 28 days. Individuals were measured randomly and heads and tails of over 1,000 specimens examined for variation. No males were observed. As with nemas measured from the soil population, measurements of more than 10 did not alter the range of variability in dimensions.

DIMENSIONS: Female (10): L = 0.48 mm; a = 18(16–20); b = 3.8 (3.6–4.1); c = (13.5–17.9); V = $^{11}64\%^{15}$ (62–66).

Little differences were found between dimensions of soil and bacteria-reared individuals. Body lengths averaged 40 μ longer and the esophagi and tails were slightly longer when grown on bacteria. However, morphologic differences of the probolae were marked between individuals from soil and agar populations. Nematodes that were allowed to feed on bacteria were uniform in size and shape of the lips, labial probolae, and tails. In all cases, the lips were rounded (Fig. 2K), whereas the lips of nematodes obtained from soil always bore axillary setiform to knob-like protuberances. The termini of labial probolae were short, pointed, and curved outward more conspicuously than variants within the soil populations. Tails also generally were longer and uniformly conoid (Fig. 2L). In addition, the intestinal cells were larger in nematodes that had fed on bacteria and their lumens contained numerous bacteria. Nematodes reared on mixed cultures of microorganisms were found to vary somewhat in curvature and length of the labial probolae termini, but the lips always remained rounded. When bacteria-reared nematodes were returned to autoclaved field soil, all reverted to the typical form (Fig. 1B). No males or appreciable morphologic variation were observed within these populations.

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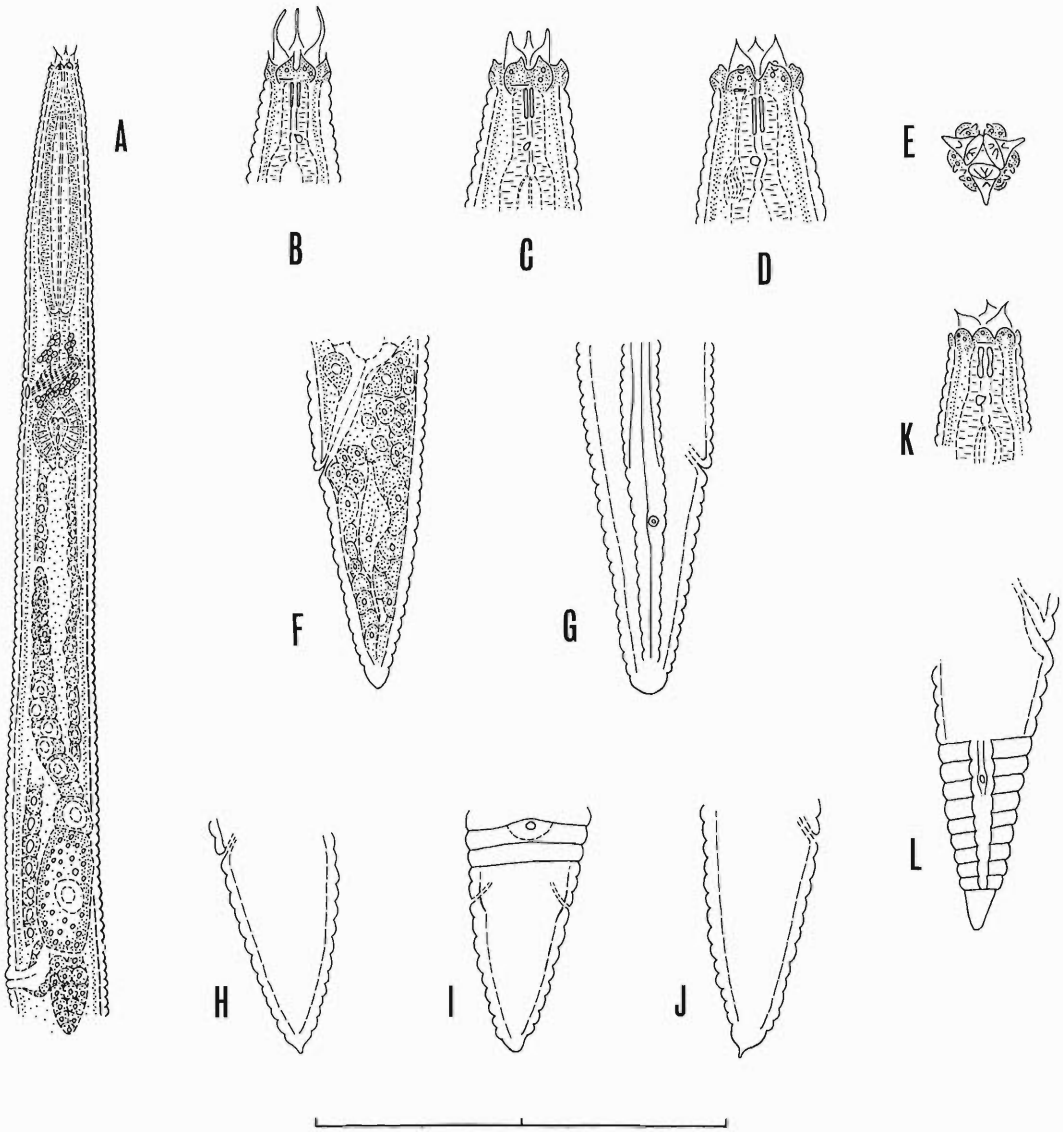


Fig. 2. Morphologic variation within *Acrobeloides uberrinus* n. sp. Scale 50 μ (× 3,000). Soil population: A. Female, note anterior position of ovary (× 1,300). B, C, D. Head views, note differences in size and shape of labial and cephalic probolae. E. Face view. F, G, H, I, J. Note differences in tail termini. Nemas reared on a bacterium: K. Head view, note round lips and short outwardly curved probolae termini. L. Tail.

Coccidiosis of the Lesser Scaup Duck, *Aythya affinis* (Eyton, 1838) with a Description of a New Species, *Eimeria aythyae*[1]

MARION M. FARR

In April, 1956 a number of sick and dying lesser scaup ducks, *Aythya affinis* (= *Nyroca affinis*) was observed at the Upper Mississippi National Wildlife refuge.[2] Several of the seriously affected live birds were collected by the refuge manager and sent for examination to the Patuxent Research Laboratory of the U.S. Fish and Wildlife Service. When found to be heavily infected with coccidia, these ducks, all greatly emaciated, were submitted to the Beltsville Parasitological Laboratory for determination of the species involved. The findings, which have already been summarized briefly (Farr, 1959), are here reported in detail.

Another die-off occurred in April, 1964, at Rock Creek Lake, Jasper County, Iowa. About 15,000 birds, most of them scaup, were on the lake, and of these approximately 300 lesser scaup were dead. Several of the dead scaup were packed in ice and shipped to the Patuxent Research Laboratory, where they were examined for fowl cholera and for *Salmonella* infection with negative results. These birds were not emaciated. Because of postmortem changes it was not possible to detect any gross lesions in the digestive tract, but great numbers of oocysts were found in the small intestines. The intestinal contents were submitted to the Beltsville Parasitological Laboratory for identification of the species of coccidia involved.

The most obvious abnormality in the ducks from the Upper Mississippi Refuge was a ballooning of the anterior third of the small intestine. Upon opening the seriously affected intestines, they were found to be distended with a soft cheesy material, in which were masses of oocysts belonging to a hitherto undescribed species of *Eimeria* and to a species of *Tyzzeria*.

A portion of the anterior small intestine from one of these ducks was fixed in Bouin's fluid, embedded in paraffin, and then sectioned at 7 microns. In sections stained with either Delafield's or Heidenhain's hematoxylin it was seen that the lumen of the intestine was filled with a mass of detached cells derived from the epithelium and tunica propria of the villi. It was not possible to determine whether this was a manifestation of coccidiosis or a result of postmortem changes. An occasional macrogametocyte was present in the detritus. There was hypertrophy of the interglandular tissue, which contained pockets of macrogametocytes and collapsed oocysts resembling the undescribed species of *Eimeria*. In addition, there were in some glands a few small macrogametocytes which, because of their early stage of development, could not be assigned to either species. Neither schizonts, merozoites, nor microgametocytes were seen.

Oocysts of *Tyzzeria* were not found in the intestinal contents of the lesser scaup ducks from Rock Creek Lake, Iowa. All oocysts seen resembled closely the *Eimeria* oocysts collected from the ducks at the Upper Mississippi Refuge.

Farr (1959) identified the *Tyzzeria* as *T. anseris* Nieschulz, 1947. It is now believed that the organism should be listed as *Tyzzeria* sp.

Tyzzeria sp. (Figs. 1, 2)

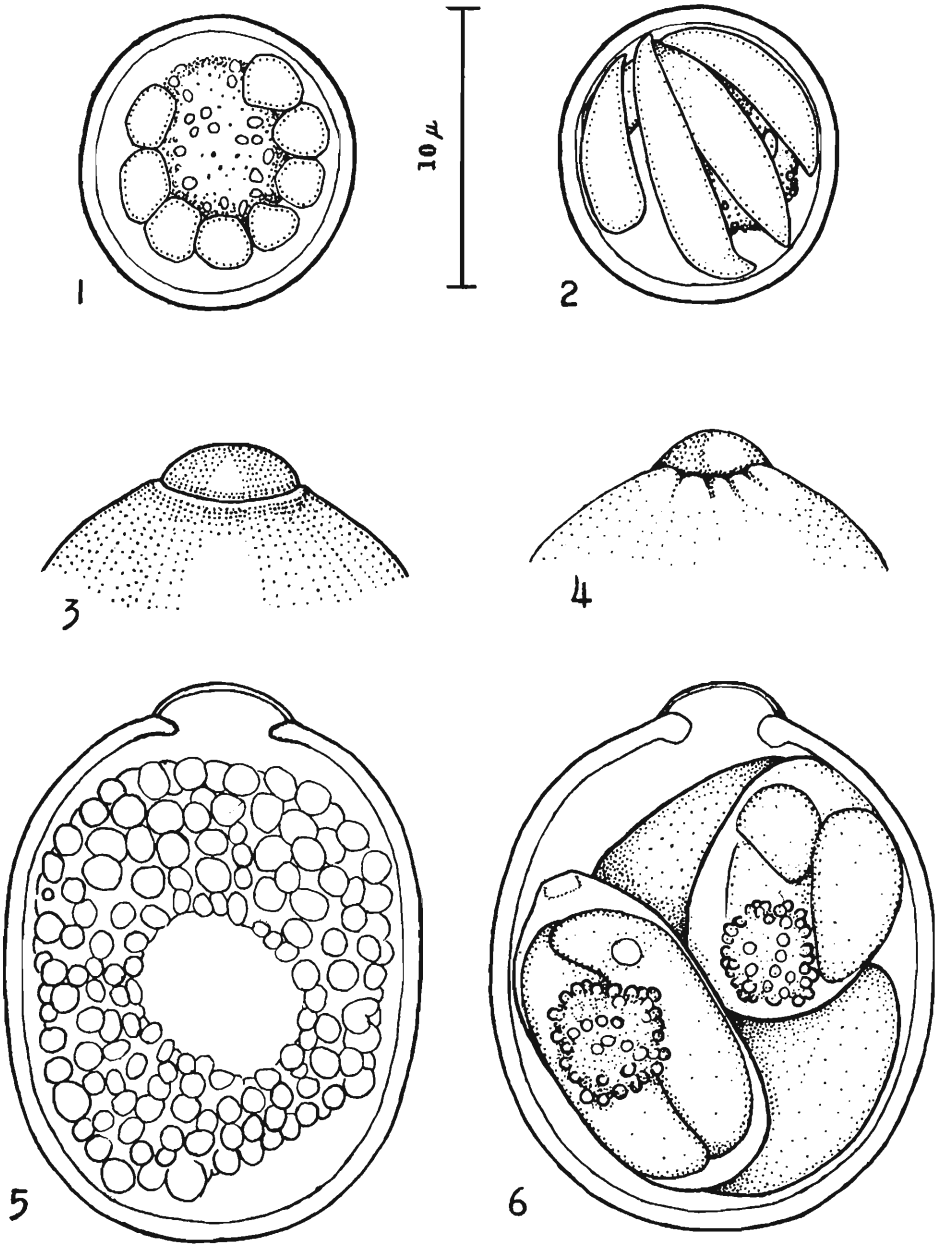
The oocysts measured 10.8–13.5 by 9.4–11.6 microns. They were subspherical to ellipsoidal in shape with smooth colorless walls without a micropyle. Each sporulated oocyst contained eight free sporozoites and a large compact residual body.

Four ducks (mallard crosses) were inoculated with a combination of the *Tyzzeria* and *Eimeria* oocysts from the scaups. The only evidence that these mallard crosses became infected was the discharge of a few unsporulated *Tyzzeria* oocysts on the 5th day after inoculation.

Three species of *Tyzzeria* have been reported from birds: *T. perniciosa* Allen, 1936 from the domestic duck, *Anas domesticus*; *T. alleni* Chakravarty and Basu, 1947 from the cotton teal, *Nettapus coromandelianus*; and *T. anseris* Nieschulz, 1947 from the domestic goose, a wild swan, and several species of wild geese. Klimeš (1963) considered that *Eimeria parvula*

[1] From the Beltsville Parasitological Laboratory, Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.

[2] This refuge is located in both Minnesota and Wisconsin. The exact location of the ducks in the refuge is unknown.



Tyzzeria sp.—Figs. 1–2: Fig. 1. End view of sporulated oocyst; Fig. 2. Side view of sporulated oocyst.

Eimeria aythyae n. sp.—Figs. 3–6: Figs. 3–4. Exterior view of anterior ends of two oocysts; Fig. 5. Unsporulated oocyst; Fig. 6. Sporulated oocyst.

Kotlán, 1933 from domestic geese, belongs to the genus *Tyzzeria* and that it is identical with *T. anseris* Nieschulz. The chief character, a very unreliable one, on which differentiation of the oocysts of these three species was originally based, is a small difference in size. There is, therefore, some question as to whether the species *T. alleni* and *T. anseris* are not synonyms of *T. perniciosa* or, if Klimeš is correct, whether they are not all synonyms of *T. parvula* (Kotlán, 1933) Klimeš, 1963. The measurements of the oocysts recovered from the scaup ducks overlap those of the species listed above. Until information is obtained on the morphology of other stages in the life cycle of the *Tyzzeria* from lesser scaup ducks, it is advisable to designate it as *Tyzzeria* sp.

Eimeria aythyae n. sp. (Figs. 3–6)

The following is a description of the new species for which I propose the name *Eimeria aythyae*. The dimensions are based on measurements of 115 oocysts.

Oocysts 14.8–23.6 (avg. 20.1) microns long by 10.5–18.2 (avg. 15.5) microns wide. Shape varying from that of a shouldered round-bottomed urn to broadly elliptical; 0.64–0.85 (avg. 0.76) as broad as long. Micropyle a wide gap in oocyst wall, 2.2–4.3 (avg. 3.6) microns in diameter. Cap over micropyle prominent, either a flattened or cone-shaped dome, with a double contour; wall of cap much thinner than oocyst wall. Cap never seen detached. Considerable variation in shape of oocyst wall at micropyle; in some cases, wall slightly expanded to form a uniformly thickened rim around the micropyle (Fig. 3); in other cases, wall irregularly expanded into lobes (Fig. 4). Oocyst wall pale yellow to colorless, smooth or lightly sculptured, 0.6 to 0.8 microns thick except at expansion at micropyle. Sporont uniformly coarsely granular. Sporulated oocyst without polar granules or oocystic residuum. Sporocysts rounded at one end and bluntly pointed at other end; small Stieda body at blunt end. Each sporocyst with two large sporozoites and a compact mass of residual material.

The oocyst of *E. aythyae* differs from that of all other species reported from ducks and geese, except possibly *E. truncata* (Railliet and Lucet, 1891), in that there is a prominent double contoured cap over the micropyle. Lerche (1923) stated that a fine membrane over the micropyle of *E. truncata* constituted a cap; Kotlán (1933) reported that a thickening in the oocyst wall around the micropyle gave the impression that there was a cap. I have been unable to find a true cap over the micropyle of *E. truncata* from Canada geese and from domestic geese. However, in some *E. truncata* oocysts there were more or less hollow expansions of the wall around the sharply cut micropyle, which in certain optical sections gave the appearance of a flat cap. *E. truncata* oocysts are ovoid to ellipsoid with a narrowed, truncated pole. *E. aythyae* differs markedly from *E. truncata* in that the oocyst of the former is neither drawn out at one pole nor sharply cut off.

DISCUSSION

As far as the writer has been able to determine, the only previous report of coccidiosis in lesser scaup ducks is that by Bump (1937); he found coccidia in two of these birds capsured in New York State. The coccidia were not indentified and their location in the birds was not stated.

Whether the *Tyzzeria* sp. was partly responsible for the outbreak reported here is open to question. The oocysts of this species were far less abundant than the oocysts of *Eimeria aythyae*. Moreover, *Tyzzeria* oocysts were not found in the dead scaups from Iowa.

Although no examination was made for bacterial or viral infections in the scaup from the Upper Mississippi Wildlife Refuge and only fowl cholera and *Salmonella* infection were ruled out as causes of death among scaups from Iowa, it is strongly suspected that *Eimeria aythyae* was responsible for the die-off.

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Trichodorus rhodesiensis and *Amphidelus trichurus*, Two New Nematode Species from Cultivated Soils of Africa

M. RAFIQ SIDDIQI AND K. F. BROWN[1]

Trichodorus rhodesiensis n. sp. was isolated from sugar-cane soil and root samples from Triangle Estates, Low Veldt, Southern Rhodesia. Other plant parasitic nematodes recovered from these samples were the species of the genera *Tylenchorhynchus* Cobb, 1913; *Scutellonema* Andrássy, 1958; and *Pratylenchus* Filipjev, 1936. *Amphidelus trichurus* n. sp. was collected from the soil about the roots of grapefruit in Sunland Farms, Sunlands River Valley, Port Elizabeth, South Africa. The only other species of the genus *Amphidelus* Thorne, 1939, reported from South Africa is *A. monohystera* Heyns, 1962.

Trichodorus rhodesiensis n. sp. (Fig. 1A–I)

MEASUREMENTS. Four males (in glycerine): Length = 0.60–0.69 mm; a = 22–26; b = 5.2–6.2; c = 50–56; T = 56–69%; spear = 39–41 microns; spicules = 42–44 microns; gubernaculum = 12–14 microns.

Four females (in glycerine): Length = 0.72–0.80 mm; a = 24–26; b = 5.5–6.2; c = subterminal; V = 50.7–54.3%; spear = 40–42 microns.

HOLOTYPE (MALE): Length = 0.69 mm; a = 25; b = 5.7; c = 53; T = 68; spear = 41 microns; spicules = 43 microns; gubernaculum = 12 microns.

ALLOTYPE (FEMALE): Length = 0.8 mm; a = 26; b = 6.1; c = 160; V = ^{19}-51-^{19}%.

DESCRIPTION: MALE: Body plump, cylindrical, almost straight (in one specimen it is ventrally bent in its posterior end). Cuticle marked by very fine transverse striae, apparently in two layers, slightly separated from the body but not abnormally swollen. Lateral hypodermal chords one-fourth as wide as body; lateral pores or cervical papillae not seen. Amphids vase-shaped, with large oval slits behind lip region; sensillar sacs oval, as large as amphids, packed with sensillar elements.

Lip region conoid–rounded, set off from body by a constriction; labial papillae slightly raised above lip contour. Stoma tubular, in two distinct parts, 19 microns long; its posterior end appearing as a collar around the spear. Spear slender, typical of the genus; its anterior solid tip measuring 19 microns long. Behind excretory pore, esophagus is a short narrow tube gradually expanding behind nerve ring to form a large sac-like structure enclosing five esophageal glands—one dorsal, two anterior, and two posterior subventrals; posterior subventral glands slightly overlapping anterior end of intestine (Fig. 1A). Esophago-intestinal valve not seen. Excretory pore located at about the level of beginning of enlargement of esophagus.

Testis single, anteriorly outstretched. Spicules paired, slightly cephalated, and ventrally arcuate, marked by fine transverse lines. Gubernaculum linear, thickened at its distal end. Precloacal, ventromedian supplementary papillae three, the anterior one not as conspicuous as the other two which lie within the spicular range. These papillae are at 10, 28, and 81 microns anterior to cloacal aperture. A pair of large, pedunculated, subventral papillae present a little behind the level of cloaca. Tail short, conoid–rounded, completely enveloped by a short bursa.

FEMALE: Essentially similar to male. Vulva a small transverse slit (Fig. 1F). Vagina with its thick circular muscles appearing as a large globular structure; anterior end of vagina with a sclerotized rim which appears as two bold dots in lateral view (Fig. 1C). Uterus containing sperms. Gonads paired, symmetrically opposed, reflexed. Tail end bluntly rounded; a pair of terminal caudal pores seen only in one individual.

TYPE HOST AND LOCALITY: Sugar cane, *Saccharum officinarum* L., in Triangle Estates, Low Veldt, Southern Rhodesia.

TYPE MATERIALS: Holotype, allotype, and paratypes in the Nematode Collections of Dr. M. Rafiq Siddiqi at the Zoology Museum, Aligarh Muslim University, Aligarh, India.

DIFFERENTIAL DIAGNOSIS: *Trichodorus rho-*

[1] Department of Zoology, Aligarh Muslim University, Aligarh, India, and 'Shell' Research Ltd., Woodstock Agricultural Research Centre, Sittingbourne, Kent, England respectively.

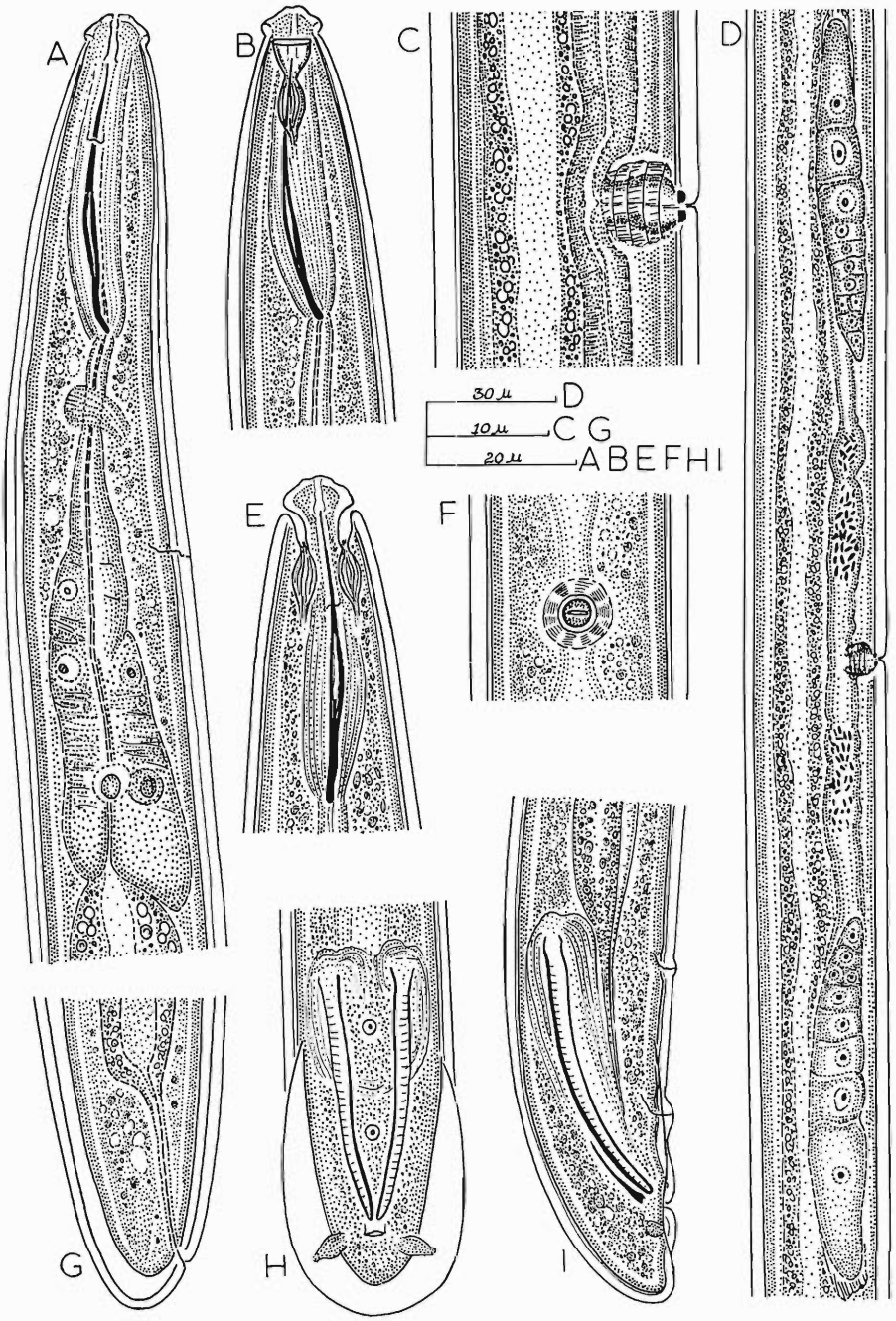

Fig. 1A–I. *Trichodorus rhodesiensis* n. sp. A. Esophagus of female. B. Head end of male. C. Vulvar region, lateral. D. Reproductive organs of female. E. Head end of female, ventral. F. Vulvar region, ventral. G. Tail end of female. H. Tail end of male, ventral. I. Tail end of male, lateral.

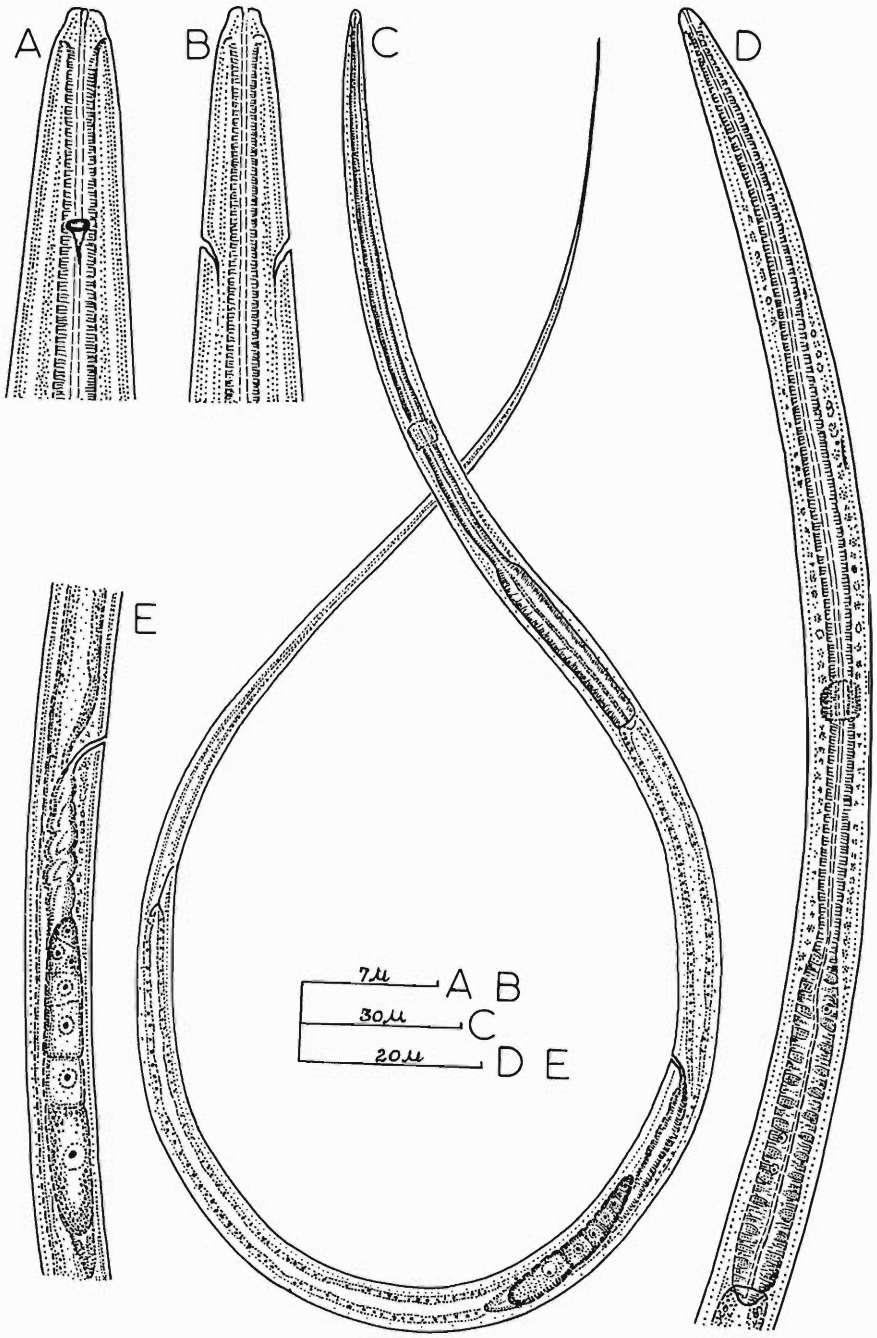

Fig. 2A–E. *Amphidelus trichurus* n. sp. A. Head end of female, lateral. B. Head end of female, ventral. C. Female. D. Esophagus of female. E. Reproductive organs of female.

desiensis n. sp. resembles *T. pachydermus* Seinhorst, 1954; *T. cylindricus* Hooper, 1962; *T. teres* Hooper, 1962; *T. tunisiensis* Siddiqi, 1963; *T. allius* Jensen, 1963, and *T. porosus* Allen, 1957.

T. pachydermus has three lateral body pores behind vulva, a ventromedian cervical papilla anterior to excretory pore in male and esophageal base not overlapping intestine. *T. cylindricus* has three ventromedian cervical papillae and only one supplementary papilla within spicular range in male, a pair of lateral pores near vulva and differently shaped vagina and its sclerotization in female. *T. teres* and *T. tunisiensis* have pre- and postanal lateral body pores, a longitudinal vulva and differently shaped vaginal sclerotization. *T. allius* has a truncated anterior end, differently shaped vaginal sclerotization and shorter spicules. *T. porosus* has intestine slightly overlapping posterior end of the esophagus, shorter spicules and ventromedian pores near vulva.

Amphidelus trichurus n. sp. (Fig. 2A–E)

MEASUREMENTS: 12 females (in glycerine): Length = 0.53–0.61 mm; a = 68–76; b = 3.1–3.9; c = 3.1–3.4; V = 36–39%.

HOLOTYPE (FEMALE): Length = 0.56 mm; a = 70; b = 3.9; c = 3.1; V = 37%.

DESCRIPTION: FEMALE: Body slightly ventrally arcuate, anteriorly tapering from middle of neck to a conoid lip region ⅔ body width at neck base. Lip region set off by an abrupt narrowing of body contour, anteriorly truncated. Body cuticle smooth, with very fine transverse striae. Amphids small, cup-like, at 4–5 head widths from front end of body; amphidial apertures oval, one-half as long as width of lip region at its base. Oral opening leading into a short, unarmed conoid stoma which is continued with the esophageal lumen in the lip region. Esophagus a narrow tube, expanding in its posterior fourth (Fig. 2D). Nerve ring enveloping esophagus a little behind its middle. Esophago-intestinal valve small, broadly rounded. Intestine with wide lumen throughout.

Vulva a small transverse slit. Vagina slightly directed backwards, not sclerotized. Anterior gonad or uterine sac absent. Posterior gonad with a muscular uterus, elongate–narrow oviduct and a reflexed ovary with oöcytes mostly in a single row (Fig. 2C). Rectum a little longer than anal body width. Tail elongate–filiform, regularly tapering, ending in a finely drawn-out terminus, about 30 times anal body width long.

MALE: Not found, and females do not contain sperms in uterus.

TYPE HABITAT AND LOCALITY: Collected from soil about roots of grapefruit, *Citrus paradisi*, at Sunland Farms, Sunlands River Valley, Port Elizabeth, South Africa.

TYPE MATERIALS: Holotype and paratypes in the Nematode Collections of Dr. M. Rafiq Siddiqi at the Zoology Museum, Aligarh Muslim University, Aligarh, India.

DIFFERENTIAL DIAGNOSIS: *Amphidelus trichurus* n. sp. comes close to *A. dolichurus* (de Man, 1876) Thorne, 1939, from which it differs in having a smaller body size, small and more posteriorly located amphids, a more posteriorly placed vulva, and by the absence of the males.

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Paralongidorus beryllus n. sp. (Nematoda : Dorylaimoidea) from India[1]

M. RAFIQ SIDDIQI AND ZAHID HUSAIN

In a general survey of the plant parasitic nematodes of Madras State, South India, conducted in December, 1964, a single female individual representing an undescribed species in the genus *Paralongidorus* Siddiqi *et al.*, 1963, was found in paddy soil at Avadi, about 12 miles northwest of Madras city. It has an offset head similar to that in *P. citri* (Siddiqi, 1959) Siddiqi *et al.*, 1963, but differs from this species in having a shorter buccal spear and a differently shaped tail. This is the sixth *Paralongidorus* species being reported from India; the other five are *P. citri* (Siddiqi, 1959) Siddiqi *et al.*, 1963; *P. sali* Siddiqi *et al.*, 1963; *P. sacchari* Siddiqi *et al.*, 1963; *P. microlaimus* Siddiqi, 1964; and *P. afzali* (Khan, 1964) n. comb. It is being named and described below as *Paralongidorus beryllus* n. sp., followed by a key to the various species of the genus.

Paralongidorus beryllus n. sp. (Fig. 1A–G)

HOLOTYPE FEMALE: (Relaxed in hot water, fixed in F. A. 4 : 10 and mounted in glycerine) Length = 4.27 mm; a = 104; b = 12.5; c = 130; V = $^{7.6}$-48-$^{8.4}$%.

DESCRIPTION: Body elongate, cylindrical, ventrally arcuate. Body cuticle with three distinct layers, marked by fine transverse striations. Lateral hypodermal chords two-fifths as wide as body; its glandular bodies prominent behind neck region, numbering 173 on one side, opening through lateral body pores. Lip region broadly rounded, set off from body by a transverse constriction, 17 microns in diameter and 7 microns high; labial papillae distinct but not raised above head contour. Amphid apertures conspicuous, slit-like, extending three-fourths lip-region width. Amphid pouch short cup-like with amphidial duct pushed forward resulting in a bilobed appearance of its base in lateral view (Fig. 1B). Spear (anterior sclerotized part of the buccal armature) 84 microns long. Spear extension 60 microns in length, with slightly swollen base (Fig. 1C). Spear guiding ring single, 28 microns or 1.6 times lip-region width from anterior end.

Esophagus typically dorylaimoid, comprising of two parts *viz.* an anterior slender tubular portion and a posterior cylindrical bulb measuring about four times as long as wide. Esophageal bulb with a dorsal and two subventral glands with distinct nuclei (Fig. 1D). Nerve ring enveloping anterior slender part of esophagus, 32 microns behind the base of spear extension. Hemizonid distinct, at the level of nerve ring. Two asymmetrical amphidial glands present behind the nerve ring. Esophago-intestinal cells form a bluntly rounded, conoid valve (Fig. 1D).

Vulva a transverse slit with thick labia, leading at right angles to ventral body surface. Vagina extends about halfway into body, enveloped by thick sphincter muscles. Powerful dilator muscles attached to vulva (Fig. 1F). Oviduct long, with a pouch-like structure at its proximal end joining uterus through a narrow passage controlled by sphincter muscles. Ovaries paired, symmetrical, reflexed, with irregularly arranged oöcytes.

Prerectum not definite. Rectum a little less than one anal–body diameter long, opening through a distinct anus. Tail dorsally convex conoid to rounded terminus, 1.3 times anal–body width long, with two pairs of caudal pores (Fig. 1G).

MALE: Not found.

TYPE MATERIAL: Female collected on 18 December 1964, deposited in the nematode collections of Dr. M. Rafiq Siddiqi at Zoology Museum, Aligarh Muslim University, Aligarh, India.

TYPE HOST AND LOCALITY: Specimen collected from the soil around the roots of Paddy, *Oryza sativa* L., at Avadi, 12 miles northwest of Madras city, South India.

DIFFERENTIAL DIAGNOSIS: *Paralongidorus beryllus* n. sp. comes close to *P. citri* (Siddiqi, 1959) Siddiqi *et al.*, 1963; *P. eucalypti* Fisher, 1964; and *P. utriculoides* (Corbett, 1964) n. comb. It can easily be differentiated from *P. citri* in having a shorter buccal spear (spear

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The authors are thankful to Prof. M. A. Basir for arranging a collection trip to South India.

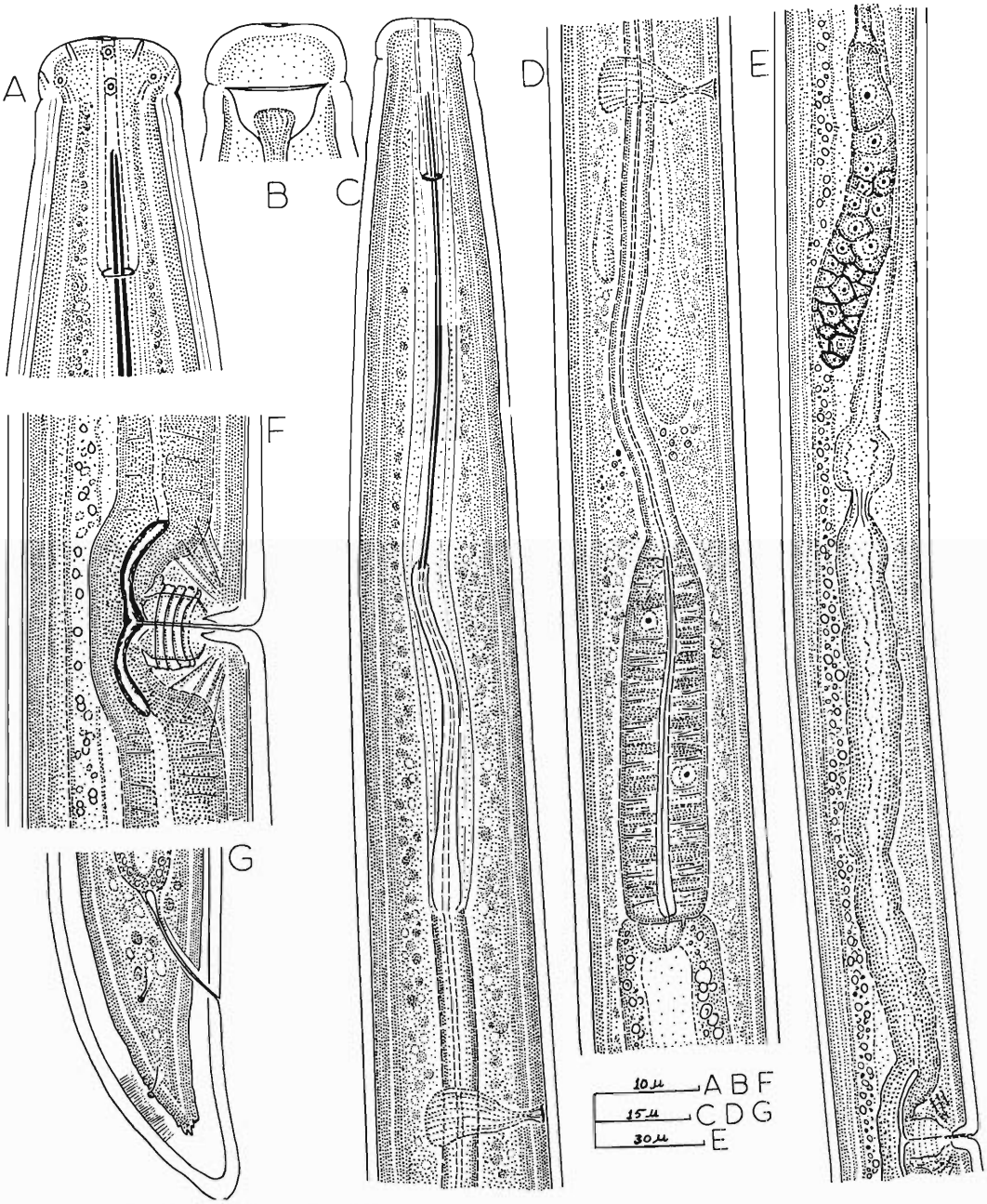

Fig. 1A–G. *Paralongidorus beryllus* n. sp. Female; A. Head end, lateral; B. Amphid; C. Esophagus, anterior half; D. Esophagus, posterior half; E. Anterior reproductive organs; F. Vulvar region; G. Tail, lateral.

128–139 microns in *P. citri*), a more posteriorly located vulva (V = 43.3–44.8% in *P. citri*), a smaller body size (6.73–7.44 mm in *P. citri*) and differently shaped tail.

It differs from *P. eucalypti* in having a shorter spear (spear 133–151 microns long in *P. eucalypti*), a larger spear extension and more tapering tail.

From *P. utriculoides* it differs in having a longer spear (spear 58–65 microns in *P. utriculoides*), an offset lip region and shorter and differently shaped amphids (amphids large, pouch-like, asymmetrically bilobed at base in *P. utriculoides*).

A key to the species of the genus *Paralongidorus* Siddiqi, Hooper and Khan, 1963, was given by Siddiqi (1964). Siddiqi (1965) expressed the opinion that *Longidorus georgiensis* Tulaganov, 1937; *L. remyi* Altherr, 1963, and *L. afzali* Khan, 1964, should be transferred to the genus *Paralongidorus*. We agree with this proposal but do not prefer to shift *Longidorus georgiensis* Tulaganov, 1937, as sufficient details about the amphids are wanting. Recently Corbett (1964) published the description of *Longidorus utriculoides* which has large slit-like amphidial aperture and thus belongs to the genus *Paralongidorus* (*vide* discussion by Siddiqi, 1965).

KEY TO THE SPECIES OF *Paralongidorus*

1. Head set off by a constriction 2
   Head not set off by a constriction 6
2. Tail one anal–body width or more 3
   Tail shorter than anal–body width 5
3. Spear 84 microns long ..... *beryllus* n. sp.
   Spear over 125 microns long 4
4. Body size 6.73–7.44 mm, V = 43.3–44.8% ..... *citri* (Siddiqi, 1959) Siddiqi *et al.*, 1963
   Body size 4.8–6.2 mm, V = 46.2–49.3% ..... *eucalypti* Fisher, 1964
5. Body size over 8 mm ..... *maximus* (Bütschli, 1874) Siddiqi, 1964
   Body size 5.5 mm ..... *remyi* (Altherr, 1963) n. comb.
6. Spear 100 microns or more 7
   Spear less than 70 microns 9
7. Tail more than two anal–body widths ..... *afzali* (Khan, 1964) n. comb.
   Tail about one anal–body width or less 8
8. Body size 2.25–2.85 mm; tail less than anal–body width long ..... *sali* Siddiqi *et al.*, 1963
   Body size 4.1–5.2 mm; tail more than anal–body width long ..... *sacchari* Siddiqi *et al.*, 1963
9. Amphid short, stirrup-like ..... *microlaimus* Siddiqi, 1964
   Amphid large, pouch-like ..... *utriculoides* (Corbett, 1964) n. comb.

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Two New Spirurid Nematode Parasites from Freshwater Fishes of India[1]

VINOD AGRAWAL[2]

ABSTRACT: Two new spirurid nematode parasites viz. *Paracucullanellus indica* n. gen., n. sp. from a freshwater fish *Rita rita* from Lucknow and *Parascarophis bharatii* n. sp. from a freshwater fish *Mastacembelus armatus* from Assam have been described.

FAMILY: CUCULLANIDAE COBBOLD, 1864

Paracucullanellus indica n. gen., n. sp.
(Figs. 1–5)

Six males, eight females, and a large number of immature specimens of this form were collected from the intestine of a freshwater fish, *Rita rita* (Ham.) from Lucknow.

DESCRIPTION: Body elongated, cylindrical, small to medium sized. Anterior extremity not bent dorsally; not much difference in size of sexes. In end on view, mouth triangular bounded with two large lateral lips on its sides; each bearing three well-developed papillae, four submedian and one lateral in position. A pair of amphids situated laterally. Mouth opening straight forward, provided with short transverse cuticular ridge. Esophagus muscular, lacking a glandular portion, club shaped, and dilated anteriorly to form a pseudobuccal capsule. Intestine simple without any diverticulum. Cephalic glands present, extending from nerve ring up to a little anterior to hind end of esophagus. Two lateral alae broad, extending throughout body length, 0.05–0.09 mm wide in male and 0.07–0.09 mm wide in female. Cuticle finely striated transversely. Striations 0.09–0.12 mm apart.

MALE: Body 6.83–9.21 mm long, 0.51–0.62 mm wide. Head, 0.09–0.11 mm in diameter. Two small cervical papillae bristle-like, 0.51–0.61 mm from anterior extremity. Anterior dilated pseudobuccal capsule, 0.16–0.26 × 0.12–0.16 mm in size and posterior muscular esophagus, 0.33–0.44 × 0.12–0.14 mm in size. Entire esophagus, 0.49–0.70 mm in length. Nerve ring at 0.23–0.27 mm and excretory pore 0.29–0.36 mm from anterior end. Tail with a terminal spike, 0.18–0.29 mm in size. Caudal end curled ventrally and forms a single turn of a spiral. Caudal alae well developed extending up to tip of tail. Eleven pairs of pedunculated caudal papillae of which four pairs preanal, one pair adanal, and six pairs postanal. Of preanal papillae one pair anterior to anal sucker and rest of three pairs situated one behind other at regular intervals. Of postanal papillae four pairs long, pedunculated, two posteriormost small and sessile close together near tip of tail. A pair of phasmids also observed at tip of tail. Spicules equal, tubular, funnel shaped, broader at anterior end while sharply pointed at posterior end. They measure 0.51–0.59 mm in length. Gubernaculum club shaped, 0.07–0.09 mm in length. Preanal sucker muscular, without chitinous rim, spindle shaped, 0.14–0.19 mm in length and situated at 0.41–0.54 mm from cloacal aperture.

FEMALE: Body 4.06–11.45 mm long, 0.25–0.62 mm wide. Head 0.10–0.13 mm in diameter. Two small cervical papillae, 0.54–0.69 mm from anterior extremity. Anterior dilated pseudobuccal capsule, 0.21–0.29 × 0.14–0.18 mm in size and posterior muscular esophagus 0.45–0.64 × 0.12–0.17 mm in size. Entire esophagus 0.66–0.93 mm long. Nerve ring at 0.25–0.30 mm and excretory pore 0.31–0.40 mm from anterior end. Tail short, pointed with a terminal spike, 0.12–0.19 mm long. It bears two lateral papillae at 0.07–0.12 mm from hind end. Vulva postequatorial 1.15–5.45 mm, i.e., almost one-third of body length from posterior end of body. Two ovaries; uterine branches opposed; oviparous. Eggs thin shelled, 0.045–0.06 × 0.03–0.037 mm in size.

DISCUSSION: Tornquist (1931) reviewed the family Cucullanidae Cobbold, 1864. He recognized the genera *Cucullanus* Mueller, 1777, *Dacnitis* Dujardin, 1845, *Dichelyne* Jagerskiold, 1902 and created the genus *Cucullanellus*. Baylis (1939) considered *Dacnitis* to be synonym of *Cucullanus*. Yamaguti (1941) added

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[1] Part of thesis accepted for the degree of Doctor of Philosophy at the Lucknow University, Lucknow.

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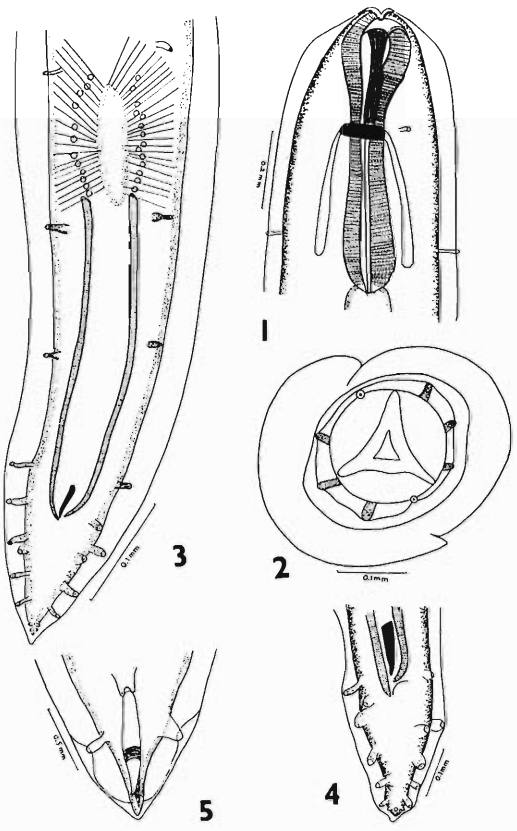
The work has been carried out under the guidance of Dr. S. P. Gupta, to whom the author is indebted for invaluable help and encouragement.

The paratype and holotype specimens of the forms described in this paper will be deposited in Dr. G. S. Thapar's Helminthological Collection, Lucknow, U.P., India.

another genus *Neocucullanellus*. Ali (1956) reviewed the family Cucullanidae and considered the genera *Cucullanus*, *Dichelyne*, *Cucullanellus*, *Neocucullanellus* as distinct and created the genus *Indocucullanus*. Campana-Rouget (1957) suppressed the genera *Cucullanellus*, *Dichelyne*, and *Neocucullanellus*. Yamaguti (1961) did not agree with Campana-Rouget and recognized the genera *Cucullanus*, *Neocucullanus*, and *Indocucullanus* under the subfamily Cucullaninae and the genera *Dacnitoides*, *Cucullanellus*, *Dichelyne*, and *Neocucullanellus* under the subfamily Dacnitoidinae. The author is in agreement with this view and follows him.



Figs. 1–5. *Paracucullanellus indica* n. gen., n. sp. Fig. 1. Anterior end of male. Lateral view; Fig. 2. End on view; Fig. 3. Male tail. Ventral view; Fig. 4. Male tip of tail. Ventral view; Fig. 5. Female tail. Ventral view.

The new form has a close resemblance to the genera *Neocucullanus*, *Cucullanus*, *Dacnitoides*, and *Cucullanellus* in the possession of a preanal sucker. The new form differs from *Dacnitoides* in the possession of two ovaries and from *Neocucullanus* in the possession of a gubernaculum. The new form resembles closely the genera *Cucullanus* and *Cucullanellus* in the possession of preanal sucker without a chitinous rim, in having spicules equal and gubernaculum present. However, the new form can be distinguished from *Cucullanus* in having mouth opening straight, in the possession of cephalic glands, in having well-developed caudal alae, in having vulva postequatorial and in the possession of a transverse cuticular ridge. The new form resembles closely the genus *Cucullanellus* but, however, differs from it in the absence of intestinal cecum, in the possession of cephalic glands and in having well-developed caudal alae. In view of the above differentiating characters, a new genus *Paracucullanellus* n. gen., n. sp. is created.

HOST: *Rita rita* (Ham.).

LOCATION: Intestine.

LOCALITY: Lucknow.

GENERIC DIAGNOSIS: Cucullanidae. Anterior extremity not bent dorsally. Mouth opening straight forward provided with short transverse cuticular ridge. Esophagus muscular, lacking a glandular portion, club shaped, and dilated anteriorly to form a pseudobuccal capsule. No intestinal cecum. Cephalic glands present. Male: Preanal sucker without chitinous rim; caudal alae well developed; tail pointed; spicules equal; gubernaculum present. Eleven pairs of caudal papillae of which four pairs preanal, one pair adanal, and six pairs postanal. Female: Oviparous, tail pointed with a pair of lateral papillae about its middle; vulva behind middle of body; two ovaries; uterine branches opposed; eggs thin shelled. Parasitic in the intestine of a freshwater fish, *Rita rita*.

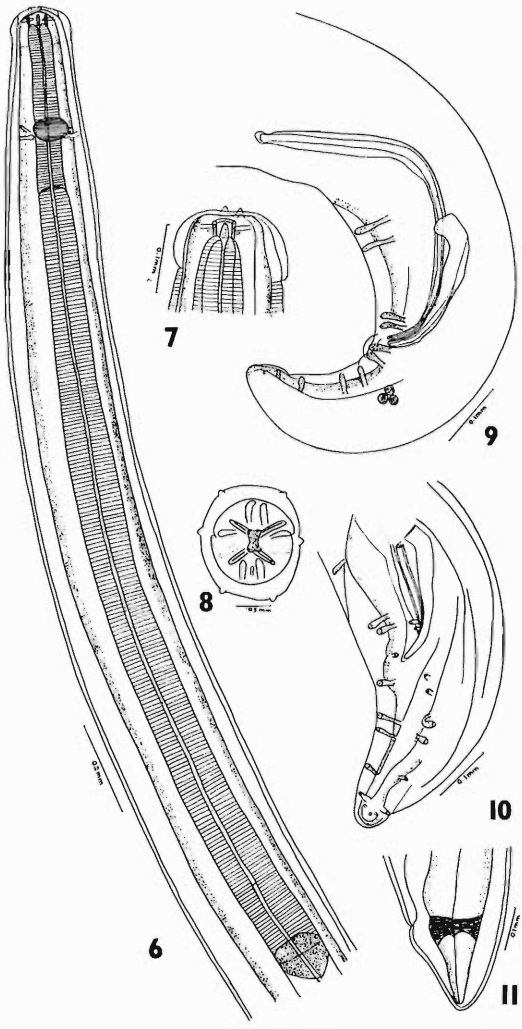
GENOTYPE: *Paracucullanellus indica* n. gen., n. sp.

FAMILY: SPIRURIDAE OERLEY, 1885

Parascarophis bharatii n. sp.

(Figs. 6–11)

A large number of males and females of this form were collected from the stomach of a



Figs. 6–11. *Parascarophis bharatii* n. sp. Fig. 6. Anterior end of male. Lateral view; Fig. 7. Anterior end enlarged. Ventral view; Fig. 8. End on view; Fig. 9. Male tail. Lateral view; Fig. 10. Male tail. Ventrolateral view; Fig. 11. Female tail. Lateral view.

freshwater fish, *Mastacembelus armatus* (Lacep.) from Assam.

DESCRIPTION: Body elongated, cylindrical, small to medium sized; not much difference in size of two sexes. In end on view, mouth elongated dorsoventrally bounded with two large bilobed lateral lips on its sides. Each bearing two large teeth and three well-developed papillae. Cephalic extremity covered by a circular disc with two amphids and four submedian papillae. Mouth leads into a short vestibule. Esophagus divided into two portions, a shorter narrow muscular anterior portion and a longer wide glandular posterior portion. Head with a cap-like cuticular expansion which extends further backwards dorsally than ventrally. Cuticle finely striated transversely. Striations 0.04–0.14 mm apart in male and 0.05–0.18 mm apart in female.

MALE: Body 16.35–23.12 mm long, 0.25–0.35 mm wide. Head 0.10–0.14 mm in diameter. Two small cervical papillae at level of nerve ring, 0.24–0.35 mm from anterior extremity. Mouth cavity followed by a vestibule 0.03–0.05 × 0.05–0.07 mm in size. Anterior muscular esophagus 0.32–0.41 × 0.05–0.09 mm in size. Posterior glandular esophagus 1.91–3.03 × 0.09–0.13 mm in size. Entire esophagus 2.07–3.44 mm long. Nerve ring at 0.21–0.28 mm and excretory pore 0.22–0.31 mm from anterior extremity. Tail sharply pointed at tip, 0.22–0.28 mm long. Caudal end curved ventrally and forms a single turn of a spiral. Caudal alae well developed 0.45–0.57 mm long extending up to tip of tail. Ten pairs of caudal papillae of which four pairs pedunculated preanal, one pair pedunculated on anterior lip of cloacal aperture, four pairs pedunculated postanal, and one pair sessile papillae near tip of tail. A pair of phasmids also observed near tip of tail. Spicules broad, alate and very unequal, right being larger. Right spicule 0.54–0.66 mm and left spicule 0.22–0.27 mm in length. Gubernaculum absent.

FEMALE: Body 16.78–26.29 mm long, 0.26–0.35 mm wide. Head 0.15–0.19 mm in diameter. Two small cervical papillae situated at level of nerve ring, 0.29–0.35 mm from anterior extremity. Anterior muscular esophagus 0.37–0.48 × 0.09–0.11 mm in size. Posterior glandular esophagus 2.61–3.56 × 0.13–0.19 mm in size. Entire esophagus 3.19–3.97 mm long. Nerve ring at 0.25–0.31 mm and excretory pore at 0.26–0.34 mm from anterior end. Tail postequatorial, slightly behind midregion of body at 8.98–15.46 mm from anterior end of body. Eggs oval, without any filament at poles, 0.08–0.085 × 0.05–0.055 mm in size.

DISCUSSION: Due to the presence of caplike cuticular expansion on the head and in the possession of eggs without polar filaments, the

present form is referred to the genus *Parascarophis* Campana-Rouget, 1955. *P. sphyrnae* only species of the genus has been described so far from *Sphyrna diplana* in Senegal. The original description of the species is based only on one female. The new form differs from it in having vulva postequatorial instead of preequatorial and in the possession of two portions of esophagus. Accordingly it is regarded as new with the specific name *P. bharatii* n. sp.

HOST: *Mastacembelus armatus* (Lacep.)
LOCATION: Stomach.
LOCALITY: Assam.

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Abbreviations Used in Recording Measurements

L is an abbreviation for length and the figure following it indicates the total length of the body, usually expressed in millimeters.

V is an abbreviation for vulva and the figure following it indicates its position. This figure is expressed as a percentage. Thus: V = 50 means that the distance from the anterior end to the vulva is 50% of the total length or that the vulva is in the middle of the body.

The values designated by a, b, c refer to the width of the body, the length of the esophagus, and the length of the tail, respectively, and all are common fractions of the total length. Thus if α (or a) = 40 it means that the width of the body is $\frac{1}{40}$ of the total length (or that the animal is 40 times longer than wide). If beta (or b) = 8 it means that the length of the esophagus is $\frac{1}{8}$ of the total length. The same applies to gamma (or c).

Development of the Rat Nematode, *Nippostrongylus brasiliensis* (Travassos, 1914) in Pregnant Hamsters

A. JAMES HALEY AND MARGUERITE S. LASSNER[1]

Adult females of the Syrian hamster, *Mesocricetus auratus*, are highly refractory to experimental infections of the rat heligmosome, *Nippostrongylus brasiliensis*. In about 200 females infected and examined by the first author during the past several years, the percentage recoveries of adult worms ranged from 0 to 2.0 with an overall mean of 0.25 percent. The purpose of the present study was to determine whether or not the development of *N. brasiliensis* in hamsters might be enhanced by pregnancy.

Twenty-two 10- to 14-week-old females in 5 groups were exposed to males for 5 days, then isolated, inoculated intracutaneously with infective larvae of a rat strain of *N. brasiliensis* and examined 10 to 10.5 days later for adult worms. In each group, an equal number of virgin females of the same age were inoculated with the same number of larvae. The dose of larvae among tests varied from 535 to 740, and the number of adult worms recovered from the small intestine at necropsy was expressed as a percentage of the dose. In these tests, pregnancies would be not less than 10 days and not more than 15.5 days duration at the time animals were necropsied. Crown–rump measurements of embryos confirmed that the animals were in the first trimester of pregnancy when they were inoculated (Ramm and Swartz, 1955, Anat. Rec. 123: 259–278).

The recovery of adult worms from the 22 pregnant hamsters ranged from 0 to 1.28 with a mean of 0.23 percent (standard error 0.07), as compared to 0 to 1.12 with a mean of 0.20 percent (standard error 0.06) for 24 virgin controls. It is evident, under the conditions of these experiments, that the development of *N. brasiliensis* in the intestine of hamsters was neither enhanced nor inhibited by pregnancy.

These results agree with those of Dunn and Brown (1962, J. Parasit. 48: 32–34) which demonstrated that pregnancy had no effect on infections of *Aspiculuris tetraptera* and *Syphacia obvelata* in inbred albino mice. Since the hamsters were in the first trimester of pregnancy when inoculated, it is conceivable that the development of *N. brasiliensis* might be enhanced or inhibited if inoculations were given at more advanced stages of gestation or during lactation. An enhancement of development following later inoculations seems unlikely for two reasons. First, according to Oshima (1961, J. Parasit. 47: 657–660) the percentage of *Toxocara canis* larvae recoverable from the tissues of mice was highest when inoculations were given early in pregnancy or immediately after parturition, but was low when inoculation was a few days before or after parturition. Second, large numbers of living third stage *N. brasiliensis* larvae can be recovered from the lungs of hamsters as late as the 18th day of infection (Haley, 1958. Exper. Parasit. 7: 338–348). Furthermore, Haley and Schellberg (unpublished data) found that when these larvae were inoculated into the skin of rats, they migrated normally and reached maturity in the gut. In the present study, no fourth or early fifth stage worms were found in the gut, thus indicating that larvae were not moving from the lungs to the gut under the conditions that pertained in mid- or late pregnancy.

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ANNOUNCEMENT—NEW EDITOR

Francis G. Tromba, Beltsville Parasitological Laboratory, Animal Disease and Parasite Research Division, Agricultural Research Service, U.S.D.A., Beltsville, Maryland, U.S.A., Zip Code 20705, has been elected EDITOR of the PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON starting with Volume 33 (1966).

Effective immediately, all manuscripts and any other correspondence on Editorial Matters on Volume 33 (1966) and beyond should be addressed to Doctor Tromba.

May I take the occasion to thank each and every contributor for his excellent cooperation. It has been a pleasure to serve you. I am sure you will give Dr. Tromba and his Editorial Committee the same cooperation you have given us in the past.

GILBERT F. OTTO
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