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PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

VOLUME 30 JANUARY 1963 NUMBER 1

A report on South African nematodes of the genera *Labronema* Thorne, *Discolaimus* Cobb, *Discolaimoides* n. gen., and *Discolaimium* Thorne (Nemata: Dorylaimoidea)*

JUAN HEYNS

The nematodes reported on in this paper were collected from cultivated fields in various localities in South Africa.

GENUS LABRONEMA Thorne, 1939

Labronema pygmaeum n. sp. (Fig. 1 A-D)

FEMALES (2): 0.90-1.20 mm; a = 18-23; b = 3.6-4.1; c = 54-66; V = $^{18}53\%$ ^{18}

DESCRIPTION: Cuticle thickened towards extremities, several times as thick as elsewhere on body; with fine transverse striae. Lip region angular, about 1/3 as wide as base of neck, with a slight post-labial constriction. Spear length equal to width of lips, the aperture occupying 1/3 its length. Amphids elongate-triangular, 1/2 as wide as head, provided with a basal sheath-like enlargement. Sensilla pouches posterior to base of spear. Anterior portion of esophagus 1/4 as wide as neck, slightly constricted where it passes through the nerve ring, which is situated about 2/3 the distance from the anterior end of the slender part. A rather sudden enlargement occurs slightly beyond middle of esophagus. Dorsal gland nucleus large, conspicuous. Cardia less than 1/3 body width, hemispherical, with a conoid terminus projecting into lumen of esophagus. Lateral cords 1/4 as wide as body, with about 25 indistinct glandular organs. Intestine apparently 6 cells in circumference. Rectum 1-1/3 times as long as anal body diameter. Prerectum slender, muscular, its length 2-1/2 times that of rectum. Anal glands conspicuous. Tail 2.3 anal body diameter in length, bluntly rounded to a slightly subdigitate terminus. One subventral and 3 subdorsal pairs of caudal papillae, the 2 members of the most dorsal pair very close together. Vulva transverse with sclerotized lips. Vagina extending 2/5 across body. Ovaries reflexed about half-way to vulva, the anterior one extending about 2/3 to base of esophagus. Male unknown, but the uteri of both female specimens were packed with spermatozoa.

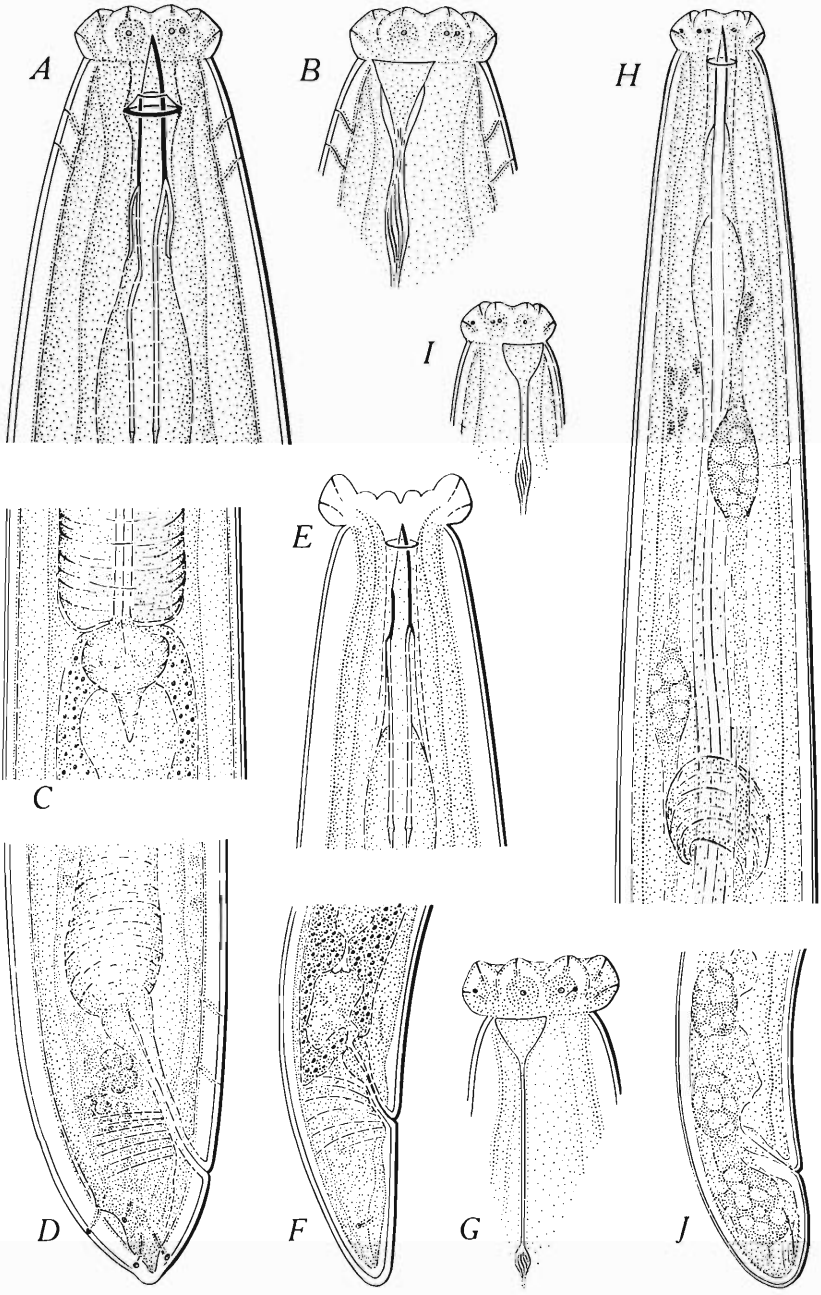
DIAGNOSIS: *Labronema pygmaeum* n. sp. corresponds with *Labronema ruttneri* (Schneider, 1937) Thorne, 1939 and *Labronema octodurensis* Altherr, 1950 in small size, but differs in the more anteriorly located vulva (53% as compared to 70% and 60% respectively), more angular lips and shorter spear.

TYPE LOCALITY AND HABITAT: Cultivated soil, Tobacco Research Station, Rustenburg, Transvaal.

*Adapted from a thesis done under the supervision of Professor Gerald Thorne, and presented to the Graduate School of the University of Wisconsin in partial fulfillment of the requirements of the degree of Doctor of Philosophy.

Present address: Division of Entomology, Private Bag 134, Pretoria, South Africa.

HOLOTYPE AND PARATYPE: Slide *Labronema* 1, collection of the Division of Entomology, Pretoria, South Africa.



GENUS DISCOLAIMUS Cobb, 1913

Discolaimus major Thorne, 1939

Several females were collected from cultivated fields in Rustenburg and Nelspruit in the Transvaal, and Modderrivier in the Cape Province.

FEMALE: 1.73-2.40 mm; a = 29-38; b = 3.4-4.5; c = 74-76; V = $^{9-12}$51-56% $^{8-11}$

Slides *Discolaimus* 2, 2a and 2d, collection of the Division of Entomology, Pretoria, South Africa.

Discolaimus monoplanus n. sp. (Fig. 1 E-G)

FEMALE: 0.82 mm; a = 24; b = 3.5; c = 29; v = $^{6.9}$46% $^{7.7}$

DESCRIPTION: Lips broadly expanded, more than 1/2 as wide as base of neck, cup-shaped, with inner ring of 6 rounded liplets surrounding oral opening. Neck tapering gradually towards head, strongly constricted at base of lips. Spear length 2/3 width of lip region, the aperture occupying slightly more than 1/2 its length. Spear extension twice as long as spear. Amphids stirrup-shaped, 1/2 as wide as head. Swelling at anterior end of esophagus enclosing spear extension, 1/3 as wide as body. Nerve ring 1/3 the distance from the enlargement, which occurs at about the middle of the neck. Anterior portion 1/2 as wide as basal enlarged part, which is 1/2 as wide as body. Cardia hemispheroid, 1/3 as wide as body. Lateral cords about 1/4 as wide as body, with glandular organs relatively few and indistinct. Intestine apparently 6 cells in circumference. Rectum as long as anal body diameter. Prerectum small, shorter than rectum. Tail dorsally convex-conoid with bluntly rounded terminus. Vagina extending slightly less than 1/3 across body. Ovaries reflexed about half-way back to vulva. Spermatozoa present in both uteri.

DIAGNOSIS: *Discolaimus monoplanus* n. sp. is smaller than any known species in this genus. It differs from *Discolaimus texanus* Cobb, 1913 which it most closely resembles, in shorter spear, longer tail and greater relative width.

TYPE LOCALITY AND HABITAT: A single female from cultivated soil at the Tobacco Research Station, Rustenburg, Transvaal.

HOLOTYPE: Slide *Discolaimus* 4, collection of the Division of Entomology, South Africa.

GENUS DISCOLAIMOIDES n. gen.

Dorylaiminae. Lip region expanded, about 1/2 as wide as base of neck. Neck tapering towards head which is about 1/3 as wide as base of neck. Guiding ring far forward near base of lips, single. Esophagus beginning with a slight swelling at base of spear extension, then continuing as a very slender tube without visible radial musculature to about middle of neck, where it suddenly expands. Dorsal esophageal gland variable in position, less than 1 body width behind esophageal expansion in *Discolaimoides smithi* n. sp. and about twice that distance in *Discolaimoides bulbiferus* (Cobb,

Figure 1. A-D: *Labronema pygmaeum* n. sp.

A. Head, × 1000; B. Surface view of head showing amphid, × 1000; C. Cardiac region, × 575; D. Female tail, × 640.

E-G: *Discolaimus monoplanus* n. sp.

E. Head, × 1000; F. Female tail, × 640; G. Surface view of head, showing amphid, × 1000.

H-J: *Discolaimium sublatum* n. sp.

H. Anterior portion of female, × 1000; I. Surface view of head showing amphid, × 1000; J. Female tail, × 640.

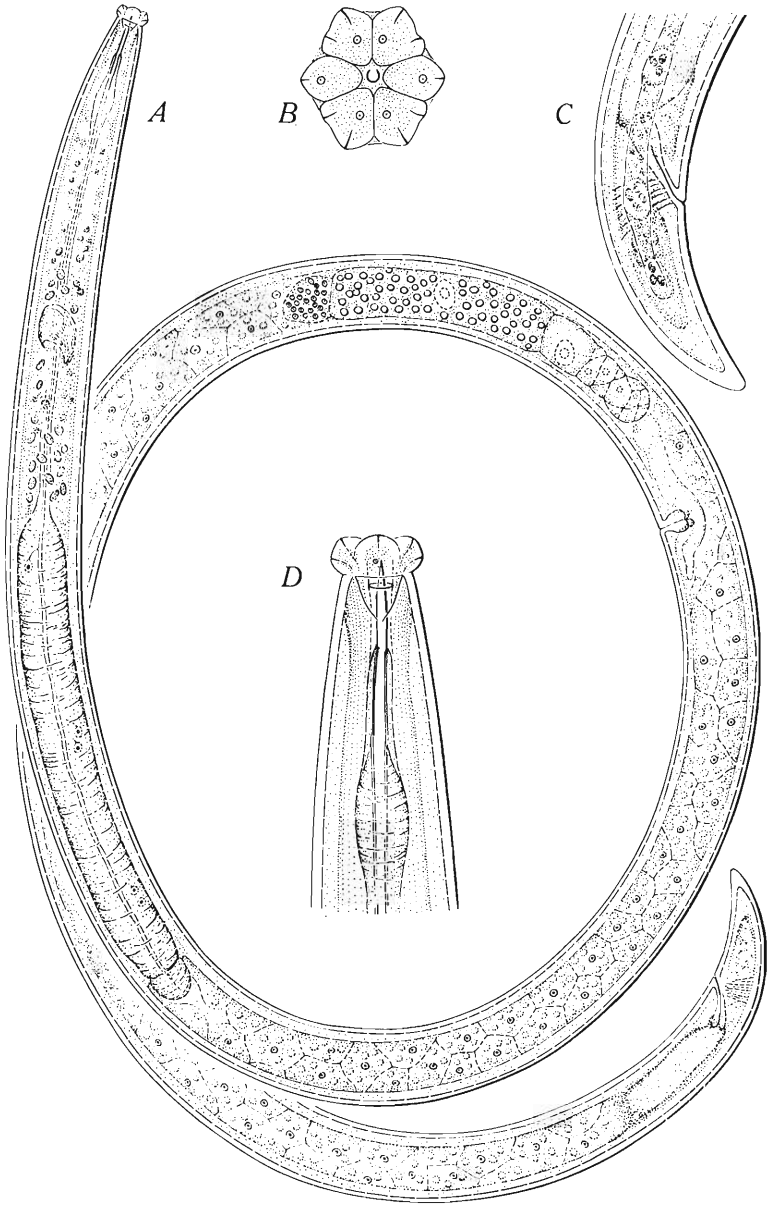


Figure 2. *Discolaimoides smithi* n. gen., n. sp.
A. Female, × 500; B. Face view, × 2000; C. Female tail, × 800; D. Head, × 1500.

1906) n. comb. Lateral cords with a series of glandular organs. One or 2 ovaries, reflexed.

TYPE SPECIES: *Discolaimoides bulbiferus* (Cobb, 1906) new combination.

DIAGNOSIS: The genus differs from *Discolaimus* in the shape of the lips which are not discoid, but high and rounded, and the very slender anterior part of the esophagus. From *Discolaimium* it differs in the tapering body and expanded lips as well as in the anterior part of the esophagus which is more slender than in *Discolaimium*, less than ¼th the diameter of the enlarged part.

Discolaimoides bulbiferus (Cobb, 1906) new combination

SYNONYMS: *Dorylaimus bulbiferus* Cobb, 1906; *Discolaimus bulbiferus* (Cobb, 1906) Thorne and Swanger, 1936

Several specimens were collected from cultivated fields in Ventersdorp and Bosveld in the Transvaal, Bothaville in the Orange Free State and Modderrivier in the Cape Province.

FEMALE: 1.19-1.71 mm; a = 34-58; b = 4.4-5.1; c = 31-38; V. = $^{6.1-7.8}$ 41-47% $^{6.5-9.9}$

The species is transferred to this genus on account of the shape of the lips and the very slender non-muscular anterior portion of the esophagus.

Discolaimoides smithi n. sp. (Fig. 2)

FEMALES (6): 1.05 (0.98-1.14) mm; a = 47 (43-51); b = 4.1 (3.6-4.5); c = 36 (32-40); V = $^{2.1\ (2.0-2.3)}$ 49 (47-50) % $^{8.7\ (6.7-10.9)}$

DESCRIPTION: Body tapering in neck region towards head which is 1/3 as wide as base of neck. Lip region expanded, slightly less than 1/2 as wide as base of neck. Spear length slightly less than width of lip region, the aperture occupying 2/5 its length. Amphids stirrup-shaped, 2/3 as wide as head. Esophagus beginning with an ellipsoid swelling at base of spear extension, 1/3 as wide as body, than continuing as a very slender tube to slightly past the middle of the neck where it suddenly expands to more than 4 times the diameter of the anterior part. Broad nerve ring is situated proximal of middle of slender part of esophagus. Dorsal esophageal gland located less than 1 body width behind the esophageal expansion, the duct leading somewhat forward into the lumen of the esophagus. Cardia hemispheroid, large, more than 1/2 as wide as body. Lateral cords about 1/4 as wide as body and supplied with about 60 glandular organs, each containing from 2 to 5, mostly 3 dark ovoid bodies. Intestine apparently 4 cells in circumference. Prerectum 2 to 2-1/2 times as long as rectum, the latter being equal to or slightly more than the anal body diameter in length. Tail slightly convex-conoid to the rounded terminus. Vulva transverse. Vagina extending almost half-way across body. Rudimentary anterior uterine branch present, usually collapsed; length equal to 1 body diameter or less. Posterior ovary reflexed half-way or more to vulva. Spermatozoa seen in some of the specimens, several of which contained developing eggs.

DIAGNOSIS: *Discolaimoides smithi* n. sp. differs from *Discolaimoides bulbiferus* (Cobb, 1906) n. comb. in smaller size, more rounded lips and in being monodelphic.

TYPE LOCALITY AND HABITAT: Cultivated soil, Tobacco Research Station, Rustenburg, Transvaal. Specimens were also collected in Lichtenburg, Transvaal. A single female from Modderrivier, Cape Province (Slide *Discolaim-*

oides 1d) is somewhat larger than the type material (1.37 mm), appreciably more slender (a = 72) and has the vulva more anteriorly located (42%).

HOLOTYPE: Slide *Discolaimoides* 1, collection of the Division of Entomology, Pretoria, South Africa.

PARATYPES: Slides *Discolaimoides* 1a and 1c, same data as above. Also slide *Discolaimoides* 1, deposited in the collection of the Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin, U.S.A.

Named in honour of Mr. A. J. Smith, formerly entomologist at the Tobacco Research Station, Rustenburg, South Africa.

GENUS DISCOLAIMIUM Thorne, 1939

Discolaimium sublatum n. sp. (Fig. 1 H-J)

FEMALES (7): 0.87 (0.80-0.93) mm; a = 29 (26-33); b = 3.6 (3.4-4.0); c = 45 (39-51); V = $^{6.0\ (5.0\text{-}8.1)}$ 49 (46-55)% $^{5.7\ (4.6\text{-}7.1)}$

DESCRIPTION: Body in relaxed specimens curved ventrally from the base of the esophagus backwards, while the neck curves dorsally, thus assuming the shape of an inverted question mark (?). Inner cuticle with radial striae. Lip region 2/5 as wide as base of neck. Inner circlet of liplets absent. Spear length equal to or more than width of lips, the aperture occupying 1/2 or slightly less of its length. Amphids stirrup-shaped, 1/2 as wide as head, the sensilla pouch situated somewhat posterior to the base of the spear. Spindle-shaped swelling in esophagus at base of spear extension, 1/3 body width. Esophagus enlarged just beyond middle to about 4 times the diameter of the slender anterior portion. Dorsal esophageal gland conspicuous, 1 body width posterior to enlargement in esophagus. Nerve ring situated at 1/3 the distance anterior of the enlargement. Cardia hemispheroid, 1/3 as wide as body. Vagina extending 1/4 to 1/3 across the body. Ovaries reflexed halfway to vulva. Lateral cords about 1/4 as wide as body, containing about 25 glandular organs, irregularly spaced, and more conspicuous towards the extremities, especially in the tail. These lateral organs are not paired, but more or less alternately arranged on the 2 sides of the body. Intestine 4 cells in circumference. Rectum and prerectum each about as long as anal body diameter. Tail blunt, rounded.

DIAGNOSIS: *Discolaimium sublatum* n. sp. is closely related to *Discolaimium latum* Thorne, 1939, from which it differs in the longer spear, the position of the guiding ring, (posterior to the post-labial constriction while anterior in *D. latum*), and the absence of the inner liplets.

TYPE LOCALITY AND HABITAT: Cultivated soil, Tobacco Research Station, Rustenburg, Transvaal.

HOLOTYPE: Slide *Discolaimium* 1b, collection of the Division of Entomology, Pretoria, South Africa.

PARATYPES: Slides *Discolaimium* 1a and 1c, same data as above. Also slide *Discolaimium* 3, deposited in the collection of the Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin, U.S.A.

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THORNE, G., and HELEN H. SWANGER. 1936. A monograph of the nematode genera *Dorylaimus* Dujardin, *Aporcelaimus* n. g., Dorylaimoides n. g. and *Pungentus* n. g. Capita Zool. 6: 1-223.

Five new species of Leptonchidae (Nemata: Dorylaimoidea) from South Africa*

JUAN HEYNS

The following is a first report on Dorylaimoidea collected during a preliminary survey of the nematode fauna of South Africa. Samples were taken from cultivated fields bearing various crops, including tobacco, maize, sunflowers, peanuts, etc., in several localities in the Transvaal, Orange Free State and Cape Province. Numerous new species representative of all the major soil and plant inhabiting groups were encountered, and it is intended to describe these and report on the known species in a series of papers.

GENUS LEPTONCHUS Cobb, 1920

Leptonchus transvaalensis n. sp. (Fig. 1 D-G)

FEMALE: 1.08-1.17 mm; a = 29-34; b = 5.5; c = 52-59; $V = {}^{15}56\%{}^{12\text{-}15}$

MALE: 0.97 mm; a = 27; b = 4.9; c = 42; T = 61%

DESCRIPTION: Body cylindroid, slightly ventrally arcuate when relaxed. Cuticle with fine transverse striae. Subcuticle coarsely striated, irregularly separated from outer layers. Lip region shaped as in *Leptonchus granulosus* Cobb, 1920, about 1/3 as wide as base of neck, and set off by strong constriction. Amphids 2/3 as wide as head, duplex, situated far forward at base of lips, the wide apertures extending anterior to the post-labial constriction. Spear slender, slightly dorsally arcuate, as long as width of lip region. Spear extension strongly arcuate, shorter than spear. Guiding ring a shallow truncated cone. Esophagus slender until it expands to form an elongate-pyriform basal bulb, which is about 1-1/3 times as long as the neck diameter. Nerve ring situated at middle of slender part of esophagus. Hemizonid not observed. Cardia discoid, as wide as base of bulb, which is 1/half as wide as corresponding body diameter. Intestine 2 cells in circumference, the cells containing coarse, yellowish, refractive granules. Junction of intestine to prerectum located about 2 body widths posterior to vulva (prerectum occupying 36% of total body length). Rectum slightly longer than anal body diameter. Tail very bluntly conoid, shorter than anal body diameter. Two pairs of caudal pores, one pair sublateral, almost terminal, the other pair subdorsal, just posterior to anus. Lateral cords 1/3 as wide as body, with pores arranged in 2 lines. Vulva a very small transverse slit, appearing almost circular in a lateral view. Ovaries reflexed 1/3 the distance back to vulva.

MALE: Anterior part of body similar to that of female, posteriorly strongly ventrally arcuate. Junction between testes near middle of body, anterior testis occupying 15% and posterior testis 12% of body length. Intestine joined to prerectum at about 10 body widths anterior to anus (prerectum occupying 31% of total body length). Spicula and lateral guiding pieces typical for the genus. Supplements consisting of an adanal pair and a ventromedian series of 9 beginning about 2 spiculum lengths anterior to anus. The 1st 4 of these are contiguous, the other 5 only slightly separated. Tail bluntly rounded, dorsally convex, ventrally somewhat arcuate.

DIAGNOSIS: *Leptonchus transvaalensis* n. sp. differs from all known species in this genus in having the supplements close together. The female can be

*Based partly on material adapted from a thesis done under the supervision of Professor Gerald Thorne, and presented to the Graduate School of the University of Wisconsin in partial fulfillment of the requirements of the degree of Doctor of Philosophy.

Present address: Division of Entomology, Private Bag 134, Pretoria, South Africa.

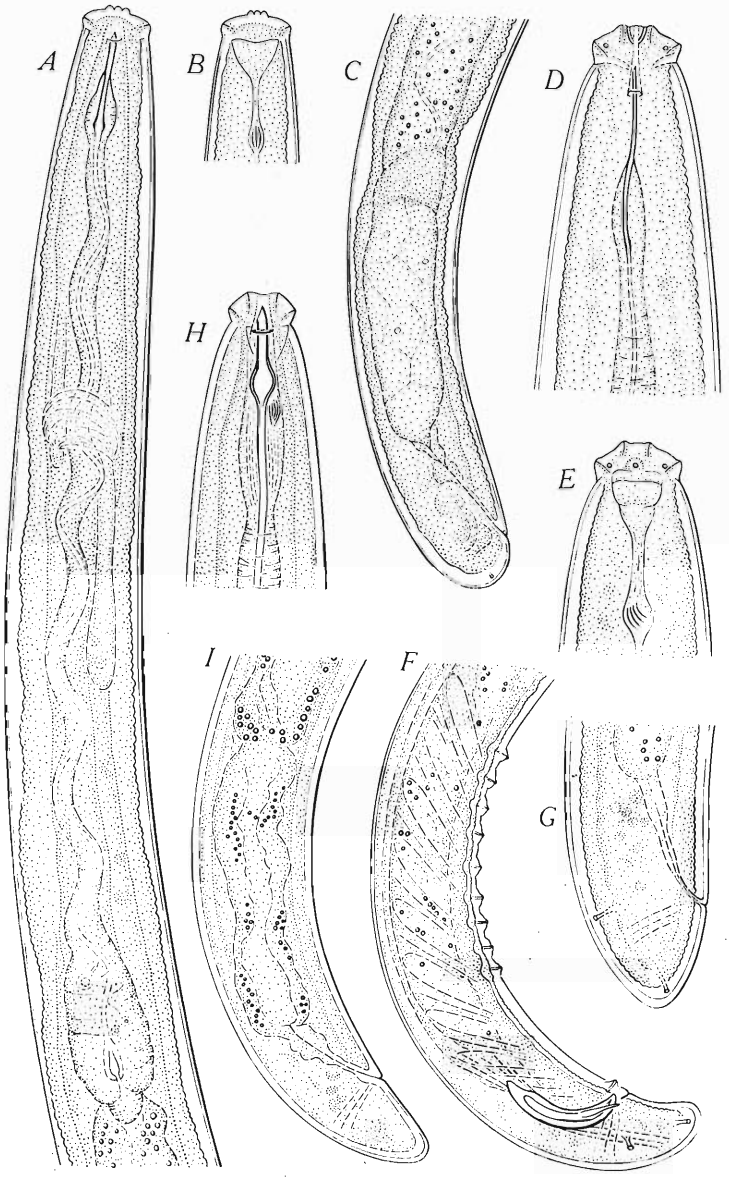

Figure 1. A-C: *Tyleptus striatus* n. sp.; A. Anterior portion of female, × 800; B. Surface view of head, showing amphid, × 800; C. Female tail, × 640; D-G: *Leptonchus transvaalensis* n. sp.; D. Head, × 1000; E. Surface view of head, showing amphid, × 1000; F. Male tail, × 450; G. Female tail, × 600; H-I: *Dorylaimoides thecolaimus* n. sp.; H. Head, × 1000; I. Female tail, × 640.

recognized by the duplex amphid, the prerectum reaching almost to the vulva, and the bluntly conoid tail.

TYPE LOCALITY AND HABITAT: Two females and a single male collected in the veld near Bethal, Transvaal.

HOLOTYPE (female) and ALLOTYPE (male): Slide *Dorylaimus* 10a, collection of the Division of Entomology, Pretoria, South Africa.

PARATYPE: Slide *Dorylaimus* 9, same data as above.

GENUS TYLEPTUS Thorne, 1939

DIAGNOSIS EMENDED: Leptonchinae. Body cylindroid. Outer cuticle smooth or with microscopic transverse striae. Subcuticle with refractive radial elements (*Tyleptus projectus* Thorne, 1939) or with transverse striae (*Tyleptus striatus* n. sp.). Lateral cords with 2 lines of coarse ducts reaching to the lateral pores. Six conspicuous, projecting liplets around the oral opening. Spear dorylaimoid with strongly sclerotized extension surrounded by conspicuous muscles. Guiding ring simple. Esophagus a slender tube until it expands to the pyriform basal bulb. Bulbar lumen in 2 sections, the posterior one forming a narrow, triquetrous, valvular chamber. Vulva transverse. Ovary single, reflexed.

TYPE SPECIES: *Tyleptus projectus* Thorne, 1939

The genus differs from *Leptonchus* Cobb, 1920, *Proleptonchus* Lordello, 1955 and *Tylolaimophorus* de Man, 1880 in the simple guiding ring and the duplex lumen of the esophageal bulb. From *Leptonchus* and *Tylolaimophorus* it further differs in being monodelphic, and from *Proleptonchus* in having the ovary posterior to the vulva, not anterior. The description of this hitherto monotypical genus is emended to include the species here described as *Tyleptus striatus* n. sp., which is closely related to *T. projectus,* but has a subcuticle like that of the genus *Leptonchus.*

Tyleptus striatus n. sp. (Fig. 1 A-C)

FEMALES (5): 0.74 (0.69-0.84) mm; a = 26 (24-31); b = 4.1 (3.9-4.2); c = 76 (65-84); $V = {}^{5.0\ (3.9\text{-}6.1)}\ 35\ (34\text{-}36)\%\ {}^{23.3\ (18.8\text{-}27.6)}$

DESCRIPTION: Body tapering slightly towards lips, which are 2/5 as wide as base of neck. Outer cuticle with microscopically fine transverse striae. Subcuticle with coarse, irregular, transverse annules, averaging about 1 micron in width. Lip region as in *Tyleptus projectus.* Spear length 2/3 width of lip region, the aperture occupying less than 1/3 its length. Spear extension heavily sclerotized, equal to spear in length. Junction between spear extension and lumen of esophagus thickened. Guiding ring frail, located far forward near base of lips. Amphids about 2/3 as wide as head. Esophagus beginning as a small ellipsoid muscular swelling enclosing spear extension, then continuing as a slender non-muscular tube in which the conspicuous lumen shows a zig-zag arrangement, until it enlarges into a pyriform basal bulb in which only 3 gland nuclei can be observed. Nerve ring situated about 1/3 the distance from the anterior end of the esophagus. Two elongate, probably glandular bodies are visible in the neck, a smaller dorsal one at about the level of the nerve ring, and a larger ventral one slightly more posterior. Two gland nuclei are present in the latter. Cardia hemispherical, 1/4 as wide as body. Intestinal wall with small refractive granules. Prerectum length about 3 times body width. Rectum length about 1-1/2 times anal body diameter. Tail hemispherical, with a pair of conspicuous subterminal papillae. Lateral cords 1/4 width of body. Vulva transverse. Vagina

extending half-way across body. Length of anterior uterine branch slightly more than body width. Ovary reflexed almost the whole distance back to vulva. In one aberrant specimen, the oviduct is coiled and the ovary out-

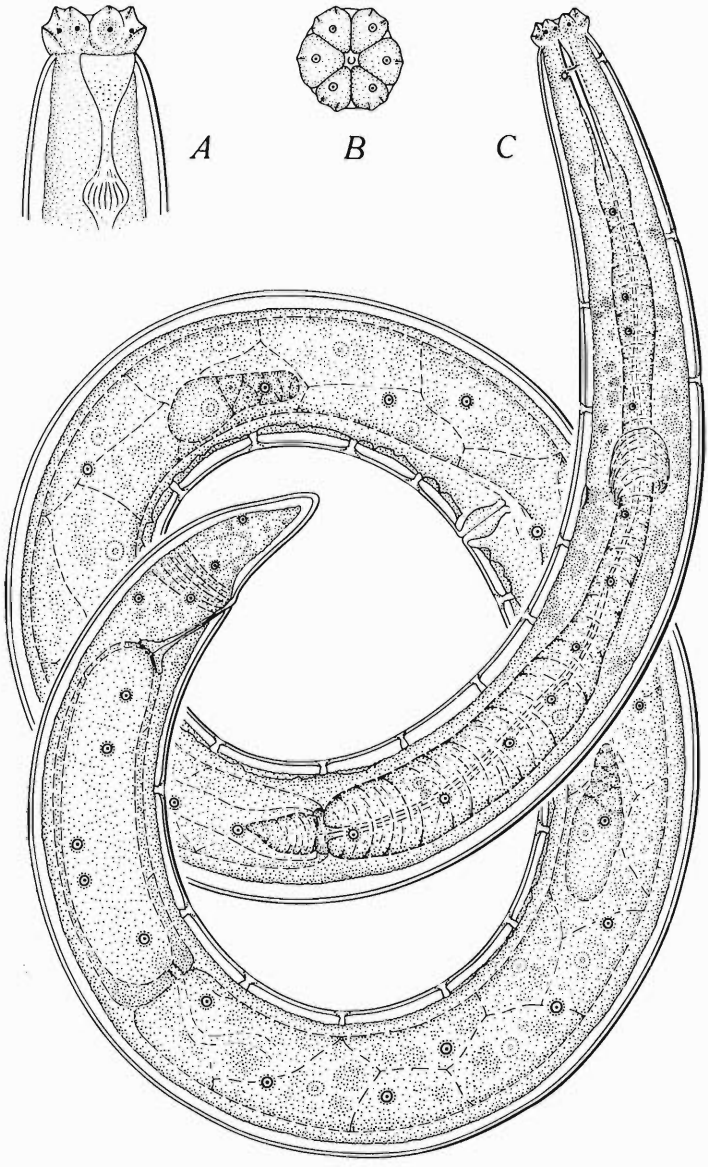

Figure 2. *Poronema porosum* n. gen., n. sp.
A. Surface view of head, showing amphid, × 1200; B. Face view, × 1200; C. Female, × 700.

stretched. Egg 3 body widths in length and 1/2 as wide as body. Male unknown.

DIAGNOSIS: *Tyleptus striatus* n. sp. differs from *Tyleptus projectus* Thorne, 1939 in the striated subcuticle, narrower and less angular spear, shorter spear extension, smaller cardia, and somewhat smaller size.

TYPE LOCALITY AND HABITAT: Five females and 2 immature specimens collected from cultivated fields, Rustenburg, Transvaal. June 1959 and 1960.

HOLOTYPE: Slide *Tyleptus* 1b, collection of the division of Entomology, Pretoria, South Africa.

PARATYPES: Slide *Tyleptus* 1a, same data as above. Also slide *Tyleptus* 4, deposited in the collection of the Department of Plant Pathology, University of Wisconsin, U. S. A.

GENUS DORYLAIMOIDES Thorne and Swanger, 1936

Dorylaimoides thecolaimus n. sp. (Fig. 1 H-I)

FEMALE: 0.95 mm; a = 33; b = 5.7; c = 52; V = $^{12.8}$ 60% $^{10.2}$

DESCRIPTION: Body cylindroid, tapering little towards extremities, and assuming a C-shape when relaxed. Cuticle with microscopic transverse striae. Lip region set off by constriction, slightly more than 1/3 as wide as base of neck. Spear length somewhat less than lip region width, the aperture occupying 1/4 its length. Spear extension shorter than spear, forming a heavily sclerotized wide chamber at the base of the spear. Guiding ring single, located near base of lips. Amphids 2/3 as wide as head. Basal 1/4 of esophagus enlarged to 1/2 the width of the neck. Dorsal gland nucleus situated close to anterior end of enlarged part of esophagus. Nerve ring surrounding esophagus at middle of neck. Cardia hemispherical, 1/3 as wide as body. Wall of intestine with large yellow refractive granules. Prerectum length slightly more than twice body width. Rectum 1-1/2 times anal body diameter in length. Tail bluntly conoid, without papillae, slightly more than 1 anal body diameter in length. Lateral cords 1/4 to 1/3 as wide as body. Vulva transverse. Vagina extending half-way across body. Ovaries reflexed more than half-way back to vulva. Male unknown.

DIAGNOSIS: *Dorylaimoides thecolaimus* n. sp. keys to *Dorylaimoides teres* Thorne and Swanger, 1936, from which it is easily distinguished by the peculiar development of the spear extension and the more posterior location of the vulva (60% as compared to 44% in *D. teres*).

TYPE LOCALITY AND HABITAT: One female and several immature specimens from soil beneath trees at Klapperkopfort, Pretoria.

HOLOTYPE: Slide *Dorylaimoides* 1, collection of the Division of Entomology, Pretoria, South Africa.

GENUS PORONEMA n. gen.

Leptonchinae. Conspicuous lateral pores arranged in two lines but spaced irregularly. Similar ventral and a few dorsal pores are present. Outer cuticle with minute striae. Subcuticle with coarse transverse striae. Spear with simple basal extension. Guiding ring single. Esophagus with elongate basal expansion, about 1/3 the length of the neck. Male of type species unknown.

TYPE SPECIES: *Poronema porosum* n. sp.

DIAGNOSIS: The genus is immediately recognized by the conspicuous ventral pores. It is exceptional also in the long basal enlargement of the esophagus, similar to that of *Dorylaimoides*.

Poronema porosum n. sp. (Fig. 2)*

FEMALES (5): 0.61 (0.55-0.67) mm; a = 21 (17-23); b = 3.8 (3.1-4.6;); c = 26 (24-29); V = $^{10.6\ (9.3\text{-}11.9)}$ 57 (56-58) % $^{10.5\ (9.9\text{-}11.2)}$

DESCRIPTION: About 28 to 38 large lateral pores, irregularly arranged in 2 lines, smaller towards extremities than on middle of body. The 1st of these is quite near the base of the lips, and the 3rd and 4th are close together. About 19 to 22 similar ventral pores are present, the 1st one opposite the 3rd lateral pore, the last one beyond the middle of the prerectum. Three similar dorsal pores occur on the 1st half of the neck.

Lip region angular, as wide as adjoining head from which it is separated by a strong constriction. Papillae very prominent. Spear length slightly more than width of lip region, the aperture occupying about 1/4 its length. Spear extension moderately sclerotized, equal to spear in length. Amphids stirrup-shaped, 3/5 as wide as head. Sensilla pouch exceptionally wide. Esophagus starting as a slight ellipsoid swelling enclosing junction of spear extension and lumen of esophagus, about 1/3 as wide as body. This is followed by a slight narrowing whereupon it widens again, and finally expands in its basal 1/3 to twice the diameter of the anterior part. Large dorsal gland nucleus and 1 pair of submedian gland nuclei observed. Nerve ring surrounding slender anterior portion of esophagus at about 1/3 its length from the basal expansion. Hemizonid opposite base of nerve ring, between 2nd and 3rd ventral pores. Cardia conoid, 1/4 to 1/3 as wide as body, attached to base of esophagus by a discoid structure. Rectum length equal to anal body diameter. Prerectum 2 to 3-1/2 times as long as rectum. Tail dorsally convex-conoid to rounded terminus.

Vulva transverse. Vagina extending about 1/3 across body. Ovaries paired, opposed, reflexed. No spermatozoa present in the young females collected.

TYPE LOCALITY AND HABITAT: Five females from cultivated soil, Rustenburg, Transvaal. June, 1959.

HOLOTYPE: Slide *Poronema* 1, collection of the Division of Entomology, Pretoria, South Africa.

PARATYPES: Slides *Poronema* 1a, 1b and 1c, same data as above.

GENUS BOTALIUM n. gen.

Leptonchinae. Body cylindroid. Outer cuticle smooth. Subcuticle striated. Lateral pores coarse, arranged in 2 lines. Spear slender, with flanged extension. Guiding ring double. Basal bulb of esophagus set off by constriction. Caudal pores conspicuous. Vulva transverse. Ovaries 2, reflexed. Testes, spicula and supplements dorylaimoid. Lateral guiding pieces present. Tails of sexes similar.

TYPE SPECIES: *Botalium eversum* n. sp.

DIAGNOSIS: This genus resembles *Xiphinemella* Loos, 1950, of the Longidoridae, but can be distinguished from it by the absence both of sclerotized plates in the vestibule and excretory pore, and anterior location of the guiding ring. Within the Leptonchinae it resembles *Doryllium* Cobb, 1920 in

*Note: After this paper went to press, the author discovered further specimens of the nematod described here in as *Poronema porosum*. Examination of these reveealed that the nematode is polymyarian, thus not a leptonchid, and could probably best be placed in the genus *Lordellonema* Andrassy, 1960, in spite of certain discrepancies, such as absence of the scale-like structures and double guiding ring mentioned by Lordello for *L. bauruense* (Lordello, 1957) Andrassy, 1960, and the presence of a few dorsal pores. *Poronema* thus becomes a synonym of *Lordellonema*, and the new species becomes *Lordellonema porosum*.

having a flanged spear extension and basal bulb set off by constriction, but differs from it in having a striated subcuticle and 2 ovaries, corresponding in these respects with *Leptonchus* Cobb, 1920.

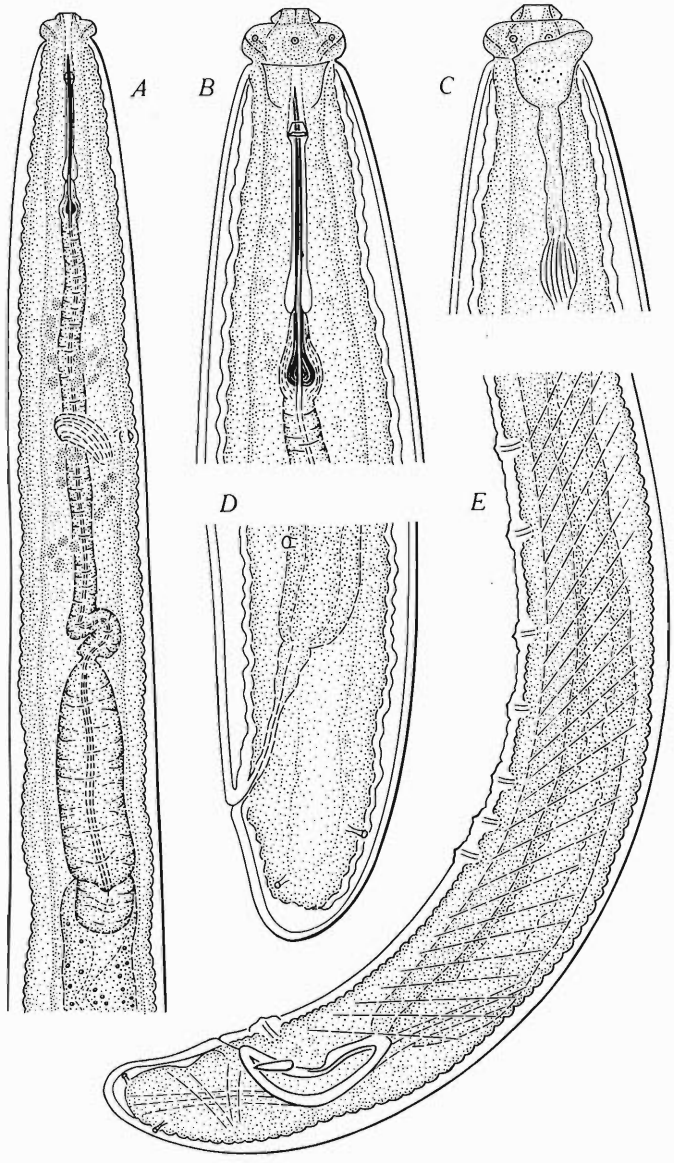

Figure 3. *Botalium eversum* n. gen., n. sp.

A. Anterior portion of female, × 550; B. Head, × 1000; C. Surface view of head, showing everted amphid, × 1000; D. Female tail, × 850; E. Mail tail. × 550.

Botalium eversum n. sp. (Fig. 3)

FEMALE: 1.37 mm; a = 34; b = 5.5; c = 63; V = $^{12.8}56\%$ $^{12.4}$

MALE: 1.35 mm; a = 34; b = 6.1; c = 45; T = 65%

DESCRIPTION: Body cylindroid, straight when relaxed, except posterior portion of male curved ventrally. Outer cuticle smooth; subcuticle coarsely striated, irregularly separated from outer cuticle. Lips closely amalgamated, rounded, with a button-shaped labial disc, about 1/2 as wide as lip region. Lip region slightly more than 1/3 as wide as base of neck, set off by a strong constriction. Amphids stirrup-shaped, 3/4 as wide as head with the amphidial pockets everted by fixation in both specimens collected. Spear length almost twice lip region width; junction with spear extension obscure. Spear extension equal to spear in length, with strongly sclerotized flanges. Guiding ring double. Esophagus slender, 1/8 as wide as neck, beginning with a small muscular section surrounding base of spear extension. Basal bulb 1/2 as wide and 1-1/2 times as long as neck diameter, set off by constriction. Nerve ring at middle of neck. Hemizonid present opposite nerve ring. Cardia cylindroid, almost as wide as basal bulb. Intestine with yellowish almost colorless granules, conspicuous only towards junction with prerectum. Prerectum extending more than 1/3 the distance to vulva, 26% of total body length. Rectum about as long as anal body diameter. Tail dorsally convex, ventrally slightly arcuate, bluntly rounded. Two pairs of caudal pores, the one subdorsal, slightly behind the anus, the other submedian, nearer to the terminus. Vulva transverse. Ovaries symmetrical, reflexed about 1/3 the distance back to vulva.

MALE: Anterior part of body similar to that of female. Testes, spicula and supplements dorylaimoid. Lateral guiding pieces lying somewhat oblique across spicula. Prerectum same length as in female. Supplements consisting of an adanal pair and a ventro-median series of 7, beginning about 2 spiculum lengths anterior to anus, the 1st 3 nearly contiguous, the other 4 spaced about 1/2 body width apart.

DIAGNOSIS: *Botalium eversum* n. sp. resembles *Botalium esseri* (Chitwood, 1957) n. comb. (syn. *Xiphinemella esseri* Chitwood, 1957) which is transferred to this genus on account of the absence of sclerotized plates in the vestibule and excretory pore, and the possession of a meromyarian intestine. *Botalium eversum* n. sp. can be distinguished from *B. esseri* (Chitwood, 1957) by the more closely amalgamated lips, smaller size (1.3 mm as compared to 2.2-3.5 mm), more posterior location of the vulva (56% as compared to 42-47%) and the special arrangement of the supplements in the male (In specimen of *B. esseri* (Chitwood, 1957) examined by author the supplements are situated at regular intervals).

TYPE LOCALITY AND HABITAT: A single male and female collected from soil about maize and cowpea roots in a field near Bothaville, Orange Free State.

HOLOTYPE (female) and *allotype* (male): Slide *Botalium* 1, collection of the Division of Entomology, Pretoria, South Africa.

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Development and Survival of Some Roundworm Larvae of Cattle at High Altitudes in Wyoming

THOMAS M. SCHWINK

Wyoming is a mountainous state with much of the good grazing land at high altitudes, accessible to cattle and sheep during only a few months of the summer. The rest of the year the animals graze on the lower-altitude plains and mountain valleys. In the Medicine Bow National Forest of southeastern Wyoming, cattle graze the lower and less rugged areas. Higher and rougher country is used by sheep. The period in which the cattle are in the forest varies somewhat with the weather, but in the area studied it is usually about July 10 to October 1. The work reported here was begun to determine whether any of the common roundworms of cattle could complete development and survive until the following summer under the conditions prevalent here at high altitudes.

MATERIALS AND METHODS

Grass was collected from around piles of 1959 cattle dung at eight sites in the Medicine Bow Range during August of 1959. During June of 1960 and June of 1961 grass samples were collected from around piles of the previous year's dung at nine sites, in most cases in the same locations as the 1959 collections. It is possible that a few of the June collections were from dung more than one year old. This would not seriously alter the significance of the findings, since the object of these collections was to determine whether the larvae could develop and overwinter there. The June collections were made before cattle entered the area; thus any larvae found had survived at least one winter. Grass samples were baermannized in the laboratory and larval counts made under the microscope.

An experimental plot was fenced at the University of Wyoming Science Camp in the Medicine Bow range at an altitude of about 9880 feet. Two piles of dung were placed on this plot on eleven different dates; two in 1959, seven in 1960, and two in 1961 (Table 1). Dung was also placed in duplicate piles on these dates in 1959 and 1960 on two fenced plots (one dry and one wet) on the Laramie Plains at Red Buttes. This is about ten miles south of Laramie and at an altitude of about 7300 feet.

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The dry plot is similar to most of the surrounding countryside used in this area for grazing cattle. The soil is very dry most of the year and the vegetation consists chiefly of short native grasses. The second plot, the wet plot, is located a short distance away along an intermittent stream. The water table there is high and the surface soil moist most of the year. Sedges dominate the vegetation.

The piles weighed about 1500 grams each and were from cattle with mixed nematode infections. Eggs per gram on different occasions ranged from 50 to 345. Nearly all were of the genera *Cooperia* and *Ostertagia*. Very few *Nematodirus* eggs were present. *Coopria oncophora* was the most abundant species present, outnumbering all others combined. Since little difference was noted in survival of the two predominant genera, they were not considered separately in compiling the results.

Dung was examined for eggs and larvae three weeks after being placed out, and for larvae, when possible, at six to eight (usually seven) weeks and twice during the following summer. At the same time as the dung samples were collected, except at three weeks, the grass from around the pile was cut and baermannized to recover larvae. Alternate piles were sampled in successive examinations.

Temperatures in the dung were recorded at Red Buttes throughout the year and at the Science Camp during the summer months. During winter (October through May) the Science Camp plot was covered with snow and was accessible in most cases only on snowshoes. Temperatures were recorded there even during this period whenever possible.

Precipitation records at the plots were not available. For precipitation comparisons, amounts at Laramie (altitude 7200 feet) and at Foxpark (altitude 9060 feet) in the Medicine Bow range were used. The Laramie precipitation is probably very similar to that at Red Buttes and the Foxpark precipitation slightly less than that at the Science Camp.

RESULTS AND DISCUSSION

Infective larvae of the genera *Cooperia, Ostertagia,* or both were recovered from grass around 1959 cow dung in six of the eight locations in the Medicine Bow cattle range sampled in August of 1959. Numbers recovered were small, averaging less than one larva per pile in the positive locations. In June 1960 six of nine locations were positive, averaging five larvae per pile in the positive locations. In June 1961 seven of nine locations were positive, averaging four larvae per pile in the positive locations.

Results obtained with the plots are summarized in Table 1. From a practical standpoint, the number of larvae recovered from vegetation is of greatest significance. Development and survival at the Science Camp were good in most of the trials. Frequently the worms did better there than on either Red Buttes plot. Compared with the results obtained in the other trials, development and survival were poor at the Science Camp in both trials started during the last week of August and in one of the two trials started in September.

In both 1959 trials, no larvae were recovered from the Red Buttes dry plot after August 15 of the following summer (1960). From the 1960 dung, however, larvae were uniformly recovered after August 15, 1961 at Red Buttes; the sampling in most cases being more than a year after the dung was deposited. This difference was probably the result of much wetter weather in 1961. Precipitation at Laramie for May through September of 1961 totaled 11.23

inches, compared with 4.33 inches in 1960 and the normal of 6.77 inches. At Foxpark the precipitation for this five-month period was 9.42 inches in 1961 and 4.09 inches in 1960, while the normal is 7.56 inches. In winter, differences in precipitation between mountains and plains are more pronounced. Thus, in the two winters of this study, snowfall totaled 314 inches at Foxpark and only 96.4 inches at Laramie.

Temperatures in the dung at the Science Camp were cooler in summer and warmer in winter than those at Red Buttes. Maximums observed were above 128° F. at Red Buttes (higher than the recorder could register), and 101° F.

Table 1. Nematode larvae recovered from the Science Camp (S. Camp) and Red Buttes (RB) Plots.

		Percent eggs as larvae in dung and on vegetation				Number of larvae recovered from vegetation		
				Following summer			Following summer	
Deposit Date	Location	3 weeks	6-8 weeks	before Aug. 15	after Aug. 15	6-8 weeks	before Aug. 15	after Aug. 15
8-26-59	S. Camp	0	0	0	†		0	3
	RB wet	1.7	2.5	0.6	5.9		7	33
	RB dry	0	0.6	2.5	0		1	0
9-16-59	S. Camp	0		40.2	23.1		13	756
	RB wet	0		2.4	1.1		0	1
	RB dry	0		0	0		0	0
6-22-60	S. Camp	50.0	19.4	1.6	1.4	112	155	32
	RB wet	64.0	5.9	0.5	0.01	20	58	15
	RB dry	17.2	8.0	1.3	6.2	3	4	1
7-6-60	S. Camp	28.7	107.6	0.34	0.31	97	16	3
	RB wet	4.4	11.8	0.01	†	2	68	1
	RB dry	5.3	5.8	1.8	3.4	0	2	4
7-20-60	S. Camp	36.9	46.1	1.3	2.5	297	76	122
	RB wet	20.6	60.0	0.14	1.9	3274	15	24
	RB dry	9.6	24.2	1.6	1.4	165	94	20
8-3-60	S. Camp	12.5	18.6	2.2	1.7	28	23	66
	RB wet	6.3	3.7	0.28	†	246	52	2
	RB dry	13.3	8.8	1.6	1.4	234	1	4
8-17-60	S. Camp	21.1	62.9	†	3.5	0	12	48
	RB wet	0.4	2.3	†	4.7	34	9	5
	RB dry	0	2.0	0.84	0.51	61	1	7
8-31-60	S. Camp	10.3		†	†		1	3
	RB wet	6.3		1.5	0.90		46	121
	RB dry	9.7		3.0	0.47		17	15
9-14-60	S. Camp	1.9		†	0		1	0
	RB wet	14.0		1.5	15.6		415	41
	RB dry	12.4		1.9	3.3		74	24
7-5-61	S. Camp	19.4	1.4			18		
7-19-61	S. Camp	55.6	3.0			97		

† = less than 0.01%

at the Science Camp. Minimums were +27° F. at the Science Camp and —1° F. at Red Buttes. Lowest temperature observed in the dung at the Science Camp during the period of complete snow cover was +31.5° F. These dung temperatures were, of course, much higher than the standard exposed shade temperatures commonly cited by other investigators. Maximum official temperature recorded at Laramie during the test period was 89° F.

These survival times of at least a year are longer than those reported in warmer climates for members of the genera *Cooperia* and *Ostertagia* from cattle (Alicata, 1961; Bell *et al.*, 1960; Williams, 1961). Good overwinter survival of *C. oncophora* and *O. ostertagi* from cattle has been reported in moderate and cool climates (Drudge *et al.*, 1958; Goldberg and Rubin, 1956; Goldberg and Lucker, 1959). Goldberg and Lucker (1959) found that *C. oncophora* survived at least 329 days at Beltsville, Maryland. Honess and Bergstrom have advised the writer that they recovered *Cooperia* larvae 382 days after dung containing eggs was put out at Red Buttes. Seghetti (1948), working with sheep, reported survival of *Ostertagia* for one year and seven months, a period which included two winters. Kates (1950), who also worked with *Ostertagia* from sheep, reported that this genus does best in cool weather and can endure considerable cold.

In view of the work cited above, it is not surprising to find *Cooperia* and *Ostertagia* developing and surviving for long periods in Wyoming's cool climate. Roundworms are apparently not a serious menace in this high-altitude grazing area, however. Numbers of grazing animals per unit area are low, and numbers of larvae recovered from vegetation in the grazing area were not high. Cases of clinical parasitism among the animals on the range are rare.

SUMMARY

Development and survival of *Cooperia* and *Ostertagia* were observed at a high-altitude plot (9880 feet) in southeastern Wyoming, and at comparison plots at an altitude of 7300 feet. Survival of both genera for more than a year was observed on the plots at both altitudes.

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Combination Die for Making Aluminum Micro Slides*

E. B. B. MASON and J. E. BOSHER

Nematologists have recognized that the Cobb slide (Cobb, 1917) for microscope mounts, consisting of a metal slide, a square cover-slip, a round cover-slip and two pasteboard tabs (Courtney, 1936) is superior to the ordinary glass slide mount in many respects. For example, the Cobb slide can be examined under a microscope from both sides, is light, durable and can be stored close-packed with no risk of the sealing compound sticking to other slides. It is also less subject to breakage, an important consideration when valuable mounts are to be examined by students, or mailed. If readily available at a reasonable cost they could be applied to related sciences such as bacteriology, or produced commercially for students. The slides are made from pre-cut aluminum blanks described by the manufacturer, Aluminum Company of Canada, Kingston, Ontario, as Alcan 57S½H mil sheet flat, 3 inches by 31 mm. by .010 inch thickness.

Apparatus for the construction of Cobb slides have been described by Courtney (1936) and Jutras and Tarjan (1961). The equipment in each case consists of two machines, (a metal punch and die assembly, and a slide former), each of which requires two separate operations.

This paper describes a new machine (Figure 1) that punches and forms Cobb metal slides with a single lever movement. The machine is 10 by 4¼ by

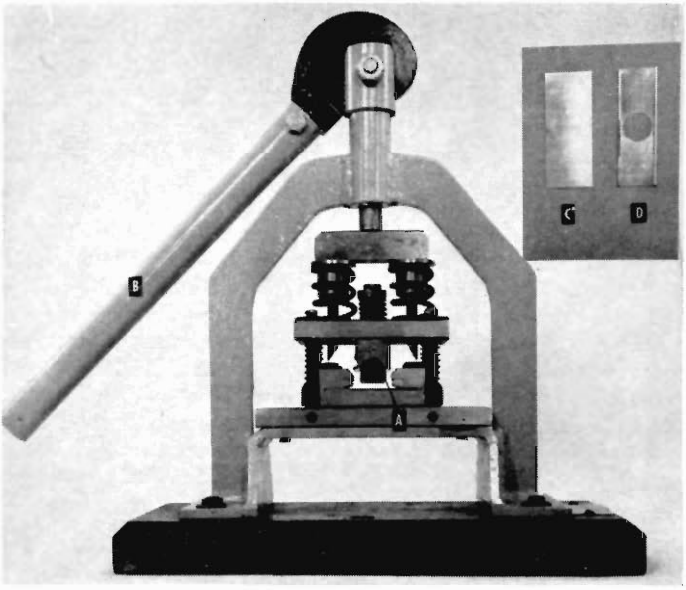

Fig. 1. Combination die for making aluminum micro slides. An aluminum blank (C) is inserted in the die at (A). The hand lever (B) is rotated approximately 230° to activate the die and apply pressure to transform the blank into the finished slide (D). When the lever is returned to its starting position, a spring-loaded ejector at the back of the die removes the slide.

*Contribution No. 190, Experimental Farm, Research Branch, Canada Department of Agriculture, Saanichton, B. C.

13 inches in height and weighs 17 pounds. Mild steel is used throughout except for the tool steel punch and springs. Surface areas subject to wear are case hardened. The machine can be fixed to a bench or mounted on a wood base. Its capacity is 6 to 8 slides per minute.

The machine could be constructed by students under supervision for $15 to $20 for materials, or made commercially for $150 to $200. Plans are available from the Experimental Farm, Canada Department of Agriculture, Saanichton, British Columbia.

The chief advantages of the Saanichton machine are its simplicity and speed of operation and accuracy in reproducing Cobb slides by unskilled workers. Slides produced in this machine, complete with cover-slips, cost $5.25 per gross compared to $6.00 for glass slides produced commercially.

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Orycytolaelaps kuntzi n.sp. (Acarina: Laelaptidae) from a Formosan Mole, *Talpa insularis* Swinhoe*

CONRAD E. YUNKER

In an effort to discriminate among parasites likely to cause disease in Formosa, the U. S. Naval Medical Research Unit No. 2, Taipei, has maintained a long-term collecting program of Formosan vertebrates and their parasites. Among the mites collected was a new species of *Oryctolaelaps* Lange, 1955 which is described here.

The monotypic genus *Oryctolaelaps* was erected for *O. bibikovae* Lange, 1955 off *Mogera robusta* (= *Talpa wogura robusta* Nehring, 1891), an Old World mole. Lange's illustration of this species (as reproduced by Bregetova, 1956) shows two pairs of setae on the margin of the epigynial plate in addition to the epigynial setae, which are submarginal. Although I was not able to see the holotype, two authentically identified specimens of each sex of *O. bibikovae* were made available to me by Academician N. G. Bregetova, of the Academy of Sciences, U.S.S.R. Both females show only one pair of setae on the epigynial plate. All other adjacent setae are on the soft integument. In this respect *O. bibikovae* is similar to all specimens of *O. kuntzi* n. sp. examined. The following generic diagnosis is modified from that of Strandtmann and Wharton (1958).

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The mites upon which this paper is based were collected by Dr. Robert E. Kuntz CDR, MSC, USN, Head of the Department of Parasitology, U. S. Naval Medical Research Unit No. 2, Taipei, Formosa. Dr. David H. Johnson, Curator of Mammals, U. S. National Museum, identified the hosts and advised on their interspecific relationships. Academician Nina G. Bregetova, of the Zoological Institute of the Academy of Sciences, U.S.S.R., Lenigrad, kindly made specimens of *O. bibikovae* available for study. Dr. R. W. Strandtmann, Department of Biology, Texas Technological College, and Dr. J. M. Brennan, Middle America Research Unit and Rocky Mountain Laboratory, read the manuscript.

Oryctolaelaps Lange, 1955

Laelaptinae, grossly with general facies of *Laelaps*. Female sternal plate reduced; third sternal setae on small platelets posterior to sternal plate. Epigynial plate linguiform, with a single pair of setae. Anal plate broad, triangular, with three setae; anal opening in center of plate. Dorsal plate panduriform, broadly rounded posteriorly; with some heavy, elongate anterior setae, a single elongate terminal pair, and many minute pairs. Peritreme segmented, elongate and extending anteriorly to level of coxae I. Tectum lobular. Chelae chelate; movable digit dentate; fixed digit reduced, with a clavate pilus dentilis. Coxae I, II and III each with a piliform anterior seta and a robust posterior seta; posterior setae of I and II elongate, that of III short and spiniform, single seta of coxa IV short and piliform. Male holoventral plate fused with anal plate, not greatly expanded posteriad to coxae IV; with 23 setae. Spermatodactyl elongate and scaphiform.

Oryctolaelaps kuntzi n. sp. Fig. 1 (a, b, c)

HOLOTYPE FEMALE, idiosoma: 370 microns wide by 592 microns long, exclusive of gnathosoma. DORSUM: Dorsal shield panduriform, with prominent shoulders, narrowest medially, becoming wider posteriorly, and terminating in broadly rounded posterior margin; dimensions: 590 microns long, 295 microns wide at shoulders, 266 microns wide at midpoint, 289 microns wide posteriorly; shield not covering entire dorsum; with 35 pairs of setae, four anterior pairs (D2, M1, M2 and M3) elongate (71-100 microns) and very thick, three anterior pairs (D1, D3 and L5) short (20-30 microns) and spiniform, a single terminal pair is elongate (77 microns) and piliform, and remaining 28 pairs minute (<16 microns); all setae nude but terminal pair, which bears minute apical serrations; surface ornamented with reticulations, regular punctations and scattered minute pores. Soft integument without setae. VENTER: Tritosternum with two pilose lacinae. Sternal plate rectangular, twice wider than long (130 microns by 63 microns); with two pairs of elongate (74 microns) thick setae, and two pairs of pores. Third pair of sternal setae similar to first two pairs, located on small triangular platelets connected to posterolateral angles of sternal shield by fine sclerotized apodemes. Metasternal setae similar to sternal setae, located at endopodal area between coxae III and IV. Epigynial plate linguiform, with a single pair of setae similar to sternal setae; anterior portion ornamented with scalelike markings, posterior with broad bands. Anal plate triangular, with slightly concave anterior margin; anus situated in center of plate; paired adanal setae arising at level of midpoint of anus, 63 microns long, similar to other ventral setae; single postanal seta much longer (82 microns), arising anterior to small cribrum. Soft integument with 20 or 21 pairs of setae similar to those on ventral plates, but shorter (37-66 microns). Metapodal platelets elongate (30 microns) and narrow. Stigma on ventrolateral surface between coxae III and IV; peritreme 4-segmented, extending from stigma anterodorsally to level of anterior margin of coxa I; peritremalia coalescing with dorsal plate at point posteriad to seta L2, not encircling coxa IV posteriorly.

GNATHOSMA: Deutosternum with 6-9 rows of 1-3 anteriorly directed teeth per row. Gnathosomal setae shorter (33 microns) than medial hypostomal setae (40 microns); both pairs of these longer and much heavier than lateral (14 microns) and distal (22 microns) hypostomal setae. Tectum membranous; anterior margin broad, lobular and somewhat irregular. Chelicerae stout, second segment 78 microns long by 19 microns wide; a pair of short

piliform structures arising at base of movable chela; chelae chelate, movable digit much longer and thicker than fixed digit, with two recurved teeth and an apical hook; fixed digit short and narrow, bearing an elongate, clavate pilus dentilis.

LEGS: Segments of all legs short and thick; legs terminating in heavy claws and caruncles. Coxae I and II each with one elongate thick seta similar to sternal setae and one thinner elongate seta. Anterodorsal spur present on coxa II. Coxa III with two setae, posterior one short, thick, and spiniform. Coxa IV with a single, weak, piliform seta. Some dorsal setae of femora and genua I and II comparatively heavy and elongate.

ALLOTYPE MALE, idiosoma: 470 microns long by 295 microns wide. DORSUM: Dorsal shield similar in shape and setation to that of female, covering entire dorsum. VENTER: Holoventral plate coalescent with anal plate, not greatly widened posteriad to coxae IV; with 11 pairs of setae plus a single adanal seta; all setae somewhat heavier and longer than nine pairs on adjacent soft integument. Metapodal plates elongate and narrow. Peritremalia similar to that of female but coalescing with dorsal shield posteriad to seta L4.

GNATHOSOMA: Setation similar to that of female gnathosoma. Chelicerae stout; fixed chela reduced, bearing an elongate, clavate pilus dentilis; movable chela longer, edentate, bearing an elongate scaphiform spermatodactyl that resembles those of many *Laelaps* and *Haemolaelaps* spp.

LEGS: Similar to those of female.

OTHER STAGES: Egg, seen within idiosoma of paratype female, oval and nearly circular in outline, 32 microns long by 27 microns wide.

ENGORGED PROTONYMPH: differing from female mainly in size (695 microns long by 444 microns wide), sclerotization and setation. Dorsal shield divided; propodosomal portion a triangle with undulating margins, seven pairs of elongate, robust setae, and eight pairs of minute setae; opisthosomal portion reniform with a straight anterior margin and a concave posterior margin, smaller than propodosomal portion, with seven pairs of minute setae and a single pair of elongate terminal setae. Soft integument of dorsum with three pairs of circular platelets, eight pairs of moderately long setae, and three pairs of minute setae. Ventral plate long and rectangular (133 microns by 74 microns), bearing three pairs of elongate heavy setae and two pairs of pores. Anal plate broad and oval, with three elongate stout setae, the postanal longest. Soft integument of venter with four pairs of setae similar to those on plates, and a single, short piliform pair. Stigma located on venter laterad to coxa IV. Peritreme short (53 microns) and 4-segmented, terminating dorsally. Gnathosoma similar to that of female. Coxa I with a posterior bifid spine that bears a slender elongate seta in its fork. All other coxae as in female.

TYPE-MATERIAL: Holotype female (U.S.N.M. No. 2816) off *Talpa insularis* Swinhoe, 1862, Yung Foh Lee, Yang Ming Shan, Formosa—taken 7 mi S of Taipei, at 650 ft, agricultural, cultivated, rice paddy area adjacent to low mountainous woods, and shrub (secondary growth)—10 August 1960, collected by R. E. Kuntz (PF 8295), deposited in the U. S. National Museum. Allotype and two paratype males, three paratype nymphs and 17 paratype females, bearing same data as holotype deposited in the U. S. National Museum.

Five paratype males and 20 paratype females off same host, Yung Foh Lee, Ming Shan Admin., Formosa, 15 March 1960, collected by R. E. Kuntz

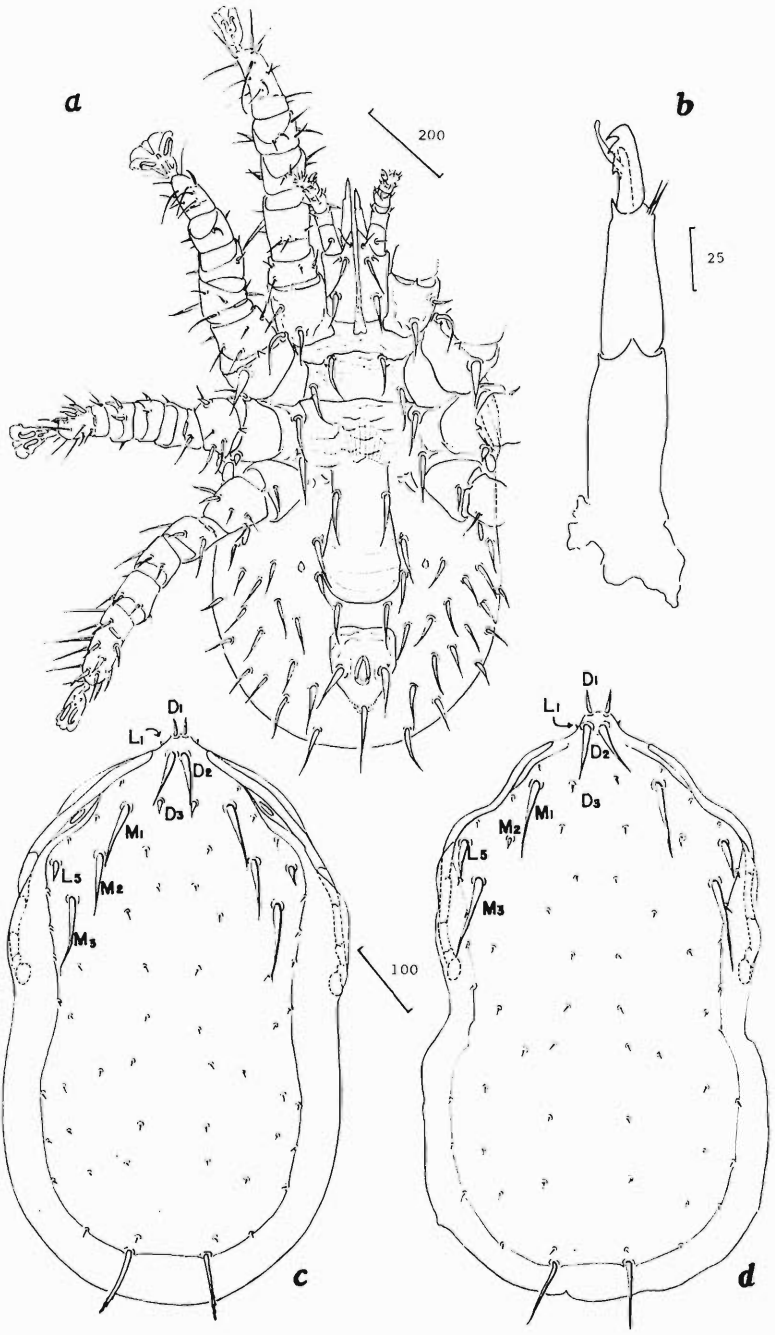

Fig. 1 (a, b, c), *Oryctolaelaps kuntzi*, n. sp., female, a) venter, b) chelicera, c) dorsal shield; d) *Oryctolaelaps bibikovae* Lange, dorsal shield of female. (scales in microns)

(PF 7118), deposited in the U. S. National Museum. Remainder of material, consisting of four paratype males and 44 paratype females bearing these data, distributed among the collections of the following institutions: Rocky Mountain Laboratory, Hamilton, Montana; Institute of Acarology, Agriculture Experiment Station, Wooster, Ohio; Snow Entomological Museum, University of Kansas, Lawrence, Kansas; British Museum (Natural History), London; Entomology Research Institute, Canada Department of Agriculture, Ottawa, Ontario; Zoological Institute, Academy of Sciences U.S.S.R., Leningrad; Natal Museum, Pietermaritzburg; South Australian Museum, Adelaide; Musée National d'Histoire Naturelle, Paris; Institute Royal des Sciences Naturelle de Belgique, Brussels; Instituto Butantan, Sao Paulo.

REMARKS: No significant variation in size (as indicated by dorsal shield measurements) was evident in the sample of 81 females of *O. kuntzi*. The longest dorsal plate was 608 microns and the shortest was 587 microns. The two females of *O. bibikovae*, however, were noticeably larger; their dorsal shields both measured 620 microns. Excluding size, *O. kuntzi* is quite similar to the latter species and differs apparently only in setation of the dorsal shield. This difference may be expressed by the following couplet (Fig. 1 c, d):

M2 robust, elongate, approximately equal to M1 or M3; L5 short, approximately equal to D3 ..... *O. kuntzi*, n. sp.

M2 minute, approximately equal to D3; L5 elongate, nearly one-half as long as M1 or M3 ..... *O. bibikovae* Lange

This small but definite dissimilarity is taken as indicating specific difference, but future collections of *Oryctolaelaps* from Talpidae in other areas may prove it to be only of subspecific value. According to Dr. David H. Johnson (personal communication), the hosts of the two species of *Oryctolaelaps, Talpa wogura* and *T. insularis*, are also closely related (i.e., in the subgenus *Mogera*).

Tipton (1960) doubted that the mole was the true host of *Oryctolaelaps*, but in view of the NAMRU-2 collections it seems likely that this is a true host-parasite relationship.

SUMMARY

Oryctolaelaps kuntzi, n. sp., off *Talpa insularis* Swinhoe from northern Formosa, is described from the female and is compared with the type-species and only other member of the genus, *O. bibikovae*, Lange, 1955. Egg, protonymph and male are also described. The genus *Orytolaelaps* Lange, 1955 is redefined.

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A Note on the Structure of Nematode Ocelli*

D. G. MURPHY

Little information is available regarding anatomical aspects of nematode ocelli, and the manner in which ocelli relate to the phylogeny of the Nemata. Observations of carefully preserved specimens of *Acanthonchus rostratus* Wieser, 1959, have given further information about their structure. This species possesses dorso-lateral, paired ocelli which clearly manifest ocelli per se to be composed of a lensatic unit and a chromatic unit as portions of a spindle shaped, tuboid structure (fig. 1, A). Anteriorly this structure narrows considerably and terminates at the body wall. The posterior extension is directed toward the nerve-ring, but could not be traced with certainty to that organ. Whether a pore communicates externally, or the tuboid apparatus is cuticular in composition, has not been ascertained. In some specimens there is indication of an additional cell located posteriorly to the chromatic unit (fig. 1, B), containing sparsely distributed pigmented granules. This may be the pigment cell discussed by Schulz (1931) and Timm (1951).

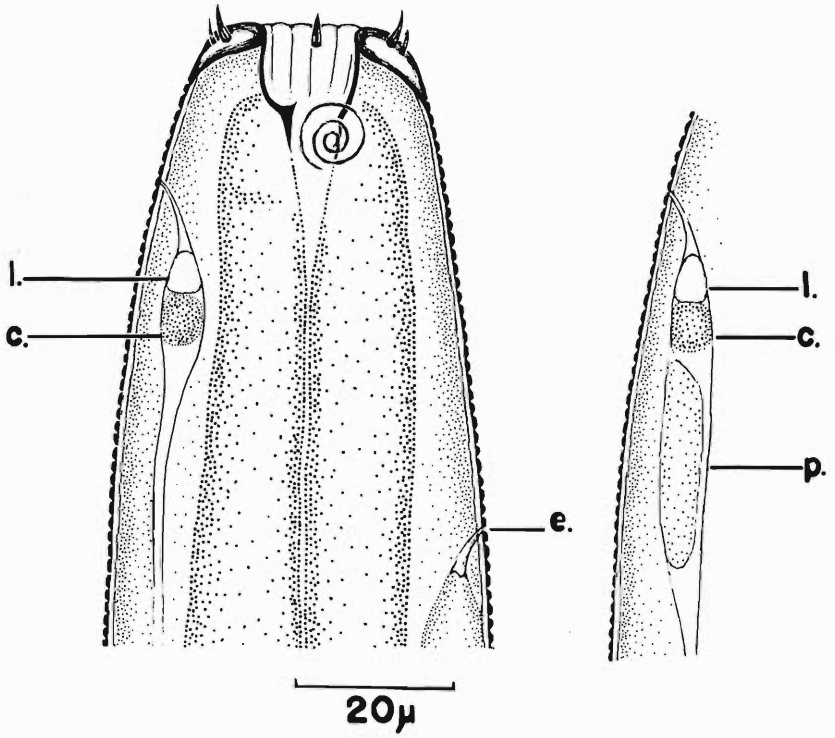

Fig. 1. Acanthonchus rostratus. A, anterior end of female. B, anterior dorsal area of another female. (l. = lensatic unit; c. = chromatic unit; e. = excretory pore; p. = pigment cell.)

*From the Department of Botany and Plant Pathology, Oregon State University, Corvallis, Oregon. Research Paper No. 423.
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These observations substantiate a similar report by Schulz of external ocellar communication in *Parasymplocostoma formosum* Schulz, 1931. Similar findings exist in the features of an anterior canal, lensatic and chromatic units, and possibly the pigment cell, the latter demonstrated by Schulz but not clear in *A. rostratus*. The posterior tuboid process demonstrated only in *A. rostratus* undoubtedly supplies a nerve which innervates the ocellus, and likely extends to the nerve-ring.

The relationship of nematode ocelli to the cerebral ocelli of rotifers, already suggested by Schulz (1931a) and Hyman (1951), becomes even more probable in view of the evidence presented here.

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Santafea New Genus (Rhabditoidea, Chambersiellidae) And a Change in the Systematic Position of *Macrolaimus* Maupas 1900

CALVIN L. MASSEY*

The nematode described was recovered during studies on the nematode parasites and associates of bark beetles. The genus *Santafea* n. gen. is closely related to the genus *Chambersiella* Cobb 1920. Sanwal (1957) placed the genus *Chambersiella* in a new family Chambersiellidae. The family was erected on the bases of the cephalic cirri, the arrangement of the stomatal rhabdions, the position and size of the amphidial apertures, ovarial characteristics, and arrangement of the caudal papillae of the male.

Studies of the close relatives of the genera *Chambersiella* and *Santafea* reveal that *Macrolaimus* Maupas 1900 has all the familial characteristics of aforementioned genera except for the position of the amphid apertures. The genus *Macrolaimus*, therefore, is removed from the family Cephalobidae and placed in the family Chambersiellidae. The family Chambersiellidae is emended to note the absence of cephalic cirri or hairlike setae in some genera. The location of the amphid apertures is omitted.

FAMILY CHAMBERSIELLIDAE SANWAL 1957, 1960 EMENDED

DIAGNOSIS: Rhabditoidea. Lip region with or without 6 cephalic cirri or hairlike setae, with 6 or 10 papillae. Cheilorhabdions distinct. Stoma widest at anterior and gradually narrowing to a vaselike channel posteriorly; posterior part of stoma surrounded by tissue which is differentiated from that of esophagus. Esophagus without a median bulb, but slightly swollen at the base of the corpus, terminal bulb valvate. Females amphidelphic or prodelphic, at times a postvulvar uterine branch is present.

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The research reported was completed at the Station's field unit in Albuquerque, New Mexico.

The author gratefully acknowledges the assistance of Mr. Gerald Thorne for the review of the manuscript.

Key to the Genera of Chambersiellidae

1. Lip region bearing cephalic cirri or hairlike setae ..... *Chambersiella*
   Lip region without cephalic cirri or hairlike setae 2
2. Cheilostom plus protostom much deeper than wide ..... *Santafea*
   Cheilostom plus protostom only slightly deeper than wide ..... *Macrolaimus*

Genus *Santafea* new genus

Chambersiella. Chambersiellinae. Cuticle finely striate. Six prominent cephalic papillae. Stoma similar to *Chambersiella;* Cheilorhabdions and protorhabdions distinct, the meso, meta and telorhabdions fused into a glottid apparatus which extends well back into the precorpus of the esophagus. Amphids opening at the anterior ⅓ of the telostom. Corpus of the esophagus without a bulb but set off by a slight swelling at its base; the isthmus swelling to a valvate terminal bulb. Ovaries paired; vulva at midbody. Testis single, spicules paired, gubernaculum present. Male tail with several pairs of caudal papillae. Tails in both sexes with a hooked terminus.

DIAGNOSIS: *Santafea* is immediately distinguished from *Chambersiella* by the absence of the cephalic cirri or hairlike setae.

TYPE SPECIES: *Santafea croca* n. sp.

Santafea croca new species

MEASUREMENTS: 4 females and 6 males.
Female: 1.4-1.6 mm., a = 32, b = 6, c = 11, V = 54%.
Male: 1.2-1.5 mm., a = 35, b = 7, c = 11.

FEMALE: Cuticle with very fine transverse striations. Body widest at the middle, tapering to a moderately broadly rounded head and a slender hooked terminus. Head without distinct lips, with a circlet of 6 prominent papillae. Fig. 1, B, C. Stoma much deeper than wide, consisting of a well defined cheilostom and protostom, the cheilorhabdions forming part of the cephalic arch; the meso, meta and telorhabdions fused to form the telostom and extending well back into the precorpus of the esophagus. Fig. 1 B. Amphids opening at the anterior ⅓ of the telostom. Fig. 1, A, B. The esophagus with a cylindrical precorpus and corpus, without a median bulb, the isthmus swelling into a valvate terminal bulb. Fig. 1 A. Nerve ring at the middle of the isthmus. Excretory pore slightly anterior to the terminal bulb. Amphidelphic ovaries at times with reflexed termini, oocytes tandemly arranged in a single row. Vulva located at midbody, transverse and protuberant. Fig. 1 E. Anal opening very prominent; rectal glands present. Fig. 1 F. Terminus hooked as in Fig. 1 F.

MALE: Testis single, reflexed. Rectal glands present. Fig. 1 D. Spicules paired, gubernaculum present. Fig. 1 D. Terminus hooked. There are 13 pairs of caudal papillae, 4 pair subventral and preanal, 1 pair lateral preanal, 1 pair postanal and lateral, 4 pair postanal subventral, 3 pair postanal and subdorsal. Fig. 1 D.

The type specimens were taken from the Sandia Mountains, Cibola National Forest, and the Otowi section of Bandelier National Monument in New Mexico. They were found associated with *Scolytus ventralis* Lec. in *Abies concolor* (Gord. and Glend.) Lindl. and *Phloeosinus* sp. in *Juniperus osteosperma* (Torr.) Little. The type specimens are deposited in the collection of the Rocky Mountain Forest and Range Experiment Station at Albuquerque, New Mexico.

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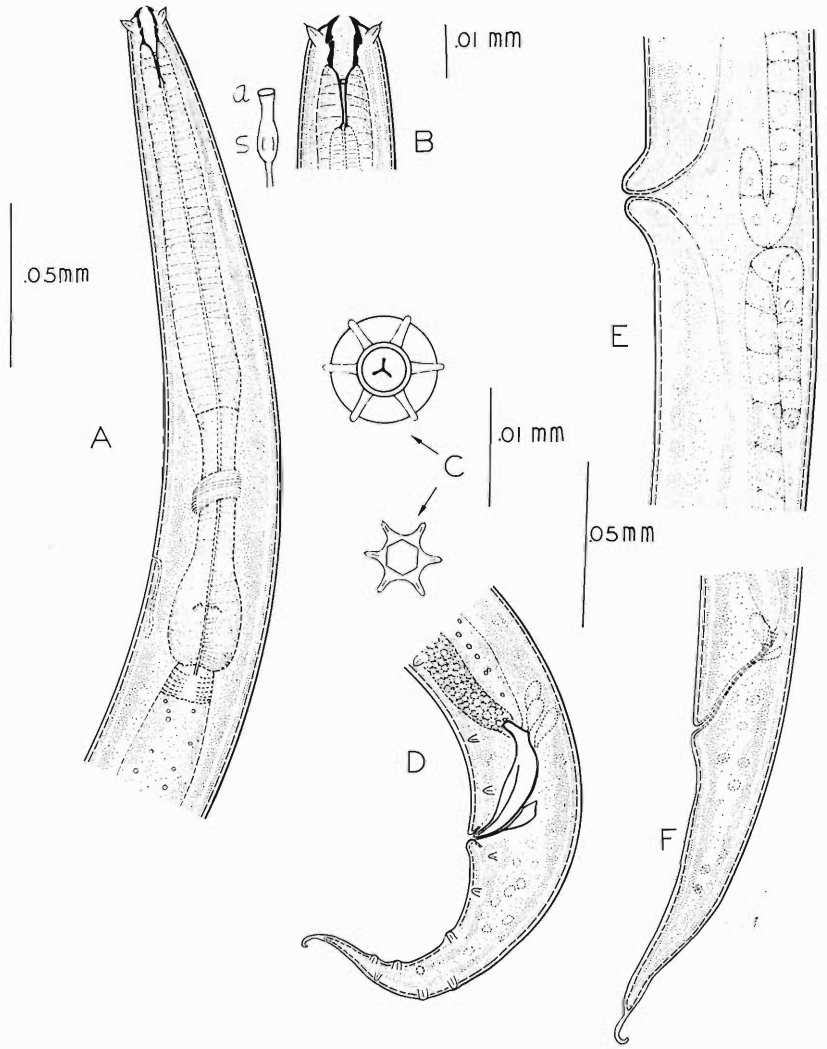

Fig. 1. *Santafea croca* n. gen., n. sp. *A*, *B*. Head (a) amphid aperture (s) sensilla pouch; *C*. Face view; *D*. Male tail; *E*. Female midbody; *F*. Female tail.

A New Species of *Monorchis* (Trematoda: Monorchidae) from the Gilt-Head Fish of the Mediterranean Sea*

GAMAL I. ISSA

Forty-five specimens of a small-sized trematode were recovered throughout the intestines of 23 *Chrysophrys aurata* (L.) Cuvier 1829, collected in 1960-1961 near Alexandria, Egypt. It was determined that they belonged to the genus *Monorchis* (Looss, 1902). In the author's opinion the worms differ sufficiently from existing members of the genus to constitute a new species.

The living specimens occurred free throughout the intestine and entire specimens were extracted easily.

The following description is based on specimens fixed in A.F.A. and stained with acito-carmine.

Species is named for Dr. Carlton M. Herman, Chief, Section of Wildlife Disease and Parasite Studies, Fish and Wildlife Service, United States Department of the Interior.

Monorchis hermani n. sp. (Figure 1)

DIAGNOSIS: Body spined, oval or round 0.27 mm long ranging from 0.21–0.36; 0.24 mm wide ranging from 0.19–0.29; oral sucker slightly wider than long 0.086 mm (0.081–0.099 mm) in transverse diameter and 0.078 mm (0.075–0.083 mm) in longitudinal diameter. Acetabulum smaller than oral sucker 0.030 mm (0.028–0.034) in transverse diameter and 0.029 mm (0.028–0.034) in longitudinal diameter; sucker ratio about 3:1; gland cells in sides and widely distributed all over specimen. Prepharynx not evident in toto mounts. Pharynx very small 0.036 mm. Esophagus very short, bifurcation nearer oral sucker than to acetabulum. Ceca distant from sides of body, bowing outward rather than inward, to form almost a complete circle, inconspicuous, posterior to testis. Genital pore median ventral and close to intestinal bifurcation. Testis ovoid, to right, near to right cecum, at a level immediately posterior third of body. Cirrus sac very large, curving around right of acetabulum to left of ovary; base at level of anterior end of testis; containing oval seminal vesicle, long pars-prostatica and a spined cirrus. Ovary sub-oval, immediately anterior to testis, between cecum and cirrus sac in zone posterior to acetabulum. Vitellaria in two lateral groups of six to nine follicles each, lateral to pharynx. Uterus with slender coils (opened or loosely spread) extending from posterior end of vitellaria to end of ceca. Metraterm only slightly smaller than cirrus sac, posterior third sac-like Eggs oval 0.021 mm (0.018–0.026) by 0.011 mm (0.010–0.013). Excretory vesicle Y-shaped, the median stem longer than the branches, extending to level of posterior edge of testis.

HOST: *Chrysophrys aurata* (Linnaeus, 1758) Cuvier, 1829.

HABITAT: Intestine.

LOCALITY: Alexandria, Egypt.

TYPE SPECIMENS: Holotype and 2 paratypes U.S.N.M. Helm. Coll. No. 59648.

DISCUSSION: There are only three species recorded for the genus

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The author wishes to express his sincere thanks to Dr. D. W. Hayne, Patuxent Wildlife Research Center, for his help with the statistical analysis, and to Dr. Allen McIntosh, Beltsville Parasitological Laboratory, for loan of specimens in the preparation of the manuscript.

Monorchis: M. monorchis (Stossich, 1890); *M. parvus* Looss, 1902; and *M. latus* Manter, 1940. Although occurring in the same host with the first two species, the new species can be readily identified by its small size (Table 1) when compared with the smallest species, *M. parvus,* longer median stem of excretory vesicle, and the widely distributed cuticular glands.

This specimen is macroscopically separable from *M. latus* because of its oval or round shape while *M. latus* is very broad.

Mounted specimens consistently show a distinct character where the eggs to one side of the ovary stain with acito-carmine while the eggs at the other side remain unstained. Measurements of the egg shell thickness averaged 0.8 μ for the stained eggs and 1.4 μ for the unstained eggs. This phenomenon suggests a difference in egg development. The younger stained eggs with their shells are consistently located to the right, while the mature unstained eggs with their shells are consistently found on the left side of the ovary.

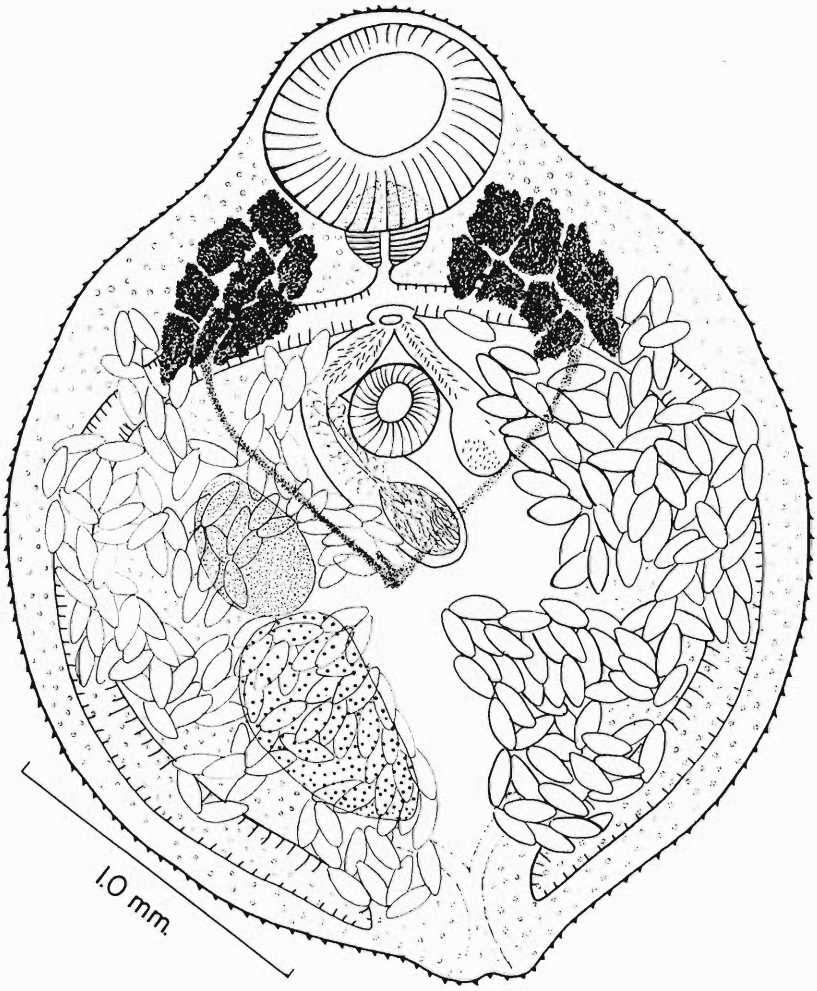

Fig. 1. *Monorchis hermani* n. sp.

Table 1. The differences between *M. parvus and M. hermani.*

		M. paracus	*M. hermani*			
		Average mms.	Average mms.	Range	Standard Error	t
Total length		0.40	0.27	0.21 –0.36	0.0072	3.60*
Total width		0.40	0.24	0.19 –0.29	0.0043	8.00**
Oral sucker:	length	0.110	0.078	0.075–0.083	0.0004	16.00**
	width	0.120	0.086	0.081–0.099	0.0010	6.18**
Ventral sucker:	length	0.059	0.029	0.028–0.034	0.0004	50.00**
	width	0.060	0.030	0.028–0.034	0.0002	25.00**
Eggs:	length	0.023	0.021	0.018-0.026	0.0004	1.00
	width	0.013	0.011	0.010–0.013	0.0003	1.30
Pharynx:	length	0.070	0.036	0.031–0.039	0.0004	17.00**

*Significant at 5% t = 2.014. **Significant at 1% t = 2.690.

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Trematode parasites of fishes from Egypt. Part II. *Diplozoon aegyptensis* n.sp. (Monogenea: Polyopisthocotylea: Diclidophoroidea) from *Labeo forskalii**

JACOB H. FISCHTHAL and ROBERT E. KUNTZ

Further study of a group of fish trematodes collected between 1948 and 1953 by R. E. Kuntz, while a member of the U. S. Naval Medical Research Unit No. 3, Cairo, Egypt, revealed the presence of a new species of monogenetic trematode belonging to the family Diplozooidae Tripathi, 1959, genus *Diplozoon* Nordmann, 1832, taken from the gills of four *Labeo forskalii.* The new species is represented in the collection by nine pairs of adults in permanent copula. All worms were killed in hot water, then fixed overnight in FAA. After a change or two of alcohol they were placed in 70 per cent alcohol with 1-2 per cent glycerine. Whole mounts were stained in either Harris hematoxylin or Mayer's paracarmine and mounted in balsam.

Diplozoon aegyptensis n. sp.

DIAGNOSIS: Adults united in pairs in permanent copula. Prohaptoral portion of body depressed, broad; opisthohaptoral portion subcylindrical,

*Contribution from the Department of Biology, Harpur College, State University of New York, Binghamton, New York. (J. H. Fischthal).

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The opinions and assertions contained herein are the private opinions of the authors and are not to be construed as official or reflecting the views of the Navy Department.

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elongate, narrow, widening at posterior end into distinct cotylophore, attached to fused region without constriction; region of fusion subcylindrical, shorter than either pro- or opisthohaptoral portions of body. Prohaptoral suckers paired, almost circular, close to one another, ventral near anterior end. Opisthohaptoral clamps large, distributed in two longitudinal rows of four each at ventro-lateral margins of colylophore; structure as shown by Thomas (1957) for *Diplozoon ghanense*. Anchors very small, two in number, each consisting of small lunate hook articulating with long, slender shaft, on ventral surface between rows of clamps.

Mouth subterminal, ventral, between prohaptoral suckers. Prepharynx short. Pharynx elongate, oval. Intestine a single cecum, sometimes containing dark granules, extending into opisthohaptoral portion of body almost to or very slightly into cotylophore, many branched diverticula in prohaptoral portion.

Testis single, smooth, compact, oval, postovarian but in contact with or overlapping ovary, within opisthohaptoral portion of body, nearer to body fusion than cotylophore. Vas deferens arising from anterior end of testis, winding diagonally across region of fusion to become contiguous with vagina of other member of pair in copula.

Ovary long, pretesticular, smaller posterior portion compact and smooth while remainder ribbon-like and much folded, partly within body fusion and partly in opisthohaptoral region. Oviduct arising from postero-median margin of ovary, receiving oviduco-intestinal canal, vagina, and vitelline duct, then passing anteriorly to form ootype surrounded by weakly developed Mehlis' gland. Uterus short, arising from ootype, ascending without windings diagonally through region of fusion in slightly arched curve; only one egg at a time contained within uterus of each member of pair in copula. Uterine pore located anteriorly in region of fusion near vas deferens—oviduct junction. Eggs very large, elongate, thick-shelled, operculate, with very long and much coiled filament at more pointed anopercular end, opercular portion of shell longer than anopercular, egg lying in uterus with anopercular end

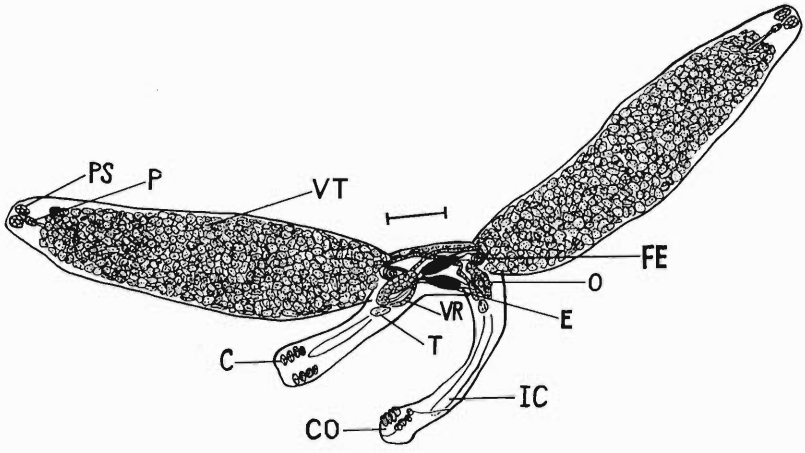

Figure 1. *Diplozoon aegyptensis*, 2 adult worms in permanent copula, ventral view. Drawn with the aid of a microprojector. The value of the scale is 0.5 mm.

Abbreviations: C, clamp; CO, cotylophore; E, egg; FE, filament of egg; IC, intestinal cecum; O, ovary; P, pharynx; PS, prohaptoral sucker; T, testis; VR, vitelline reservoir; VT, vitellaria.

directed anteriorly and filament extending far forward, zygote within shell undivided and surrounded with much yolk. Vitellaria extensive, follicles large, filling prohaptoral region commencing short distance posterior to pharynx and just entering anterior region of fusion of pair in copula. Vitelline duct arising in prohaptoral region, descending diagonally through region of fusion, swelling into yolk reservoir before entering oviduct.

Mean measurements in millimeters (with minima and maxima in parentheses) of 5 pairs of whole mount adult worms in copula are: body, total length 4.529 (3.620-5.767); prohaptoral region, length 2.665 (1.879-3.452), width 0.558 (0.299-0.836); region of fusion, 0.727 (0.652-0.874) × 0.376 (0.291-0.437); opisthohaptoral region, 1.128 (0.867-1.871) × 0.178 (0.130-0.245); cotylophore, length 0.298 (0.253-0.360); prohaptoral suckers, 0.110 (0.095-0.125) × 0.095 (0.078-0.103); distance from anterior end of body to prohaptoral suckers, 0.038 (0.029-0.046); clamp, 0.070 (0.065-0.079) × 0.097 (0.092-0.102); prepharynx, length 0.027 (0.020-0.034); pharynx, 0.062 (0.051-0.075) × 0.044 (0.040-0.050); testis, 0.136 (0.103-0.190) × 0.080 (0.063-0.093); ovary, 0.359 (0.276-0.460) × 0.183 (0.103-0.202); intrauterine egg, 0.292 (0.254-0.313) × 0.107 (0.081-0.132); opercular portions of egg, length 0.170 (0.158-0.187); distance from anterior end of body to vitellaria, 0.292 (0.228-0.360); anchor shaft, length 0.049 (0.048-0.049); anchor hook, length 0.0165 (0.016-0.017).

HOST: *Labeo forskalii* (family Cyprinidae).

HABITAT: Gills.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATES: August 15, September 6 and 20, October 12, 1952.

TYPES: U. S. Nat. Mus. Helm. Coll., No. 59653 (1 slide of type specimen), and No. 59654 (2 slides with 1 paratype specimen each).

Diplozoon aegyptensis may be distinguished from the eight known species of the genus by the following key modified from Thomas (1957) and Tripathi (1959):

1. All clamps on one side in a single series ..... *barbi* Riechenbach-Klinke, 1951
   Clamps in two series of four each 2
2. Intestine with bifurcation in area of fusion, reuniting behind testis 3
   Intestine without bifurcation 6
3. Egg without filament ..... *cauveryi* Tripathi, 1959
   Egg with filament 4
4. Testis entire ..... *indicum* Dayal, 1941
   Testis lobed 5
5. Pair of sticky glands near mouth ..... *nipponicum* Goto, 1891
   Sticky glands absent ..... *kasmirensis* Kaw, 1950
6. Testis lobed ..... *paradoxum* Nordmann, 1832
   Testis entire 7
7. Testis occurring in region of fusion ..... *ghanense* Thomas, 1957
   Testis occurring in opisthohaptoral region 8
8. Egg very small, 0.064 × 0.034 mm ..... *soni* Tripathi, 1959
   Egg large, 0.254-0.313 × 0.081-0.132 mm ..... *aegyptensis* n. sp.

LITERATURE CITED

THOMAS, J. D. 1957. A new monogenetic trematode, *Diplozoon ghanense*, sp. nov. (Polyopisthocotylea: Discocotylea) from a West African freshwater fish *Alestes macrolepidotus* (C. & V., 1849), in West Africa. J. West. African Sc. Assn. 3: 178-182.

TRIPATHI, Y. R. (1959.) Monogenetic trematodes from fishes of India. Indian J. Helminthol. 9: 1-149. 1957.

Marine Nematodes of the Suborder Monhysterina from the Arabian Sea at Karachi

R. W. TIMM*

The Zoological Survey of Pakistan collected nematode material from four marine habitats in July, 1959, at Karachi, West Pakistan. The nematodes of the Suborder Monhysterina obtained from this material, excluding the Linhomoeidae previously described (Timm, 1962), are reported here. The records of the habitats are as follows:

Habitat 1.—Native jetty, Karachi. Piling scrapings including crustacean larvae, small polychaete annelids, encrusting protochordates, hydroids, and algae.

Habitat 2.—Native jetty, Karachi. Bottom mud with much organic detritus.

Habitat 3.—Native jetty, Karachi. Bottom mud with little organic detritus.

Habitat 4.—Manora Island, Arabian Sea. Thick bottom ooze with little organic detritus.

Measurements were made of formalin-fixed specimens but the type specimens were measured after mounting in glycerine. Type slides are in the author's personal collection.

SUPERFAMILY AXONOLAIMOIDEA

Araeolaimus elegans de Man, 1888 (Fig. 1, A-D)

FEMALE ($n = 2$): 1.03–1.04 mm.; a = 25.5–27.1; b = 7.8–8.2; c = 9.5–10.3; V = 51–52.9%; Ov_1 = 21.8%; Ov_2 = 12%.

MALE ($n = 4$): 0.86–1.08 mm.; a = 27–33.8; b = 6.7–7.9; c = 9.3–10.

DESCRIPTION: Cuticle finely striated and speckled in appearance due to dark granules of hypodermis. Head narrowed, not set off, rounded at anterior; lips fused. Four cephalic setae at extreme anterior, 5 to 6 microns long or 70 to 80% of head diameter; 4 subcephalic setae at level of amphids, 6 microns long or 70% of head diameter. Two groups of 4 cervical setae between amphids and ocelli. Well-formed reddish ocelli with lens, 27 to 32 microns from anterior or 3.5 to 4.4 head diameters. Amphids sausage-shaped, 7 microns wide or about 80% of head diameter. Narrow lightly sclerotized cylindrical stoma, 8 microns long or about 1 head diameter. Esophagus gradually expanded at base; small swelling behind ocelli, with break in tissue. Nerve ring at about 60% of esophageal length. Excretory pore opposite base of amphids; ampulla present; prominent excretory cell ½ body diameter wide, 64 to 95 microns posterior to esophagus, with small cell just behind it. Many clear coelomocytes. Intestine very dark green, with small globular cell inclusions. Female reproductive system double; 1 ovum in each uterus at a time, about 40 by 25 microns. Testis single, ½ body diameter wide, 40% of body length long; spicules 27 to 30 microns long or 0.8 to 1 anal body diameter, strongly arcuate and distinctly cephalated. Two prominent gland cells at some distance anterior to anus. Gubernaculum consisting of sleeve around spicules and 2 posteriolateral apophyses 7 microns long. Supplements lacking. Tail conical, uniformly tapering to short blunt digitate tip. Caudal glands and spinneret prominent, with clear nuclei. Male tail 3.7 to 4.7 anal body diameters long, female tail 4.5 to 5 anal body diameters.

DISCUSSION: This is a very cosmopolitan species. Therefore close atten-

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tion should be given to details in order to find the range of intraspecific variations. In the description of Wieser (1956) the amphids are located more posteriorly and there are no subcephalic setae at the level of the amphids. Our specimens correspond better to the description of *Coinonema punctatum* Cobb, 1920, synonymized by Wieser with *Araeolaimus elegans*.

LOCALITY: Habitat 1.

Araeolaimus texianus Chitwood, 1951 (Fig. 1, E-F)

MALE: 0.73 mm.; a = 38.4; b = 6.3; c = 10.4.

DESCRIPTION: Cuticle finely striated; hypodermal chords granulated. Head not set off, rounded at anterior, ½ the diameter at esophageal base; lips fused. Four cephalic setae at extreme anterior, 6 microns long or 0.7 head diameters. Subcephalic setae lacking but cervical setae behind amphids. Well-formed ocelli 23 microns posterior or 3.3 head diameters. Amphids sausage-shaped, 1 head diameter from anterior, 45% of head diameter wide. Narrow lightly-sclerotized stoma, 8 microns long or 1.1 head diameters. Excretory pore opposite swelling in anterior of esophagus, behind ocelli. Testis almost the full body diameter in width. Spicules 22 microns long or 1.2 anal body diameters, bent at almost a 90° angle. Gubernaculum with gently arching posterior apophysis 7 microns long. Tail conical, bluntly tapering to small rounded tip, 5 anal body diameters long.

DISCUSSION: The excretory pore of the present specimen is slightly more posterior than in Chitwood's description and the spicules are slightly smaller. In all other characters and measurements, however, there is close agreement.

LOCALITY: Habitat 1.

Parodontophora, n. gen.

DIAGNOSIS: Axonolaimidae, Axonolaiminae. *Odontophora* species with parallel stomatal walls. Type species: *Parodontophora paragranulifera* (Timm, 1952) n. comb.

Parodontophora pacifica (Allgén, 1947) n. comb. (Fig. 1, G-H)

FEMALE (n = 3): 0.71-0.74 mm.; a = 23.1-26.2; b = 6.3-6.5; c = 6.7-8.3; V = 54.6-55.6%.

DESCRIPTION: Cuticle finely striated; hypodermal chords with fine granulation; lateral alae absent. Head rounded; 4 cephalic setae, 6 microns long or 70% of head diameter; 4 groups of 2 cervical setae each at mid-stoma. Stoma sclerotized, cylindrical with parallel walls, 6 odontia at anterior, 22 microns long from tip of odontia to base. Amphids shepherd's crook, 16 microns long, with long arm sloping dorsally. Esophageal base swollen but without definite bulb. Large excretory cell at esophageal base, 32 microns long and 50% of body diameter wide; excretory pore indistinct, near anterior. Tail half conical, half cylindrical, 4.8-6.1 anal body diameters long.

DISCUSSION: Timm (1952) revived the genus *Pseudolella*, referring to it a number of species with thin straight parallel stomatal walls and six odontia. Timm (1957) set up the genus *Pseudolelloides* for a species (*bengalensis*) with a stoma as in the following species (*Pseudolella granulifera*). Cobb (1920) in both *Pseudolella granulifera* and *P. cephalata* had pointed out that six minute odontia were *probably* present, whereas the two large odontia of *Pseudolelloides* are extremely thick and prominent. However, in Cobb's drawings the stomatal walls are shown to flare outwards at the base and then curve sharply inwards, as in *Pseudolelloides*. On the basis of this character it is probable that *Pseudolelloides* should be made a synonym of *Pseudolella*. Gerlach (1957) transferred *Pseudolella paragranulifera* Timm, 1952 to

Odontophora and mentioned that *P. cobbi* Timm, 1952 and *P. breviamphida* Timm, 1952 also belong in *Odontophora*. Since the *Pseudolella*-like species of *Odontophora* can readily be distinguished from the species with funnel-shaped stomatal walls a separate genus in herein designated for them. The following new combinations and synonyms are established:

Parodontophora breviseta (Stekhoven, 1950) n. comb. (= *Odontophora breviseta* Stekhoven, 1950; *Pseudolella breviseta* (Stekhoven, 1950) Timm, 1952).

Parodontophora cobbi (Timm, 1952) n. comb. (= *Pseudolella cobbi Timm,* 1952).

Parodontophora pacifica (Allgén, 1947) n. comb. (= *Odontophora pacifica* Allgén, 1947; *Odontophora quadristicha* Stekhoven, 1950; *Pseudolella breviamphida* Timm, 1962; *Pseudolella quadristicha* (Stekhoven, 1950) Timm, 1952; *Pseudolella pacifica* (Allgén, 1947) Timm, 1961).

Parodontophora polita (Gerlach, 1955) n. comb. (= *Pseudolella polita* Gerlach, 1955; *Odontophora polita* (Gerlach, 1955) Gerlach, 1957).

Parodontophora paragranulifera (Timm, 1952) n.comb. (= *Pseudolella paragranulifera* Timm, 1952; *Odontophora paragranulifera* (Timm, 1952) Gerlach, 1957).

Parodontophora diegoensis (Allgén, 1951) n.comb. (= *Odontophora diegoensis* Allgén, 1951) is regarded as a *species inquirenda*.

The present specimens are smaller than any previously reported; however, they agree well in stoma, seta, and amphid length with the description of *Pseudolella bravamphida* Timm, 1952, which is twice the length. The identification of Wieser's (1956) specimens with *Odontophora pacifica* was based more on charity than fact; others may prefer to consider *Parodontophora pacifica* as a *species inquirenda* and recognize the later descriptions as referring to *P. quadristicha*.

LOCALITY: Habitat 3.

Pseudolella granulifera Cobb, 1920 (Fig. 1, I-J)

FEMALE: 0.81 mm.; a = 21.2; b = 7.2; c = 6.3; V = 53.6%; Ov_1 = 23.8%; OV_2 = 17.8%.

MALE: 0.69 mm.; a = 24.6; b = 6.5; c = 6.7; T = 24%.

DESCRIPTION: Cuticle with rough granular appearance due to dark inclusions of hypodermal chords; lateral alae absent. Head tapering, rounded; lips mostly fused. Stoma sclerotized, 32-35 microns long, with parallel walls flaring out and then arching in sharply at base. Two heavy subventral odontia at anterior of stoma. Four cephalic setae 3 microns long or 37% of head diameter; 4 groups of 2 or 3 cervical setae each opposite anterior of stoma, less than 2 microns long. Amphids shepherd's crook, opening toward dorsal side, slightly longer than stoma (in one molting fourth stage male the old amphid was 23 microns long, the new amphid 41 microns long). Esophagus with swollen base in form of bulb. Excretory cell 64 microns behind esophageal base, 50% of body diameter wide; excretory pore opposite odontia. Intestine dark due to dark green inclusion bodies in cells. Female reproductive system amphidelphic; prominent granular vaginal gland cells; large sperm in uterus. Spicules broadly cephalated, with internal division, 28 microns long or 1.5 anal body diameters. Gubernaculum with posterior apophysis 9 microns long and sleeve around spicules. Tail 5.9 anal body diameters long.

DISCUSSION: *Pseudolelloides* Timm, 1957 is accepted as a synonym of *Pseudolella* Cobb, 1920, following the interpretation of *Pseudolella* by Ger-

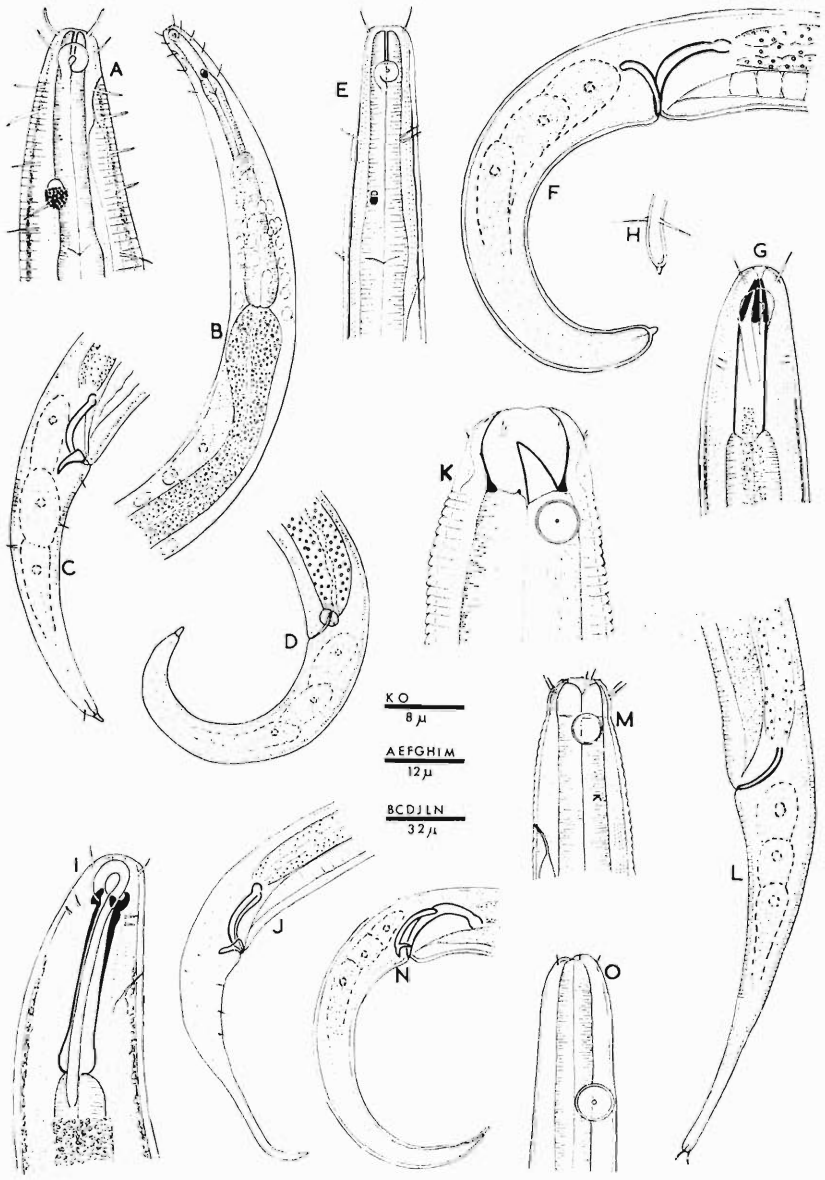

Fig. 1. A-D. *Aracolaimus elegans.* A. Male head. B. Esophageal region. C. Male tail. D. Female tail. E-F. *Aracolaimus texianus.* E. Male head. F. Male tail. G-H. *Parodontophora pacifica.* G. Female head. H. Tail tip. I-J. *Pseudolella granulifera.* I. Male head. J. Male tail. K-L. *Cobbia macrostoma.* K. Male head. L. Male tail. M-N. *Monhystera karachiensis.* M. Female head. N. Male tail. O. *Monhystera parelegantula.* Male head.

lach (1957). The following are recognized as valid species: *P. granulifera* Cobb, 1920 (type by original designation); *P. cephalata* Cobb, 1920; *P. intermedia* Gerlach, 1957; and *P. bengalensis* (Timm, 1957) n.comb (= *Pseudolelloides bengalensis* Timm, 1957). *P. norvegica* Allgén, 1947 is regarded as a *species inquirenda*.

Since both short- and long-stemmed amphids are found in *Campylaimus, Parodontophora,* and *Pseudolella,* the character of elongated amphids obviously cannot be used as the sole basis for distinguishing a subfamily. Hence the subfamily Campylaiminae Chitwood, 1937 is reduced to synonymy with the Axonolaiminae (*partim*).

SUPERFAMILY MONHYSTEROIDEA

Cobbia macrostoma n.sp. (Fig. 1, K-L)

FEMALE: 1.03 mm.; a = 25.7; b = 4; c = 6.2; V = 63.7%; Ov_1 = 18.6%; Ov_2 = 12.4%.

MALE (n =): 0.93-0.95; a = 25.1-26.5; m = 4-4.1; c = 7.1-7.3.

HOLOTYPE MALE: 0.93 mm.; a = 26.5; b = 4.1; c = 7.3.

DESCRIPTION: Body dark due to fine dark intestinal granules. Prominent transverse striations, about 1 micron wide. Lateral alae lacking. Head continuous with body contour, rounded at anterior; head diameter slightly less than one half the body diameter at esophageal base. Six small papillae of inner circle; 10 tiny cephalic setae of external circle, about 1.5 microns long; seeemingly 12 in female. Amphids circular on surface (actually cryptic spiral), double-walled, with central point, 5 microns in diameter or 35% of corresponding head diameter; amphidial pouch and sensilla distinct. Stoma 8 to 10 microns deep, heavily sclerotized, with thickenings at base; large dorsal tooth extending one-half the length of stoma; 2 small subventral projections at base of stoma. Esophagus broad and muscular for its full length; conical esophago-intestinal valve, 9 microns long. Nerve ring distinct, at about 50% of esophageal length. Excretory cell at esophageal base (?). Intestinal inclusions orange-brown in color. Testis reflexed; spicules narrow, consisting of almost parallel blades with slight cephalization, 21 microns long or about 1 anal body diameter. Gubernaculum absent; velum present. Male tail conical-cylindrical, 5.4 anal body diameters long. Female tail similar in shape, 7.5 anal body diameters long, with 2 fine setae at blunt tip.

DISCUSSION: The tiny cephalic setae, the capacious well-sclerotized stoma, and the lack of a gubernaculum distinguish this from all other species of *Cobbia*. In spite of its many differences it is kept in this genus because of the large dorsal tooth.

TYPO-LOCALITY: Habitat 3; also found in Habitat 4.

HOLOTYPE: Male on Slide M116.

ALLOTYPE: Female on Slide M116a.

Monhystera karachiensis n. sp. (Fig. 1, M-N)

FEMALE (n = 2): 1.06-1.08 mm; a = 34-40.7; b = 6.5-7.3; c = 7.2; V = 74.9%; Ov_1 = 48%.

MALE (n = 2): 0.76-1.11 mm; a = 31.5-42.5; b = 5.7-6.3; c = 6.2-8.1.

DESCRIPTION: Cuticle with prominent striation. Head offset by constriction. Stoma shallow and unsclerotized. Inner circle of 6 labial papillae; outer circle of 12 cephalic setae, almost equal, 5 microns long or 35–40% of head diameter; subcephalic and cervical setae lacking. Amphids circular, distinct, opposite head constriction, 4–5 microns in diameter of 35% of head

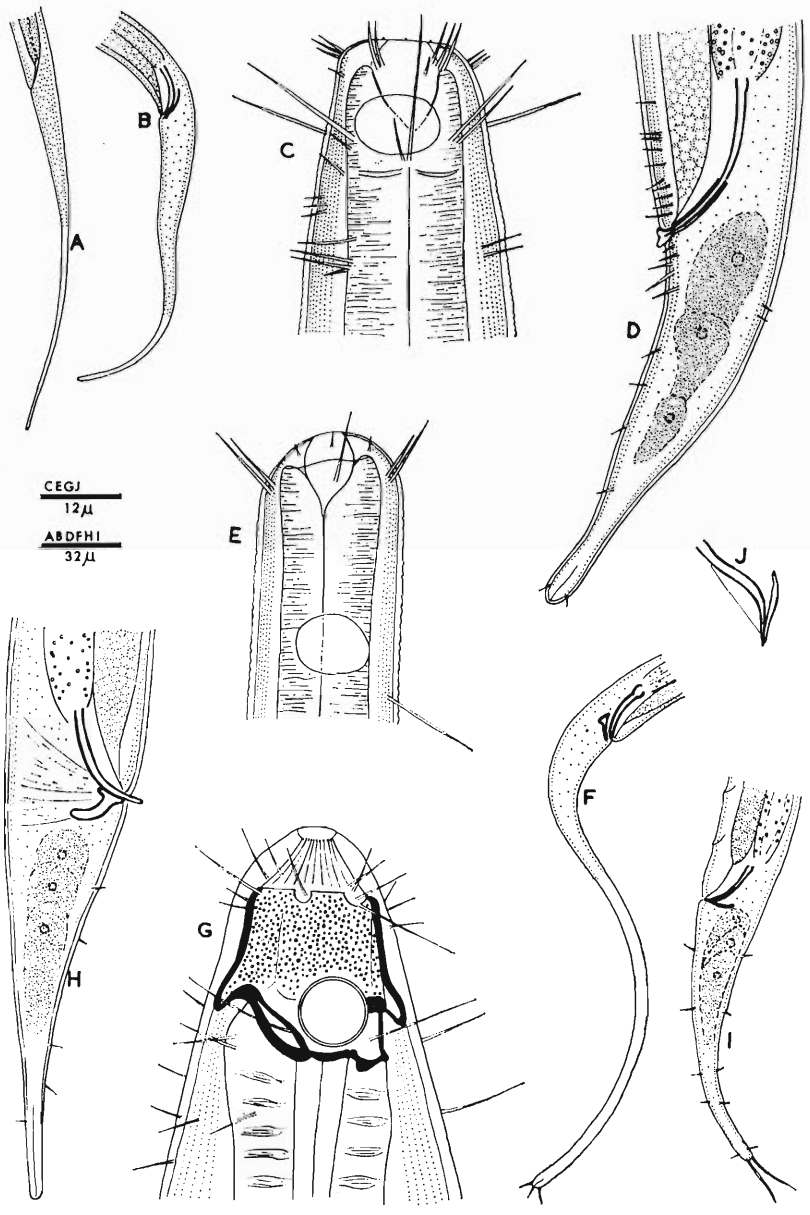

Fig. 2. A-B. *Monhystera parelegantula.* A. Female tail. B. Male tail. C-D. *Paramonhystera pellucida.* C. Male head. D. Male tail. E-F. *Paramonhystera longicaudata.* E. Male head. F. Male tail. G-H. *Sphaerolaimus macoticus.* G. Male head. H. Male tail. I-J. *Steineria simplex.* I. Male tail. J. Male copulatory apparatus.

diameter; 60% of head diameter posteriorly. Ocelli lacking. Typical *Monhystera*-like esophago-intestinal valve. Excretory pore 2.3 head diameters from anterior, with prominent ampulla. Nerve ring inconspicuous, at about 38% of esophageal length. Single prodelphic outstretched ovary in female and small postvulvar ovarian sac 3 body diameters long containing 4–5 oocytes; 2–3 rows of oocytes in ovary, extending almost to esophageal base; 1 ovum in uterus, 42 by 25 microns. Testes containing double row of spermatocytes for about one-half the testis length; anterior testis extending almost to esophageal base. Spicules distinctly cephalated, capitulum directed ventrad, 40 microns long or 2.8 anal body diameters. Gubernaculum 25 microns long, with large anterior and ventral tooth-like projections at tip. Female tail 7.9 anal body diameters long, male tail 6.2 anal body diameters long.

DISCUSSION: The present species comes close to *Monhystera macramphis* Filipjev, 1930 in most measurements but the terminal part of the tail in that species is cylindrical. It is described by Meyl (1955) as having ocelli and by both Filipjev and Meyl as having a smooth cuticle, as is usual in *Monhystera*. The form of the gubernaculum is the most distinctive feature of the new species.

TYPE-LOCALITY: Habitat 1.

HOLOTYPE: Male on Slide M117.

ALLOTYPE: Female on Slide M117a.

Monhystera parelegantula de Coninck, 1943 (Figs. 1,O and 2, A-B)

FEMALE (n = 2): 0.39–0.42 mm.; a = 26.2–32.2; b = 5.1–5.5; c = 3.3; V = 48.2–52.2%; Ov_1 = 19–24%.

MALE: 0.41 mm.; a = 25.3; b = 5; c = 3.8.

DESCRIPTION: Cuticular striation not observed. Head continuous with body contour, rounded at anterior. Six tiny cephalic setae at extreme anterior; other setae lacking. Amphids circular with thick walls and central point (in male only), 3-3.5 microns in diameter or 35% of head diameter in female and 46% in male, situated 1.5 head diameters from anterior in female and 2.7 head diameters in male. Single prodelphic ovary; 1 ovum at a time in uterus, about 35 by 10 microns. Vulva-anus distance equal to 67% of tail length. Spicules 17 microns long or 1.3 anal body diameters, without distinct capitulum. Gubernaculum 11 microns long, parallel to spicules, with tooth-like projection at tip. Tails of both sexes uniformly tapering to finely rounded tip, 9 anal body diameters long in female, 13–16 in female.

DISCUSSION: The correspondence of the present specimens in size and in relation of the vulva-anus distance to tail length is much greater with *Monhystera parelegantula* than with *M. elegantula* Stekhoven, 1935. However, the position of the amphids is much closer to the latter, if one accepts de Coninck's (1943) rather than Timm's (1952) explanation of the discrepancy in Stekhoven's description. This is the first report of the male of *M. parelegantula*.

LOCATION: Habitats 1 and 2.

Paramonhystera (*Leptogastrella*) *pellucida* (Cobb, 1920) (Fig. 2, C-D)

FEMALE: (*n* = 5): 1.25-1.35 mm; a = 20-23.8; b = 4.6-5.2; c = 8-10.1; V = 66.5–70%; Ov_1 = 40–48%.

MALE: (*n* = 5): 1.18-1.42 mm; a = 17.2-22.1; b = 4.5-5.4; c = 7.4-9.9.

DESCRIPTION: Body moderately striated. Head not set off, truncate at an-

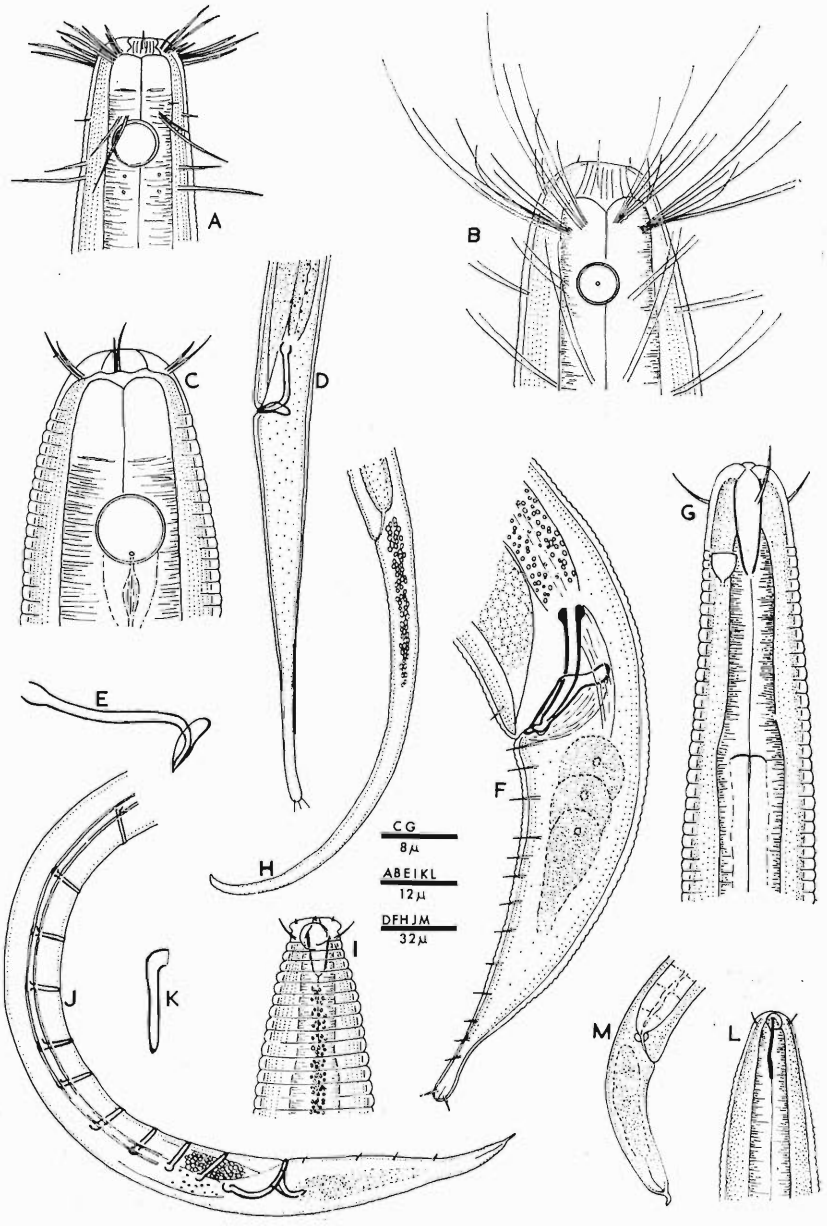

Fig. 3. A. *Steineria simplex*. Male head. B. *Steineria pilosa brevisetosa*. Male head. C-E. *Theristus polaris*. C. Female head. D. Male tail. E. Male copulatory apparatus. F. *Theristus normandicus*. Male tail. G-H. *Chronogaster typicus*. G. Female head. H. Female tail. I-K. *Paraphanolaimus granulifera*. I. Male head. J. Male tail. K. Male supplement. L-M. *Camacolaimus tardus*. L. Female head. M. Female tail.

terior. Six small setose papillae at anterior; 12 cephalic setae 8 microns long or 33% of head diameter; subcephalic setae immediately behind cephalic setae giving impression of 3 sublateral cephalic setae in each group; 4 small cervical setae between subcephalic setae and amphids; 6 long cervical setae immediately behind amphid level, 20 microns long or 1.1 corresponding head diameters, accompanied by 6 smaller setae. Scattered somatic setae. Amphids transversely elliptical, 8 microns deep by 13 microns wide, or 55-60% of head diameter in both sexes. Nerve ring at about 45% of esophageal length. Female reproductive system single; ovary prodelphic, outstretched, extending almost to esophageal base. Spicules narrow and uncephalated, 45–63 microns long or 1.1–1.7 anal body diameters. Gubernaculum narrow, parallel with spicules, 29 microns long, with 2 large blunt teeth at tip. Tail in both sexes conical-cylindrical, 3.5–4 anal body diameters long in male, 3.5–4.5 in female; subventral setae on male tail; 1 pair of small setae at tail tip in both sexes.

LOCALITY: Habitats 1, 2 and 3.

COLLECTION: 30 males, 42 females, 40 juveniles.

Paramonhystera (*Paramonhystera*) *longicaudata* n. sp. (Fig. 2, E-F)

MALE: (n =2): 1.14-1.33 mm; a = 30-41.5; b = 5.1-7.5; c = 5.1-6.8.

FEMALE: unknown.

DESCRIPTION: Cuticle moderately striated; *Theristus*-like in appearance but very narrow. Head rounded at anterior, with cuticular inflation at labial region. Six prominent labial setae; 10 cephalic setae, the longest 16 microns or 50% of head diameter; only 1 cervical seta observed, just behind amphid; somatic setae lacking. Amphids elliptical, thin-walled, 10 microns wide or 50% of head diameter, situated 1.3 head diameters from anterior. Nerve ring at 45% of esophageal length. Spicules 26–28 microns long or 1.5 anal body diameters, cephalated. Gubernaculum 13–15 microns long, shaped like an inverted triangle. Tail 1/5 conical, 4/5 uniformly cylindrical, 10 anal body diameters long, with rounded unswollen tip bearing 3 spines 11 microns long.

DISCUSSION: Wieser (1956) has called attention to variability of cephalic characters in this genus and has therefore urged that descriptions be based on several males and females. However, because of the distinctively long tail in the present species I feel justified in neglecting this good advice. Neither the tail nor the copulatory apparatus fit the pattern of the genus.

TYPE-LOCALITY: Habitat 2.

HOLOTYPE: Male on Slide M119.

Sphaerolaimus maeoticus Filipjev, 1922 (Fig. 2, G-H)

FEMALE: 1.2 mm.; a = 15.6; b = 4.2; c = 8; V = 70.5%; Ov_1 = 28%.

MALE: 1.2 mm.; a = 17.1; b = 4.6; c = 7.7.

DESCRIPTION: Cuticle distinctly striated. Head rounded; lips fused. Stoma 35 microns deep; anterior part punctate. Cephalic setae 5-6 microns long or 30% of head diameter; subcephalic setae up to 18 microns long, in groups of 3 or 4. Amphids circular, heavily sclerotized, 8 microns in diameter or 30% of head diameter in female, 12 microns or 45% of head diameter in male. Single prodelphic ovary, reflexed 140 microns at anterior; embryonated ova in uterus, the largest 100 by 50 microns. Spicules slightly cephalated, 54 microns long or 1.1 anal body diameters. Gubernaculum with posterior apophysis 22 microns long. Tail conical-cylindrical, 3.2–3.4 anal body diameters long, with 3 spines at tip.

DISCUSSION: The present specimens reconcile to some extent the original description by Filipjev (1922) and that of Gerlach (1957). The amphids and subcephalic setae are smaller than in Gerlach's specimens but the characteristic apophysis of the gubernaulum is the same.

LOCALITY: Habitats 3 and 4.

Steineria simplex n. sp. (Figs. 2, I-J and 3, A)

FEMALE (n = 5): 0.63–0.75 mm.; a = 18–20.6; b = 4–4.6; c = 6.7–7.7; V = 57.6–64.7%. Ov_1 = 17.4–20.5%.

MALE (n = 5): 0.66–0.72 mm.; a = 18.8–22.6; b = 4.3–4.5; c = 7.1–8.6.

HOLOTYPE MALE: 0.63 mm.; a = 21.7; b = 4.1; c = 7.

DESCRIPTION: Cuticle moderately striated. Head continuous with body contour, rounded at anterior; 6 distinct lips with labial papillae. Ten cephalic setae; 8 groups of 3 subcephalic setae each, the longest 22 microns or 1.4 head diameters long; 2 groups of unequal cervical setae just anterior to each amphid; 8 groups of cervical setae posterior to amphid; fine somatic setae on body and tail; 2 tail spines, 19 microns long in male, 25–28 microns in female. Amphids 8 microns in diameter or 45% of head diameter in female, 7 microns or 42% in male, located 92% of head diameter from anterior. Nerve ring at about 45% of esophageal length. Small excretory cell at base of esophagus; excretory pore at about 66% of esophageal length. Prodelphic outstretched ovary in female, extending almost to esophagus. Spicules 22–26 microns long or 1 anal body diameter, cephalated but without thickening; teeth lacking at tip. Gubernaculum a simple dorsal piece 9–11 microns long. Apparently 2 small papillate preanal supplements in one male, with clear innervations. Tails of both sexes ⅔ conical, ⅓ cylindrical, 4.5–5.6 anal body diameters long in female, 4–4.8 in male.

DISCUSSION: This is the only species of *Steineria* with groups of three subcephalic setae; otherwise, it is near to *S. cobbi* Wieser, 1956, which is much longer.

TYPE-LOCALITY: Habitat 1; also found in habitats 2 and 3.

COLLECTION: 19 males, 32 females, 14 juveniles.

HOLOTYPE: Male on Slide M120.

ALLOTYPE: Female on Slide M120a.

PARATYPES: Male and females on Slide M120b.

Steineria pilosa brevisetosa Timm, 1957 (Fig. 3, B)

FEMALE (*n* = 2): 0.84 mm.; a = 20.1-21.4; b = 4.7; c = 6.5-7.3; V = 63.7–65%.

MALE (*n* = 2): 1.18-1.21 mm.; a = 16.9-19; b = 5.4-5.6; c = 8.4.

DESCRIPTION: Cuticle finely annulated. Head almost truncate; lips distinct. Stoma shallow, with fine cheilorhabdions. Cephalic setae 10, the longest 12 microns or 50% of head diameter; subcephalic setae in 8 groups, up to 7 setae in a group, the longest 40–49 microns long or 2 head diameters; 8 groups of cervical setae at level of amphids and posterior to amphids, 2 setae in each group; longest somatic setae 26 microns. Amphids circular, 7–8 microns in diameter or 30% of head diameter, 14 microns from anterior or 70% of head diameter. Excretory cell 49 microns posterior to esophagus. Spicules very slightly cephalated, 52 microns long or 1.4 anal body diameters. Gubernaculum with broad sleeve around spicules and broad posterior apophysis, 27–30 microns long in total; anterior and lateral teeth at tip of spicules. Preanal supplements lacking. Tail ½ conical, ½ cylindrical, 3.9 anal body diameters long in male, 4.1–4.6 in female, with 2 tail spines 28 microns long.

DISCUSSION: The female is here reported for the first time.
LOCALITY: Habitats 2 and 3.
COLLECTION: 3 males, 4 females, 3 juveniles.

Theristus (*Cylindrotheristus*) *polaris* (Cobb, 1914)

SYNONYM: *Monhystera polaris* Cobb, 1914 (Fig. 3, C-E)
FEMALE ($n = 5$): 0.78-1.02 mm.; a = 17-27; b = 4.5-6.3; c = 5-6.1; V = 50.8–60.4%; Ov_1 = 40–42%; Ov_2 = 5–9%.
MALE ($n = 5$): 0.84-0.95 mm.; a = 19.7-29.3; b = 4.9-6.4; c = 5.7-6.4.
DESCRIPTION: Cuticle moderately striated. Head rounded, not set off. Six small labial papillae at anterior; 12 cephalic setae, the longer 8 microns or 80% of head diameter in female, 6.5 microns or 80% of head diameter in male. Amphids circular, with small central point, 7 microns in diameter or about 40% of head diameter in both sexes, situated 14 microns or 1.4 head diameters from anterior. Nerve ring at about 50% of esophageal length. Many hypodermal pores in esophageal region. Intestinal cells containing coarse globular olive inclusions. Ovaries amphidelphic but posterior ovary consisting only of a short sperm-containing sac, 1–2 body diameters long; anterior ovary extending almost to esophagus; 1 ovum in uterus at a time, about 110 by 40 microns. Testis reflexed, ½ of body diameter wide, expanded at anterior. Spicules thin, distinctly cephalated, 33–42 microns long or 1.4–1.5 anal body diameters. Gubernaculum with sleeve-like portion and inconspicuous dorsal apophysis. Tails of both sexes long and tapering to bluntly rounded tip, 6.7–7 anal body diameters long in male, 7.5–9.6 in female; 2 tail spines, 10 microns long in both sexes.
DISCUSSION: The present specimens satisfactorily fit the measurements of *Theristus polaris*, regarded as a doubtful species by Wieser (1956). Measurements of the setae and amphids show them to be of similar relative size and position. In view of the close resemblance I feel it is better to remove the doubtful status of Cobb's species than to set up a new species.
LOCALITY: Habitats 2, 3 and 4.
COLLECTION: 22 males, 20 females, 15 juveniles.

Theristus (*Cylindrotheristus*) *normandicus* de Man, 1890 (Fig. 3, F)

MALE: 0.96 mm.; a = 12; b = 6; c = 6.
DESCRIPTION: Body fat and dark; cuticle heavily striated. Small labial setae; 12 cephalic setae 9 microns long or 55% of head diameter; cervical and somatic setae lacking. Stoma distinct, lightly sclerotized, with distinct cheilorhabdions. Amphids circular, situated just behind base of stoma, 13 microns in diameter or 50% of head diameter. Spicules thick, slightly arcuate, strongly knobbed, 51 microns long or 90% of anal body diameter; heavy antero-lateral teeth at tips. Gubernaculum between spicules, with dorsal apophysis 15 microns long. Tail conical with a very short slightly swollen cylindrical portion at tip, 2.8 anal body diameters long; numerous subventral setae equally spaced posterior to anus and 3 small spines at tip.
DISCUSSION: The present specimen is much broader than in the many descriptions given of *Theristus normandicus*. However, in other respects and in the copulatory apparatus especially there is good correspondence.
HABITAT: Station 4.

SUPERFAMILY PLECTOIDEA

Chronogaster typicus (de Man, 1921) de Coninck, 1935 (Fig. 3, G-H)
FEMALE (immature): 1.11 mm.; a = 42.8; b = 7.4; c = 6.8; V = 55.5%.

DESCRIPTION: Cuticle coarsely striated; striae about 1.2 microns apart; lateral alae present. Head rounded, not set off; 6 partially fused lips. Four sublateral cephalic setae, 1.2 head diameters long; cervical and somatic setae absent. Amphids bowl-shaped, 3 microns wide or 40% of head diameter, located over base of stoma. Stoma cylindrical-conical, 8 microns long or 1.2 head diameters. Esophagus consisting of a narrow portion surrounding base of stoma, a swelling surrounding the triradiate sclerotizations characteristic of this genus, followed by a uniformly narrow portion ending in an expanded bulb with valve-like apparatus bearing tiny denticles. Long narrow esophago-intestinal valve, 30 microns long or a little longer than the bulb. Nerve ring at 78% of esophageal length. Excretory pore not observed. Prominent hypodermal glands and small crystalline bodies present. Female reproductive system not clearly observed because of immaturity of specimen. Tail long and uniformly tapering to rounded tip, 12.7 anal body diameters long.

DISCUSSION: *Chronogaster alatus* Gerlach, 1954 from the Brazilian coast is the only marine species of *Chronogaster* described so far. My specimen cannot clearly be distinguished from the type species, *Chronogaster typicus*, although the esophagus and tail are both somewhat longer and the vulva is slightly more posterior. The immaturity of the specimen could account for these differences.

LOCALITY: Habitat 4.

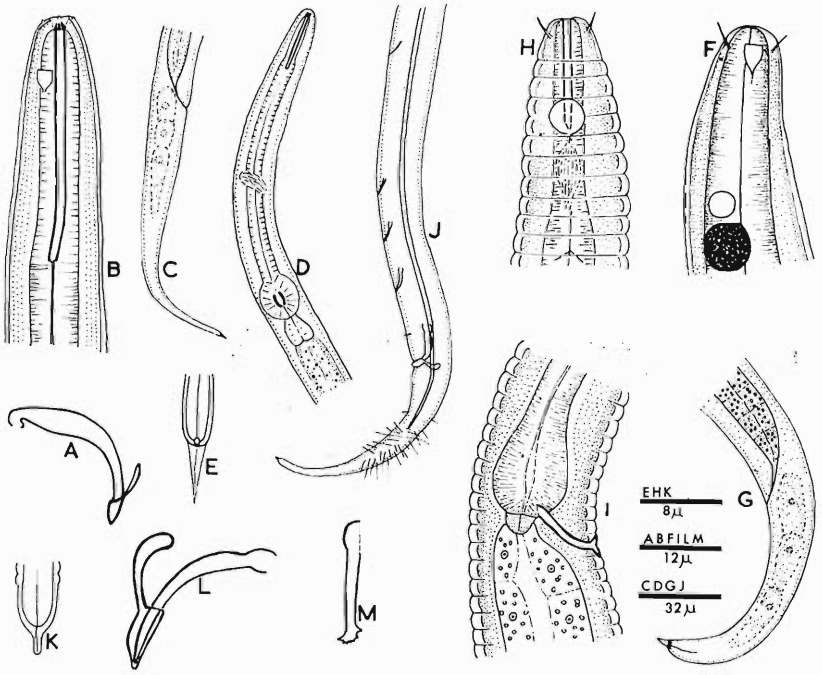

Fig. 4. A. *Camacolaimus tardus*. Male copulatory apparatus. B-E. *Syringolaimus brevicaudatus*. B. Female head. C. Female tail. D. Esophageal region. E. Tail tip. F-G. *Ionema cobbi*. F. Female head. G. Female tail. H-M. *Leptolaimun luridus*. H. Male head. I. Esophageal base. J. Male tail. K. Tail tip. L. Male copulatory apparatus. M. Male supplement.

Paraphanolaimus granuliferus n. sp. (Fig. 3, I-K)

MALE: 1.32 mm.; a = 45.6; b = 7; c = 14.2.

DESCRIPTION: Cuticle annulated; annulations 1.5 microns apart; very thick lateral alae, 6 microns wide or 28% of body diameter. Head set off by constriction and wider than body at anterior of stoma; truncate at anterior; lips fused. Four sublateral cephalic setae, 4 microns long or 54% of head diameter. Cervical and somatic setae lacking. Stoma sclerotized cylindrical, tapering slightly towards base, 7 microns long or 1 head diameter. Amphids single spiral, located at extreme anterior, about 60% of head diameter wide. Esophagus expanded at base for 25% of its length but no distinct bulb. Nerve ring at 44% of esophageal length. Small excretory cell behind esophageal base. Spicules 40 microns long or 1.6 anal body diameters, distinctly cephalated. Gubernaculum with ventrally curved posterior apophysis 10 microns long. Ten large cephalated ventro-medial preanal supplements, 17 microns long. Tail conical, uniformly tapering to small digitate tip, 3.7 anal body diameters long.

DISCUSSION: This species corresponds best in cephalic characters to *Paraphanolaimus*, although there is great diversity of stomatal shape in the three previously described species. This species differs from *P. behningi* Micoletzky, 1923, of which only the female is known, by the greater length of the stoma and the shorter tail. It is much closer to *P. cantor* Gerlach, 1957 but differs in the shorter tail, lack of preanal cuticular pores, and in the posterior apophysis of the gubernaculum. In *P. longisetosus* Altherr, 1960 and *P. behningi* conspicuous hypodermal gland cells are present, which are absent in the present species, while lateral alae are lacking in the other three species.

TYPE-LOCALITY: Habitat 2.

HOLOTYPE: Male on Slide M115.

Syringolaimus aff. *brevicaudatus* Micoletzky, 1922 (Fig. 4, B-E)

FEMALE: 0.55 mm.; a = 30; b = 5.1; c = 5.5; V = 51.6%; Ov_1 = 13%; Ov_2 = 14%.

DESCRIPTION: Cuticle finely striated; faint lateral alae. Head rounded; lips fused. Stoma long and narrow, sclerotized, 35 microns long or 5.8 head diameters; 3 small solid teeth at anterior of stoma, with outward thrust, apparently doubled at base. Six small labial papillae. Amphids indistinct, bowl-shaped, about 20% of head diameter wide, one head diameter posterior. Esophageal bulb well set off, with thickened crescentic internal plates, 13% of esophageal length; broad esophago-intestinal valve, about 10 microns long. Nerve ring at 56% of esophagus. Excretory cell compressed against intestine, pore apparently just anterior to stoma base. Intestine with fine irregular greenish-yellow inclusions. Two ovaries, outstretched. Tail conical-tapering, with acuminate tip, 7.7 anal body diameters long.

DISCUSSION: The small size, anterior position of the excretory pore, absence of conspicuous striation on the tail, and the length of the spinneret all seem to point to an identification with *Syringolaimus brevicaudatus*. However, the position of the vulva and the length of the tail correspond better to *S. striaticaudatus* de Man, 1888. Unfortunately Micoletzky (1922) did not illustrate his specimen.

Camacolaimus tardus de Man, 1889 (Figs. 3, L-M and 4, A)

FEMALE (n = 5): 0.76–1.15 mm.; a = 23.6–37.6; b = 4.7–6.3; c = 14.9–21; V = 50.5–60%; Ov_1 = 14–17%; Ov_2 = 10–17%.

MALE: 0.94 mm.; a = 50; b = 5.3; c = 14.7.

DESCRIPTION: Body double coiled in death or anterior and posterior coiled separately. Cuticle moderately striated, with narrow refractive alae extending from esophageal base to anal region. Head continuous with body contour; lips fused. Four sublateral cephalic setae, about 20% head diameter long; subcephalic and somatic setae lacking. Amphids single spire, located at extreme anterior. Mural stylet 15 to 16 microns long, with blunt tip. Ocelli absent. Esophagus slightly narrowed at stylet region, expanded at base into a bulb. Nerve ring 45–49%. Excretory pore a short distance anterior to nerve ring. Excretory cell small, just posterior to esophageal base. Intestinal lumen distinct; prominent rectal glands. Female reproductive system amphidelphic; ovaries reflexed about ⅔ the distance to vulva. One ovum in each uterus at a time, about 60 by 30 microns. Male spicules arcuate, 35 microns long or 2 anal body diameters; capitulum ventrally inclined. Gubernaculum 12 microns long, with dorsal apophysis and sleeve-like ventral portion. Tails in both sexes broadly conical, with dorsally-inclined digitate tip; tail 2.5–3.2 anal body diameters long in female, 4 anal body diameters in male.

DISCUSSION: My measurements better fit the description of this species by Wieser (1956) than the original description of de Man (1889). The present specimens are somewhat shorter than those of Wieser.

LOCALITY: Habitats 1 and 2.

COLLECTION: 1 male, 8 females, 3 juveniles.

Ionema cobbi n. sp. (Fig. 4, F-G)

FEMALE: 1.22 mm.; a = 48.7; b = 8; c = 13.5; V = 54.2%; Ov_1 and Ov_2 = 9%.

DESCRIPTION: Body pale. Cuticle apparently smooth. Head rounded, head diameter 6 microns. Four cephalic setae, 55% of head diameter long. Prominent ocelli 16 microns or 2.7 head diameters from anterior end, consisting of compact bright red pigment mass and large spherical hyaline lens distinct from pigment mass. Amphids bowl-shaped, about one-third head diameter wide, situated at level of cephalic setae. Lining at anterior of esophagus obscurely thickened but no distinct tooth. Excretory cell 200 microns posterior to esophageal base. Intestinal cells distinct, hyaline in appearance, 4 in cross section, containing pale yellow globules. Tail conical, 5 anal body diameters long, with bluntly-pointed tip bearing a spinneret. Three prominent refractive nuclei in caudal glands.

DISCUSSION: This species is shorter than *Ionema ocellatum* Cobb, 1920 and the esophagus is much longer. Cobb mentioned that there are several species from tropical oceans but he described only the one and the genus has not been found since then by other authors. According to Wieser (1956) "Cobb's description and figure are not quite clear and a tooth may be present. If so, this genus should be synonymized with the following one" (i.e. *Nemella* Cobb, 1920). However, *Ionema* has page priority by one page.

TYPE-LOCALITY: Habitat 1.

HOLOTYPE: Female on Slide M113.

Leptolaimus luridus n. sp. (Fig. 4, H-M)

FEMALE: 0.5 mm.; a = 20; b = 4.7; c = 5.7; V = 50.3%.

MALE (n = 5): 0.52–0.76 mm.; a = 27.4–36.7; b = 5–5.7; c = 6.8–8.7.

HOLOTYPE MALE: 0.68 mm.; a = 33.6; b = 5.8; c = 8.4.

DESCRIPTION: Body very pale in color. Cuticle thick and hyaline, with

coarse transverse striation; thick refractive lateral alae, one-seventh of body diameter wide at mid-body, ending at mid-tail. Head not set off, rounded at anterior; lips fused for most part. Inner circle of 6 tiny papillae; outer circle of 4 sublateral setae, 3 microns long or 50% of head diameter. Cervical and somatic setae lacking. Amphids single spiral, 3 to 4 microns broad or about 35% of corresponding head diameter, situated over base of stoma or about 1.5 head diameters posteriorly. Narrow sclerotized cylindrical stoma, about 12 microns long or 2 head diameters (difficult to see). Esophagus narrowed at base of stoma and surrounding entire stoma; basal bulb 15% of esophageal length; narrow esophago-intestinal valve. Nerve ring at 62% of esophageal length. Small cell (excretory?) 130 microns posterior to esophagus; excretory pore opposite base of stoma. Spicules distinctly cephalated, 35 microns long or 1.8 anal body diameters. Gubernaculum with sleeve-like portion around spicule tips and a dorsal apophysis 19 microns long. Four tubular preanal median supplements, 17 microns long, anteriormost considerably (70 microns) separated from others; 1 supplement at esophageal base; each supplement with proximal anterior tooth and many small posterior denticles. Tail conical-cylindrical, 4–4.5 anal body diameters long, with small digitate or bifurcate tip. Many fine filamentous fungi clustered on tails of all specimens.

DISCUSSION: This species seems nearest to *Leptolaimus praeclarus* Timm, 1961 from the Bay of Bengal, but in that species the four preanal supplements are equally spaced and the supplement at the esophageal base is lacking. Tubular organs in the esophageal region are a characteristic of *Halaphanolaimus pellucidus* Southern, 1914. In the redescription of this species by Gerlach (1952) only one such organ is present and the head characters are as in *Leptolaimus*. Except for the posterior vulva of *Halaphanolaimus* the two genera cannot be adequately distinguished.

TYPE-LOCALITY: Habitat 1; also found in Habitat 2.

HOLOTYPE: Male on Slide M114.

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Some Digenetic Trematodes from Amphibians and Reptiles in Southern Rhodesia Including Two New Species and a New Genus: *Sarumitrema hystatorchis* n.gen., n.sp. (Plagiorchiidae) and *Halipegus rhodesiensis* n.sp. (Halipegidae)

MARY BEVERLEY-BURTON (MRS. D. F. METTRICK)

During the three years 1959-1961 198 amphibians have been caught and examined for helminths. Sixty-eight specimens of *Bufo regularis* (Reuss) and 103 specimens of *Rana adspersa* (Tschudi) were taken on the University site; 27 specimens of *Xenopus laevis* (Daudin) were available for examination at Henderson Fisheries Research Station at Mazoe, which is about 20 miles from Salisbury. A single crocodile, *Crocodylus niloticus* (Laurenti), was shot near Gatooma, and 3 specimens of the lizard, *Mabuya striata,* taken at Dombashawa near Salisbury were examined.

Five species of dignetic trematodes were recovered representing four families. The worms were washed in normal saline, fixed, under slight coverslip pressure, in cold formal acetic alcohol and stained in Kirkpatrick's carmalum.Transverse sections were cut of unflattened specimens of *Sarumitrema hystatorchis* n.g., n.sp. using polyethylene glycol distearate wax. Unless otherwise stated all measurements are in mm.

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The author is indebted to Mr. S. Prudhoe of the British Museum (Natural History).
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PLAGIORCHIIDAE Lühe, 1901, *Emend.* WARD, 1917

Sarumitrema n.gen.

DIAGNOSIS: Plagiorchiidae Luhe, 1901, emend. Ward, 1917; body lanceolate. Oral sucker subterminal; prepharynx short; pharynx surrounded by glandular cells; oesophagus present; intestinal caeca simple ending blindly in posterior quarter of body. Ventral sucker present. Testes symmetrical, immediately posterior to intestinal caeca. External seminal vesicle absent. Cirrus sac, anterior to ventral sucker, contains coiled internal seminal vesicle; pars prostatica and unarmed ejaculatory duct. Common genital pore situated on left of body at level of intestinal bifurcation. Ovary obliquely posterior to ventral sucker. Receptaculum seminis and Mehlis' gland posterior to ovary. Uterus, with coiled descending and ascending limbs, does not extent posterior to testes. Metraterm opens at common genital pore. Follicular vitellaria in two lateral extracaecal bands. Excretory bladder Y shaped; excretory pore dorsal, subterminal. Eggs thin shelled, operculate and numerous. Adults in intestine of Amphibia.

TYPE SPECIES: *S. hystatorchis* n.sp.

Sarumitrema hystatorchis n.sp.

SPECIFIC DESCRIPTION: With characters of the genus. Body measures 1.58–4.54 long by 0.56–1.35 in diameter. Cuticle with spines, measuring, in anterior region of body up to 11 microns long. Cuticular spines absent posterior to testes. Oral sucker subterminal, globular, 0.18–0.37 long by 0.19–0.40 wide; mouth triangular or oval and ventral in position; prepharynx variable, up to 0.08 long, or completely obscured by pharynx. Pharynx, 0.08–0.18 long by 0.08–0.24 wide, surrounded by deeply staining glandular cells. Oesophagus thin walled, up to 0.26 long; intestinal ceaca extend into posterior quarter of body and end just in front of testes. Ventral sucker shallow, 0.13–0.29 long by 0.13–0.32 wide; situated at about one third of body length from anterior end. Testes symmetrical, posterior to all other genitalia and intestinal caeca. Testes rounded and entire; right testis measures 0.15-0.41 long by 0.16-0.41 wide; left testis 0.13-0.43 by 0.15-0.41. External seminal vesicle absent. Cirrus sac, 0.23-0.54 long by 0.09-0.18 in diameter, contains voluminous, coiled seminal vesicle, short pars prostatica and unarmed ejaculatory duct. Cirrus sac and metraterm pass, ventral to left intestinal caecum, to common genital pore which lies to left of intestinal bifucation. Ovary, 0.12–0.37 long by 0.11–0.29 wide, lies obliquely posterior to ventral sucker; oviduct, visible in immature and sectioned specimens, arises from posterior border of ovary and receives duct from receptaculum seminis and vitelline dut. Receptaculum seminis thin walled, globular, 0.06–0.15 long by 0.05–0.16 wide, lies dorsal to uterine coils, posterior to ovary. Uterus with descending and ascending limbs which tend to remain separate on different sides of body in posterior region. At level of female complex ascending uterus with large coils extending right across body, obscuring ovary, receptaculum seminis and Mehlis' gland. Uterine coils tend to cover intestinal caeca, but do not extend behind level of testes. Metraterm, 18 microns in diameter, opens at common genital pore. Vitelline follicles irregular, extending from level of anterior margin of ventral sucker to level approximately halfway between ovary and testes. Transverse vitelline ducts, apparent on each side of body at level of Mehlis' gland, meet medianly to form short common yolk duct before entering oviduct. Excretory bladder

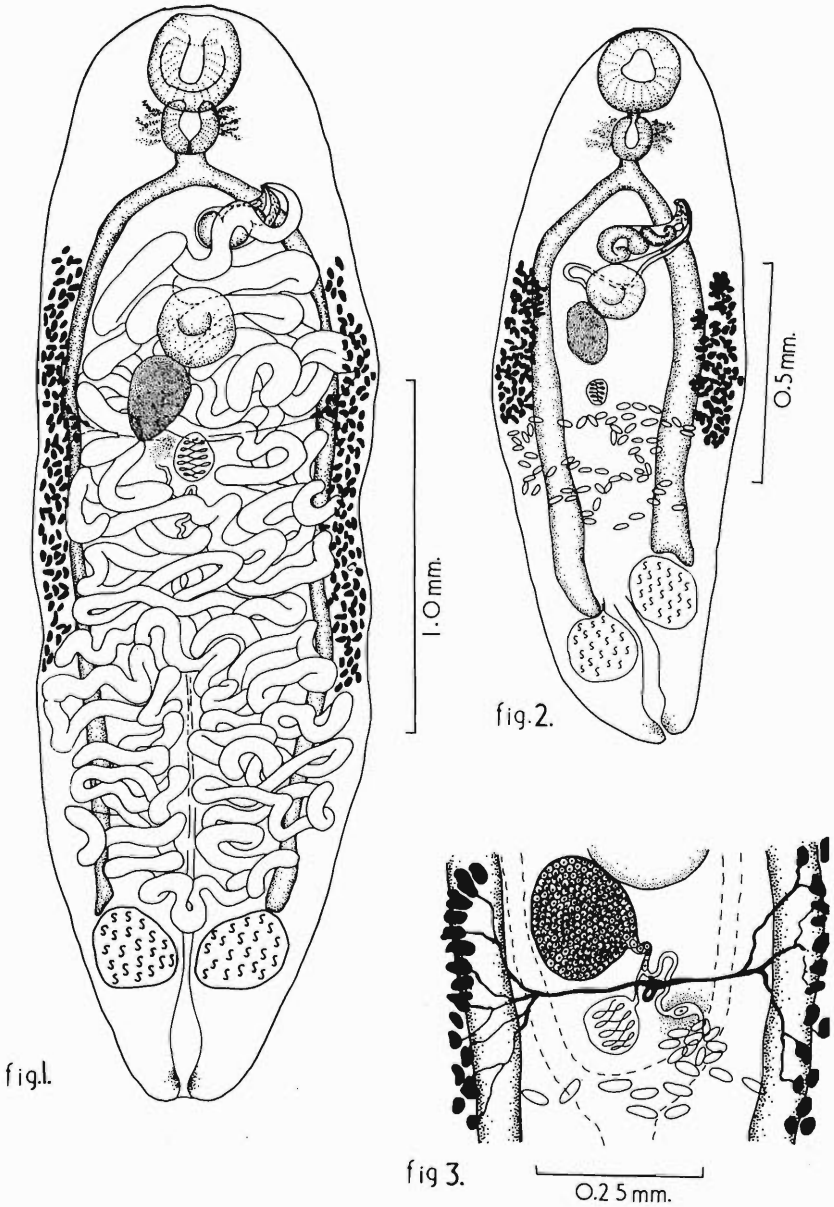

Fig. 1. *Sarumitrema hystatorchis* n.g., n.sp. Entire mature specimen, ventral view.

Fig. 2. *Sarumitrema hystatorchis* n.g., n.sp. Entire immature specimen. Ventral view.

Fig. 3. *Sarumitrema hystatorchis* n.g., n.sp. Details of female genital ducts. Ventral view.

Y shaped; stem of excretory bladder extends from excretory pore to just behind receptaculum seminis where it divides; arms of bladder embrace ventral sucker. Eggs thin shelled, numerous, operculate, 30–35 microns long by 12–14 microns wide.

TYPE HOST: *Rana adspera* (Tschudi).

OTHER KNOWN HOSTS: *Bufo regularis* (Reuss).

LOCATION: Intestine.

LOCALITY: University site, Salisbury, Southern Rhodesia.

S. hystatorchis was recovered from 22 specimens of *B. regularis* (32.34% infection) and from 57 speciments of *R. adspersa* (55.33% infection). The largest number of trematodes recovered from a single host was 17.

HOLOTYPE AND PARATYPES: To be deposited in the British Museum (Natural History).

DISCUSSION: According to both Skrjabin (1958) and Yamaguti (1958) the family Plagiorchiidae has been sub-divided into a large number of sub-families and different taxonomic schemes have been presented by many previous authors. *Sarumitrema* n.g. clearly belongs to the family Plagiorchiidae but is not, at the present time, assigned to any sub-family.

Sarumitrema is separated from other plagiorchiid genera on a combination of 4 distinctive features: posterior position of the testes; lateral position of the genital pore; confinement of the uterine coils to the pre-testicular region of the body; presence of a receptaculum seminis.

Glypthelmins Stafford, 1905.

Glypthelmins africana Dollfus, 1950.

DESCRIPTION: Body lanceolate, 2.22–2.67 long by 0.79–0.93 wide. Cuticle armed with small spines anteriorly. Oral sucker, 0.33–0.36 long by 0.33–0.40 wide; prepharynx short, up to 0.02 long in extended specimens; pharynx 0.12 long by 0.15–0.17 wide; oesophagus up to 0.08 long; intestinal caeca, extend to posterior quarter of body, and separated from posterior body margin by uterine coils. Ventral sucker, 0.19–0.22 long by 0.18–0.20 wide, smaller than oral sucker and situated at one third of body length. Rounded testes oblique in median body region; anterior testis 0.24–0.31 long by 0.30–0.31 wide; posterior testis 0.30–0.35 by 0.30–0.31. External seminal vesicle absent. Cirrus sac conspicuous, 0.54–0.56 long by 0.13–0.14 in maximum diameter curving to right or left of ventral sucker. Cirrus sac contains large seminal vesicle, 0.29–0.35 long by 0.10–0.11 wide. Common genital pore median, immediately anterior to ventral sucker. Rounded ovary, 0.20–0.22 long by 0.24–0.29 wide, lies on right of body, separated from ventral sucker by base of cirrus sac. Receptaculum seminis small, posterior to ovary. Uterus with descending and ascending limbs which tend to separate testes. Uterus fills all available space behind intestinal caeca. Vitelline follicles irregular, in two lateral bands extending along entire length of intestinal caeca. Transverse vitelline ducts meet medianly forming small reservoir near receptaculum. Excretory vessel Y-shaped. Eggs numerous, small, 32-35 microns long by 18-21 microns wide.

HOSTS: *Rana adspersa* (Tschudi) and *Mabuya striata*.

LOCATION: Intestine.

LOCALITY: University site, Salisbury and Dombashawa, Southern Rhodesia.

Only 1 specimen of *R. adspersa* and 1 specimen of *M. striata* were found to be infected with this trematode. 4 worms were recovered from the frog and 2 from the lizard.

DISCUSSION: The above description applies to the specimens collected from *Rana adspersa*. Measurements of the material from *Mabuya striata* are included in Table 1. A brief re-description of *Glypthelmins africana* has been included as the present material is slightly smaller than the type material described by Dollfus (1950) which was recovered from *Rana mascariensis* in the Congo. (Table 1.)

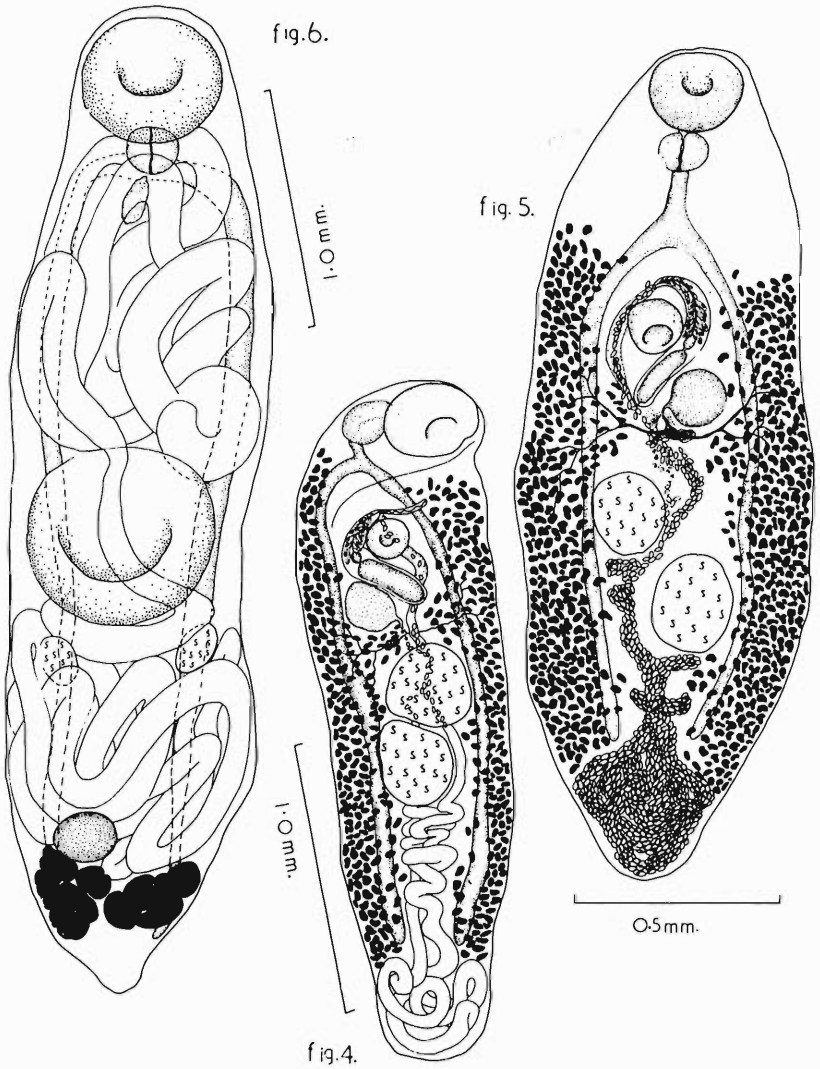

Fig. 4. *Glypthelmins africana* Dollfus, 1950. Entire specimen from *Rana adspersa* (Tschudi). Ventral view.

Fig. 5. *Glyphelmins africana* Dollfus, 1950. Entire specimen from *Mabuya striata*. Ventral view.

Fig. 6. *Halipegus rhodesiensis* n.sp. Entire specimen. Ventral view.

Dollfus (1950) considered that the genus *Glypthelmins* belonged to the family Brachycoeliidae sensu Dollfus, 1927, which is characterised by having an I shaped excretory bladder. Both Skrjabin (1958) and Yamaguti (1958) included *Glypthelmins* in the family Plagiorchiidae, and stated in the generic diagnosis that the excretory bladder is Y shaped (a plagiorchid characteristic). The present author accepts the placing of the genus *Glypthelmins* in the family Plagiorchiidae as the excretory bladder, in the Rhodesian material under consideration, is Y shaped. Dollfus (1950) stated that the excretory bladder in the Congolese specimens was not seen.

The genus *Glypthelmins* Stafford, 1905 has been used to accommodate a heterogenious collection of species. Rankin (1944) reviewed the genus and reduced the number of valid species to four, viz: *G. quieta* Stafford, 1905, *G. elegans* Travassos, 1926, *G. lingatula* (Rudolphi, 1819) and *G. repandum* (Rudolphi, 1819). Dollfus (1950) commented that many of the species included in genus *Glypthelmins* are very similar to forms which have been assigned to the genus *Astiotrema* Looss, 1900. (Yeh and Fotedar (1958) reviewed the genus *Astiotrema* and accepted only four species as valid). According to Dollfus (1950) the objection to placing *africanum* in the genus *Astiotrema* was one involving host specificity; species of the genus *Astiotrema* parasitize fishes and chelonians while species of the genus *Glypthelmins* are found in amphibians. Therefore *africanum,* recovered from *Rana mascariensis* was assigned to the latter genus. The present author accepts the synonymy proposed by Rankin (1944) in the genus *Glypthelmins* and the subsequent inclusion of *africanum* proposed tentatively by Dollfus (1950).

It is of interest to note that some of the species assigned to the genus *Plagiorchis* from reptiles and amphibians show more similarity to *G. africanum* than do the accepted species of *Glypthelmins*. *P. (P.) himalayai* (Jordon, 1930), *P. (P.) momplei* (Dollfus, 1932) and *P. (P.) ramlianus* Looss, 1896 are all similar in appearance with uterine coils which fill the available space behind the intestinal caeca and vitellaria. It is suggested that if a comparative survey were made of plagiorchiids from amphibia some of the species concerned might possibly be assigned to a separate new genus.

HALIPEGIDAE Poche, 1925

Halipegus Looss, 1899

Halipegus rhodesiensis n.sp.

DESCRIPTION: Body cylindrical, 2.77–4.0 long by 0.75–1.03 wide. Cuticle unarmed. Oral sucker muscular, 0.38–0.49 long by 0.44–0.59 in diameter; prepharynx absent; pharynx globular, 0.10–0.15 wide; oesophagus not apparent in present specimens; intestinal caeca extend to level of posterior vitelline follicles. Ventral sucker powerful, 0.54–0.73 long by 0.56–0.76 wide, situated equatorally or just inside posterior half of body. Testes almost symmetrical, in posterior third of body, separated from ventral sucker by single uterine coil. Testes rounded and smooth in outline; right testis 0.16–0.19 long by 0.16–0.18 wide; left testis 0.19–0.22 by 0.15–0.19. Seminal vesicle, 0.12 long by 0.05 wide; cirrus sac absent. Common genital pore ventral, situated at level of posterior border of pharynx. Ovary rounded or transversely oval, 0.19–0.22 long by 0.19–0.24 wide, posterior in position, on right hand side of body, separated from posterior body margin by vitelline follicles. Receptaculum seminis, 0.12 in diameter, median to

Table 1. The measurements of specimens of *Glypthelmins africana* taken from three African host species.

	R. mascariensis After Dollfus (1950)	*R. adspersa* Present material	*M. striata* Present material
Body length	3.46-3.58	2.22-2.67	2.04-2.15
Body diameter	1.20-1.28	0.79-0.93	0.67-0.81
Oral sucker	0.43-0.44 × 0.44-0.50	0.33-0.36 × 0.33-0.40	0.19-0.22 × 0.22-0.25
Ventral sucker	0.25-0.26 × 0.26	0.19-0.22 × 0.18-0.20	0.15-0.16 × 0.14-0.15
Pharynx	0.22-0.25 × 0.21-0.23	0.12 × 0.15-0.17	0.09-0.10 × 0.10-0.13
Oesophagus length	0.07-0.12	up to 0.08	0.06-0.11
Cirrus sac dia.	0.14-0.17	0.13-0.14	0.08-0.10
Eggs (microns)	31-36 × 21-22	32-35 × 18-21	32-35 × 18-21

left of ovary. Uterus, with ascending limb only, fills all available space between ovary and pharynx except in region of ventral sucker where coils are sparse. Vitellaria in 2 compact clusters, each with 3 to 5 lobes, up to 0.19 in diameter, situated on either side of ovary. Small central vitelline reservoir forms at confluence of transverse vitelline ducts. Eggs, 70–74 microns long by 24-28 microns wide, bear long polar filaments up to 240 microns long; ratio of measurement of egg: polar filament 1:3. (Eggs and pilar filaments were measured after dissection from anterior uterine coils.)

HOST: *Xenopus laevis* (Daudin).

LOCATION: Stomach.

LOCALITY: Henderson research Station, Mazoe, Southern Rhodesia.

Only 4 worms were recovered; 2 specimens of *X. laevis* were infected which represents 7.4% of the total examined.

HOLOTYPE AND PARATYPES: To be deposited in the British Museum (Natural History).

DISCUSSION: Rankin (1944a) reviewed the genus *Halipegus* and recognised the following six species as valid forms: *H. ovocaudatus* (Vulpian, 1859); *H. occidualis* Stafford, 1905; *H. mehransis* Srivastava, 1933; *H. eccentricus* Thomas, 1939; *H. japonicus* Yamaguti, 1936; and *H. amherstensis* Rankin, 1944. Yamaguti (1958) included twelve species of *Halipegus* from amphibia while Skrjabin (1955) listed eleven from the same host group. Both Skrjabin (1955) and Yamaguti (1958) ignored the synonymy proposed by Rankin (1944a). The present author regards the six species listed above as valid forms and also accepts *H. africanus* Dollfus, 1950. The measurements of these seven species are compared with the present material in Table 2.

Rankin (1944a) stated that it is extremely difficult to separate the species of the genus *Halipegus* if only the adult worms are available for examination. Dollfus (1950) considered that the ratio of the measurements of the egg and polar filament were of specific importance although in 1931 he apparently stated that this was an unreliable feature. From a comparison of the data presented in Table 2 the present material is most similar to *H. occidualis* Stafford, 1905, taken from *Rana clamitans* and *R. catesbiana* in Canada. In spite of this similarity to *H. occidualis* a new species is tentatively proposed as *H. occidualis* has not previously been recorded from Africa and *H. rhodesiensis* was recovered from *Xenopus laevis,* a different host genus.

According to Dollfus (1950) the only other species of *Halipegus* that

have been described from Africa in the adult form are *H. africanus* Dollfus, 1950, *H. ovocaudatus* which was reported by Grobbelaar in 1922 from *Rana fuscigula* in South Africa and *Halipegus sp.* described from *Bufo regularis* by Porter (1938). Fain (1953) gave a brief description of experimental adult material of a species of *Halipegus* developed from *Cercaria bulla* Fain, 1953, but did not include details of the measurements of the eggs. Superficially the material described by Fain (1953) resembles that described in the present paper. *H. africanus, H. ovocandatus* and the *Halipegus* sp. described by Porter (1938) are considerably larger than *H. rhodesiensis* and have comparatively short polar filaments.

PARAMPHISTOMATIDAE Fischoeder, 1901

Diplodiscus Diesing, 1836

Diplodiscus doyeri Ortlepp, 1926

DESCRIPTION: Body cylindrical; 1.76-2.31 in total length, 0.57-0.62 wide; with bell-shaped posterior, sucker 0.57–0.67 deep by 1.0–1.43 wide. Ruffled peduncle present in centre of posterior sucker. Pharynx terminal, 0.19–0.35 long by 0.21–0.25 in diameter; lateral pharyngeal pouches present, 0.09–0.15 wide; oesophagus up to 0.64 long with thickened, muscular walls before entry to intestinal bifurcation; intestinal caeca extend to testicular region. Single testis present, 0.12–0.27 long by 0.15–0.27 wide, median, immediately anterior to ovary. Seminal vesicle, 0.19–0.27 long by 0.06–0.08 wide, lies ventral to intestinal bifurcation. Common genital pore median and ventral in oesophageal region. Ovary 0.14 long by 0.14–0.16 wide, median or submedian, post-testicular. Uterus with descending and ascending limbs eventually fills entire body and obscures degenerating genitalia. Vitellaria follicular, in two clusters posterior to intestinal caeca. Embryonated eggs measure up to 140 microns long by 84 microns wide.

HOSTS *Xenophon laevis* (Daudin).

LOCATION: Intestine and rectum.

LOCALITY: Henderson Research Station, Mazoe, Southern Rhodesia.

18 specimens of *X. laevis* were found to be infected with *D. doyeri* which represents 66.66% of the animals examined. The largest number of specimens of *D. doyeri* recovered from one host was five.

DISCUSSION: Ortlepp (1926) described *D. doyeri* from *Xenopus laevis* in Natal, South Africa. According to Yamaguti (1958) this is the only species of *Diplodiscus* that has been recorded from Africa. Ortlepp (1926) included measurements of the body, ventral sucker and seminal vesicle (?) which are similar to those of the present material which is therefore identified as *D. doyeri.* A more detailed re-description has been included in the present paper in order to facilitate the identification of trematodes from Rhodesian amphibia.

PROTERODIPLOSTOMATIDAE Dubois, 1936

Pseudoneodiplostomum Dubois, 1936

Pseudoneodiplostomum bifurcatum (Wedl, 1862) Dubois, 1948

DESCRIPTION: Body measures 3.07–4.42 long; fore body 1.73–1.92 long by 0.85–1.04 wide, hind body 1.15–2.5 by 0.73–0.89. Holdfast oval in shape, 0.60–0.62 long by 0.54 wide, with papillae arranged along the median apperture. Oral sucker, 0.04–0.06 long by 0.05 in diameter, is followed by pharynx 0.05 long by 0.04 wide. Short oesophagus leads to intestinal caeca, which extend to the posterior region of hindbody. Ventral sucker, 0.10

long by 0.11–0.12 wide, is twice as large as the oral sucker and lies half way along the length of the forebody. Testes rounded, posterior to ovary in hindbody; anterior testis 0.27–0.54 long by 0.41–0.58 wide; posterior testis 0.25–0.62 long by 0.47–0.56. Seminal vesicle coiled behind testes and leads to ejaculatory duct which traverses genital cone. Genital cone measures up to 0.79 long by 0.18 wide and can be extruded through opening of copulatory bursa giving the appearance of a terminal bifurcation. Ovary rounded, 0.19–0.23 long by 0.24–0.31 wide, lies anterior to testes. Mehlis' gland and vitelline reservoir, 0.06 long by 0.19 wide, situated between testes. Uterus contains few eggs and opens at base of genital cone into copulatory bursa. Vitelline follicles extend from level of ventral sucker to that of anterior border of posterior testis. Eggs measure 100–109 microns long by 74–81 microns wide.

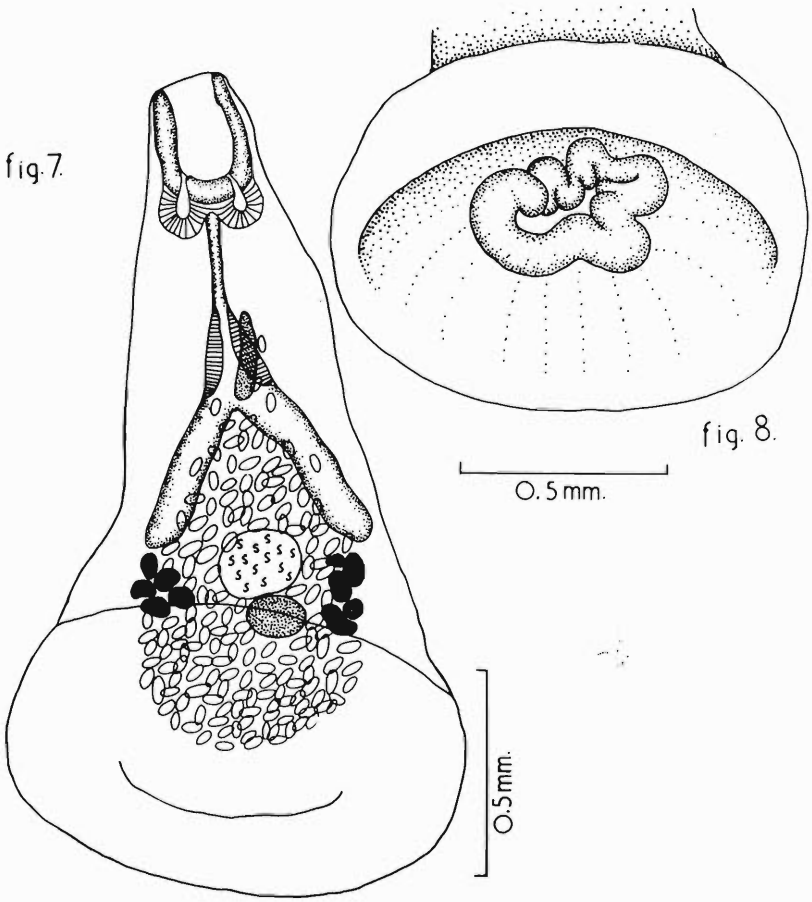

Fig. 7. *Diplodiscus doyeri* Ortlepp, 1926. Entire specimen. Dorsal view.
Fig. 8. *Diplodiscus doyeri* Ortlepp, 1926. Details of campanulate, terminal sucker.

Table 2. The measurements of the 8 species of *Halipegus* considered valid by the present author.

	H. ovocaudatus after Lühe (1909)	*H. occidualis* after Skrjabin (1955)	*H. mehransis* after Skrjabin (1955)	*H. eccentricus* after Skrjabin (1955)	*H. japonicus* after Yamaguti (1936)	*H. amherstensis* after Rankin (1944)	*H. africanus* after Dollfus (1950)	*H. rhodesiensis* n. sp.
Length	13	5.8	1.7–4.5	6	2.17–5.38	3.9–4.4	12.2	2.77–4
Width	—	1.7	0.6–0.9	1.75	0.65–1.6	0.9–1.3	3.3	0.75–1.03
Oral sucker dia.	0.8	0.47	0.28	0.45	0.25–0.68	0.26–0.28	0.1	0.44–0.59
Pharynx dia.	—	0.154	0.1–0.4	0.145	0.09–0.2	0.1–0.12	0.353	0.10–0.15
Ventral sucker dia.	1.3	0.714	0.5–0.72	0.720	1.4–1.8	0.5–0.59	1.41	0.56–0.76
Eggs length (Microns)	63	61	45	52	45–48	43–46	56.5–62	70–74
Eggs width (Microns)	22	26	18	23	16–18	15–19	18 –22.6	24–28
Polar filament length (Microns)	—	160–200	320	56–58	300	120–170	102–127	210–240
Ratio of measurement of egg to polar filament	1:1–1.5	1:3	1:7	1:1	1:6	1:3.5	1:2	1:3

HOST: *Crocodylus niloticus* (Laurenti).

LOCATION: Intestine.

LOCALITY: Gatooma, Southern Rhodesia.

The single crocodile was a young animal, about 3 feet long. 136 specimens of *P. bifurcatum* were collected.

DISCUSSION: *Pseudoneodiplostomum bifurcatum* is briefly redescribed as the material recovered by the present author and is slightly larger than that described by Dollfus (1950) from the Congo. *P. bifurcatum* was also described by Dubois (1948), who reviewed the genus *Pseudoneodiplostomum*, and is included in the list of strigeids from African hosts compiled by Bisseru (1957). This is, apparently, the first record of *P. bifurcatum* from Southern Rhodesia.

SUMMARY

Two new species, *Sarumitrema hystatorchis* n.g., n.sp. (Plagiorchiidae) and *Halipegus rhodesiensis* n.sp. (Halipegidae) from amphibia are described.

Brief re-descriptions of *Glypthelmins africana* Dollfus, 1950, *Diplodiscus doyeri* Ortlepp, 1926 and *Pseudoneodiplostomum bifurcatum* (Wedl., 1862) Dubois, 1948 are given.

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Observations on the Histochemistry of *Syncoelium spathulatum* n.sp.*

WILLIAM H. COIL** and ROBERT E. KUNTZ***

The U. S. Naval Expedition to Lan Yu Island spent two weeks on this little-known island which lies approximately 45 miles east of the southern tip of Taiwan. This island has been given a number of different names: Orchid Island, Botel Tobago, Koto-sho (Japanese) and Lan Yu (Chinese). The expedition was organized to permit medical studies of the Yami tribe of aborigines and to make investigations on the parasites of man and animals on the island. This is a continuation of the geomedical and biological studies by the U. S. Naval Medical Research Unit No. 2 on Taiwan and countries of southeast Asia.

The present paper is the second in a series based on the collection of vertebrate helminths obtained by the examination of vertebrate hosts on Lan Yu in March of 1959.

Two specimens were taken from the gills of the flying fish *Prognichthys* and further examination indicated that these worms belonged to an undescribed species. A study of the anatomy revealed a number of interesting features not commonly seen in trematodes and worthy of further investigation.

MATERIALS AND METHODS

The trematodes were killed by quick immersion into hot water and they were transferred to stender dishes with AFA (formalin-acetic acid-alcohol) for fixation. After 5–15 hours the worms were moved to vials with 70 percent alcohol and two percent glycerine for preservation. Originally, two whole mounts were made. In order to place the distomes in a flat position, the long pedunculate acetabulum was cut off with a razor blade and mounted next to the worm. Harris' haematoxylin, methyl salicylate, and piccolyte were used in preparing the whole mounts.

After study of the whole mounts, one of them was dissolved off the slide and sectioned. The sections were placed on three different slides and stained with Heidenhain's iron haematoxylin and eosin. Subsequent to study of the sectioned material, one of the slides was returned to xylene to remove the coverglass and it was subjected to the periodic acid-Schiff technique and counterstained with fast green. After study with these stains, it was found necessary to use another stain on these sections. The slide was again returned to xylene and it was then stained with malachite green and destained in 100 percent ethyl alcohol until colorless to the naked eye.

Syncoelium spathulatum n.sp. (figs. 7, 8)

DIAGNOSIS: (measurements in mm.) with characters of genus. Large, spatulate distomes with body divided into two distinct parts; anterior part attenuate with posterior part much wider. Cuticular spines not observed. Body length up to 13 long, anterior part up to 1.3 wide and 4.5 long,

*The opinions and assertations contained herein are those of the authors and are not to be construed as official or reflecting the views of the Navy Department. Studies from the University of Nebraska, Department of Zoology and Physiology, No. 338.

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posterior section up to 3.8 wide. No prepharynx present. Pharynx elongate, fusiform 0.29-0.39 by 0.44-0.60. Esophagus very short, 0.12 long. Intestine of cyclocoel type, extending past vitelline follicles almost to posterior end. Gut slightly undulating. Pedunculate acetabulum, 0.61-0.63 wide. Length of peduncle about 1.6, located at juncture of anterior and posterior body segments. Testes of irregular shape, ten to seventeen in number, located in anterior half of hindbody, 0.32-0.53 wide. Seminal vesicle long, tubular, convoluted, extending from bifurcation of gut to juncture of fore- and hindbody. No copulatory organ observed. Ovary divided into five lobate parts, located symmetrically in posterior third of worm, 0.42-0.54 wide, connected by branching, convoluted oviducts. Small seminal receptacle (?) adjacent to Mehlis gland. Uterus with numerous transverse slings extending into lateral margins and posterior end. Genital pore in region of oral sucker. Seminal vesicle associated with cells of possible prostate function. Vagina thin-walled and narrow. Vitelline follicles divided into seven small, dense bodies, located in posterior one-sixth of body. Mehlis gland large and well-developed. Due to dense uterus and eggs extent of excretory bladder not observed. Small bodies of unknown function widely distributed throughout the parenchyma. Eggs small, rotund with very thick shell, 0.023-0.027 by 0.030-0.034.

HOST: *Prognichthys* sp. (Flying fish)

HABITAT: Gills.

LOCALITY: Hung Tou Tsun, Lan Yu Island

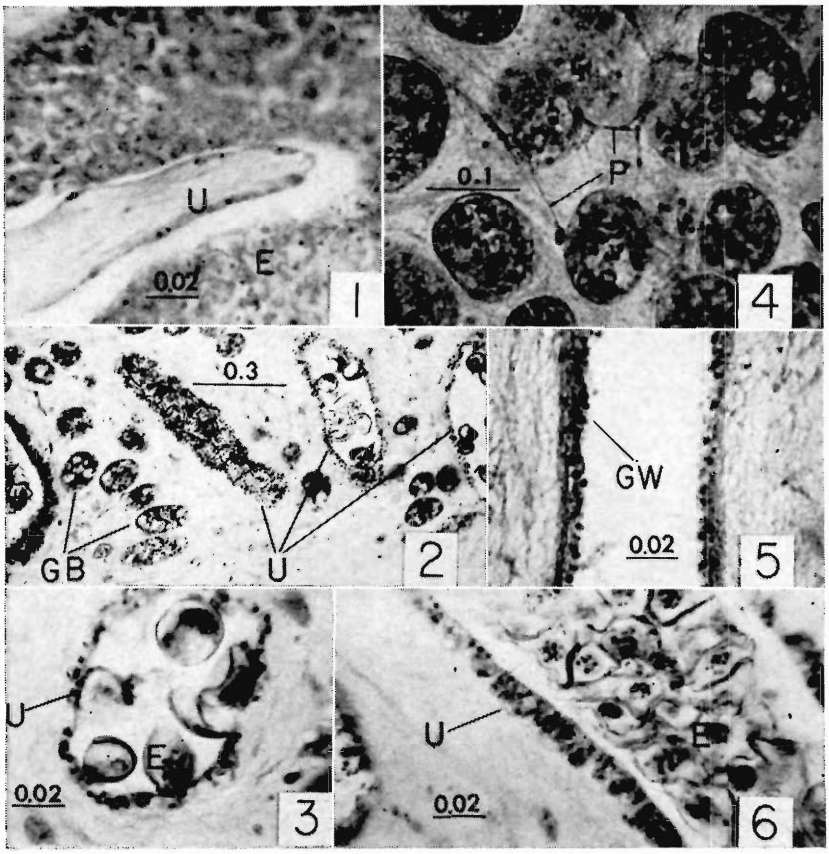
SPECIMENS: Holotype in the Helminthological Collection of the U.S.N.M., No. 59688.

The species named here seems to be most similar to *Syncoelium katuwo* Yamaguti, 1938, collected from the Pacific Coast of Japan. The eggs of these two species are about the same size, but significant differences are noted in the new species, namely: a larger oral sucker and pharynx, and a hindbody which is much wider.

Trematodes of the genus *Syncoelium* possess a number of features that are remindful of the Hemiuridae. In fact, Odhner (1927) removed this group from the hemiurids and established the family Syncoelidae. The several features still held in common between the Syncoelidae and some of the Hemiuridae are: Arms of excretory bladder or primary collecting ducts unite anteriorly in the region of the pharynx or oral sucker; vitelline glands consisting of lobes; numerous small eggs; ductus hermaphroditicus present; smooth cuticle; etc.

Besides the extraintestinal nature of these worms, there are several other interesting features not commonly found in most trematodes. A large-bore cyclocoel gut is present. Although some of the members of the family possess numerous large, intestinal diverticula, the species studied here exhibits only very small undulations and diverticula which are thought to be of insufficient size to be considered comparable with the others found in the family. It seems very likely that the intestine which has small, sparsely distributed, circular and longitudinal muscle fibers is a highly plastic organ. Thus, it is quite possible that the shape of the intestine is modified by the slings of the uterus which pass both dorsal and ventral to it. The epithelium which lines the gut appears to be of a stratified type and it gives the appearance that the cells on the inner surface are breaking down as the formation continues (fig. 5). The nuclei are relatively large and many of them possess the large nucleolus and heavy peripheral chromatin which seems to be a characteristic of glandular cells in the trematodes. This corroborates, in part, work done by Stephenson (1947a) on *Fasciola*.

Distributed throughout both the fore- and hindbody are numerous gland-like bodies (figs. 2, 4). In the forebody, the "glands" are more or less evenly distributed while in the hindbody they are located along the lateral edges between the slings of the uterus. The outside of the gland is covered with a thin membrane which stains with PAS and eosin. On the inside there are 10 or so irregularly-shaped sinuses or clear areas which are negative to haematoxylin, eosin, and PAS, but they were stained with fast green. In each "gland" there are several large (5.5 microns) nuclei which possess a large nucleolus and a heavy nuclear membrane. Other normal sized nuclei are present also. The morphology of these bodies is strongly suggestive of a glandular function; however, no ducts were noted. PAS positive, fibrous



Syncoelium spathulatum (measurements in mm.)

Abbreviations: E—eggs, GB—Glandular bodies, GW—gut wall, P—process, U—uterus.

Fig. 1. Uterus with simple epithelial lining and newly-formed eggs.

Fig. 2. Section through anterior part of hindbody showing the reduction of uterine glands and the development of the egg shell.

Fig. 3. Uterus with fully-formed eggs. Note the heavy egg shell and the reduction of uterine glands.

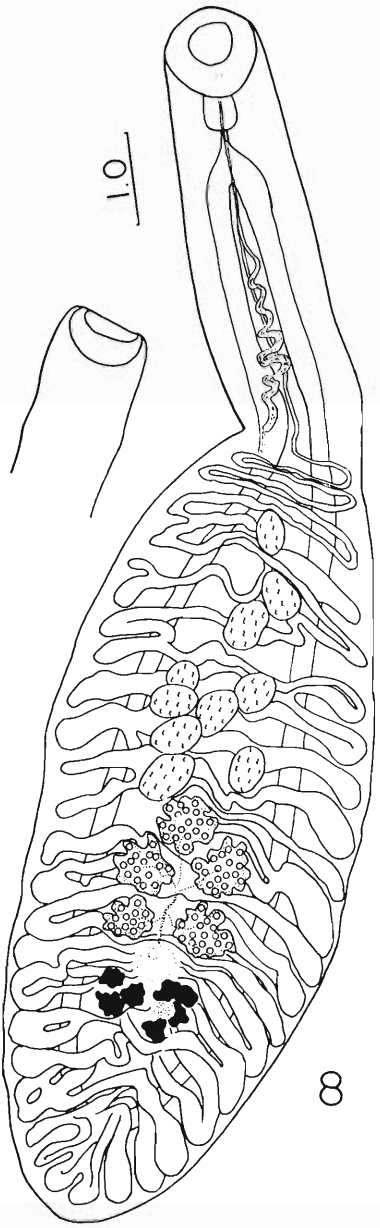
Fig. 4. Section of glandular bodies with the associated processes.

Fig. 5. Longitudinal section of the gut wall showing the epithelium.

Fig. 6. Glandular uterus with developing eggs.

processes were noted in association with the "gland" bodies (fig. 4).

The fully developed eggs possess a heavy shell which must certainly be composed of two layers (fig. 3). However, the latter point was not proved definitely due to the small amount of material available for experimentation. Shortly after the egg has left the ootype, a thin, plastic membrane surrounds



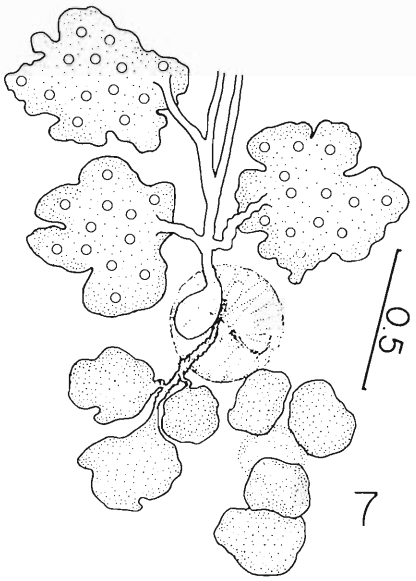


Fig. 7. *S. spathulatum*, ventral aspect, drawn with the aid of a microprojector.
Fig. 8. *S. spathulatum*, female reproductive complex.

the egg (fig. 1). A vitelline complex is present and although it is small for such a large worm, it is considerably larger than the vitellaria found in some of the other trematodes. There is a well-developed Mehlis gland present. Either the vitellaria and/or the Mehlis gland could contribute substances to form this inner membrane (the first, thin membrane). Later on, as the eggs move down the uterus, they pass through a section of the uterus which has a highly developed glandular epithelium (fig. 6). During the passage through the glandular part of the uterus, it can be noted that the egg shells become progressively thicker. By the time the eggs reach the forebody, they appear to be fully-formed and in the case of some of them in which the operculum has become detached, a fully developed miracidium could be seen.

Crowcroft (1948) in his discussion of *S. thyrsitae* from Tasmania inferred that the plainly glandular uterus contributed to the helminth egg shell during the thickening of the shell in the middle uterus. However, the year before Stephenson (1947b) in his study on *Fasciola hepatica,* established some of the basic principles of the egg shell formation by using some of the elegant tools of histochemistry:

"The polyphenol of the newly formed egg shell is oxidized into a quinone in the anterior uterine coils. Polyphenol oxidases have not been conclusively demonstrated. The relative uterine coils are surrounded by an especial concentration of a generally distributed tissue haemaglobin. The final egg shell is composed of a quinone tanned protein, similar to the sclerotin of the cockroach ootheca."

Later Smyth (1956) was able to demonstrate the presence of polyphenol oxidase in *Schistocephalus* in both the vitelline granules and in the egg shell itself by using the catechol technique. With the addition of Ogren's work (1959) it became apparent that there is a common process of egg formation found in most of the platyhelminth parasites.

There are several histochemical techniques which have been used to detect or demonstrate the substances in the various steps in the formation of the egg shell. Both bromophenol blue and malachite green will combine with and stain the basic proteins in the vitelline glands and in the egg shell before complete tanning has taken place (Johri et al, 1956 and Smyth, 1951). The presence of phenolic substances can be demonstrated with fast red and the activity of polyphenol oxidase can be detected by the use of catechol as a substrate.

The species of *Syncoelium* described here differs from most other trematodes and cestodes in the placement of the glands which secret the proteins and phenols which contribute to the finished egg shell. Generally, the substances which react to form the egg shell are produced by the vitelline gland. In our species, however, the typical reaction described by Johri et al (1956) and Smyth (1951) are found limited to the uterine glandular epithelium (fig. 6). When eggs are first formed, they are enveloped in an exceedingly thin membrane which is negative to malchite green. In support of this is the fact that neither the vitelline glands nor the Mehlis gland are positive to malachite green. In contrast to this, however, is the fact that the vitelline granules in the uterine epithelium give a strongly positive reaction to malachite green, even after prolonged destaining in 100 percent ethyl alcohol. The egg shell elaborated in the middle uterus gives the typical positive reaction to malachite green. As the tanning of the protein progresses, the intensity of the staining is reduced and in the fully formed egg there is no color due to the stain, but only the natural brown color.

There can be little doubt that the Mehlis and/or vitelline glands contribute to the formation of the inner egg shell or membrane. Their lack of reaction to the techniques which detect the typical substances that lead to the egg shell, supports the idea that another type of process leads to the formation of this membrane.

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Preservation of Plant Parasitic Nematodes by Freezing*

BERT M. ZUCKERMAN**

This paper describes a technique whereby nematodes can be preserved in fresh-appearing condition for long time periods. A valid comparison cannot be made between the proposed method and permanent mounting techniques, since the objectives and results of these methods differ.

MATERIALS AND METHODS

In each test five nematodes of a single species were heat-relaxed and fixed in FAA. Measurements were taken of total length and width at base of esophagus of each nematode. The nematodes were transferred to a 1.8 ml screw cap bottle which contained 1 ml of 15% glycerine in saturated saline solution. This medium was selected on the basis of the work of Chandler and Weinman (1956) in which protozoa were frozen at −15°C in 15% glycerol in saturated saline and peritoneal fluid and recovered after 184 days storage at −70°C. In the current tests the nematode-containing medium was held at −14°C during storage. Two to six bottles were removed from the freezer at intervals of a month, the nematodes mounted and examined. The mounting medium was the solution in which the nematodes had been stored. A total of 515 nematodes were used in these experiments, some of which are still in storage. These were: *Hemicycliophora similis* Thorne, an unidentified *Hemicycliophora* sp., two *Helicotylenchus* spp. tentatively identified as *H. pseudorobustus* (Steiner) Golden and *H. erythrinae* (Zimmerman) Golden, *Tylenchorhynchus claytoni* Steiner and *Trichodorus christiei* Allen. Nematode

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species were represented in unequal numbers, the smallest number being 20 *T. claytoni*.

RESULTS

Nematodes have been examined up to 420 days after being stored. After the storage medium was liquified by holding the bottle at room temperature for 10 minutes, the nematodes were mounted. Examination showed that the treatment did not result in clearing of the internal organs. Stored Tylenchids were as fresh-appearing as newly fixed specimens. Measurements taken at this time and compared with those taken prior to storage proved that no shrinkage in total length or width at the base of the esophagus had occurred. In most cases all five of the nematodes were recovered from each bottle and, on the basis of the size differences recorded at the inception of the experiment, individual nematodes were readily identified. Cuticular structures were clearly delineated as were all morphological features visible in freshly fixed specimens. The reproductive system and esophageal structures were particularly well detailed.

The esophageal regions of specimens of *T. christiei* preserved by this method appeared granular in some cases, but none of the specimens had shrunk. On the basis of this limited comparison of a nematode in the Dorylaimoidea with nematodes in the Tylenchoidea, it appears as though the Tylenchids lend themselves more readily to the described treatment.

Slides examined 3-5 days after nematodes were mounted showed that specimens had undergone considerable shrinkage and were unusable for taxonomic purposes. However, when nematodes were thawed and mounted by the method of Seinhorst (1959), slides appeared to be satisfactory after 30 days. To prepare the nematodes for permanent mounting, it was necessary to decrease the glycerine and saline concentrations gradually, while increasing the concentration of ethyl alcohol prior to beginning the procedure described by Seinhorst.

DISCUSSION

The primary advantage of the freezing method is that nematodes are preserved in a fresh-appearing condition. To the best knowledge of the author there is no permanent mounting technique in which this condition is attained. The method also has advantages in that it is simple and large numbers of nematodes can be treated simultaneously with facility. The method appears well adapted to classroom use where students could be given vials of frozen specimens for immediate mounting and study. Freezing of nematodes can be advantageous as a prelude to permanent mounting under circumstances where time for permanent treatment during a period of collection is lacking.

CONCLUSIONS

Plant parasitic nematodes frozen at −14°C in 15% glycerol in saturated saline solution were preserved in fresh-appearing condition for 420 days. It is probable that nematodes can be preserved for longer periods under the conditions of this experiment.

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Studies on Cysticercoid Histology. VII: Observations on the Fully Developed Cysticercoid of *Hymenolepis microstoma* (Cestoda: Cyclophyllidea).*

MARIETTA VOGE

Studies on the biology of *Hymenolepis microstoma* by Dvorak *et al* (1961) demonstrated the close structural similarity of this species with *Hymenolepis nana*. For this reason, the histology of the cysticercoid of *H. microstoma* was investigated and compared with that described for *H. nana* by Voge and Heyneman (1960), to ascertain the extent of structural similarities or differences between the cysticercoids.

MATERIALS AND METHODS

The strain of *H. microstoma* was obtained from Rice University, Houston, Texas, through the courtesy of Dr. Clarence Weinmann. Cysticercoids of *H. microstoma* were grown in the confused flour beetle, *Tribolium confusum*, maintained on enriched flour at 30°C. Infection of beetles was accomplished by feeding the beetles eggs obtained from gravid proglottids passed in the feces of infected white mice. Infected beetles were kept at 30°C and cysticercoids harvested eight days or one month after infection. Cysticercoids were fixed in Zenker's fixative, embedded in paraffin, and sectioned at 7 microns. Stains used were Mallory's aniline blue stain for the demonstration of fibrous tissue (Gridley, 1953), and Mayer's hemalum (Lillie, 1954) and Gomori's trichrome as used by Voge (1960), for nuclear and cellular morphology.

DESCRIPTION

A longitudinal section of the cysticercoid of *H. microstoma* is presented in figure 1. The outermost layer is the delicate external membrane which surrounds the whole cysticercoid. The external membrane, which in some sections appears to consist of two layers, is separated by a narrow space from the next tissue layer. In old cysticercoids this space is filled with an acellular material which stains orange-red with Mallory's stain and red with Gomori's trichrome. It extends only over the body of the cysticercoid and is absent in the tail. Beneath this space is a layer of circular fibers which surrounds the body of the cysticercoid. The circular fibers are oriented transversely, crossing the longitudinal fibers beneath at an angle of approximately 90 degrees. The longitudinal fibrous layer is relatively thick and contains numerous nuclei. Fibers from this layer extend into the cysticercoid tail. Fibers of both fibrous layers stain an intense blue with Mallory's stain indicating the presence of connective tissue, while the nuclei in the longitudinal layer stain red. No nuclei were observed among the circular fibers in cysticercoids which were several weeks old. In eight day-old cysticercoids cells or nuclei are present adjacent and external to the layer of circular fibers. It seems likely that these cells are at least in part responsible for the formation of the circular fibrous layer. All fibers stain green with Gomori's trichrome.

Beneath the longitudinal fibrous layer is a narrow, delicate tissue, the lining of the cysticercoid cavity (Fig. 1), which stains pink with Mallory's stain.

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The nuclei in this layer are more elongate than those in the longitudinal fibrous layer. Within the cysticercoid cavity is the scolex with surrounding tissues. In living material the tissue surrounding the scolex is in contact with the lining of the cysticercoid cavity. In eight day-old individuals the scolex has a well developed cuticle, muscular suckers and a rostellum with fully-

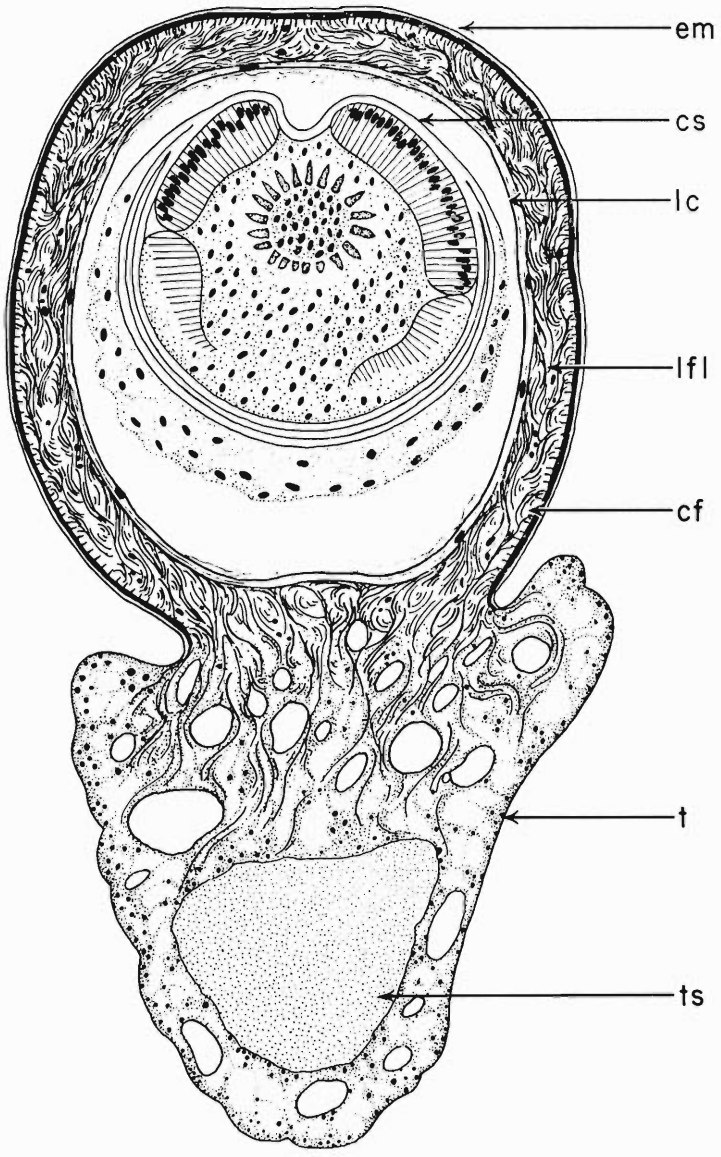

Fig. 1. Free-hand diagram of longitudinal section of *H. microstoma* cysticercoid; cf, circular fibers; cs, cuticle of scolex; em, external membrane; lfl, longitudinal fibrous layer; lc, lining of cysticercoid cavity; t, tail; ts, tail space.

formed hooks. The tissue of the scolex is dense and compact when compared to the other tissues of the cysticercoid.

The tail of *H. microstoma* may vary considerably in size and shape (Fig. 2). In some specimens the tail may be three or four times as long as the body part of the cysticercoid. Even in eight day-old individuals the tail contains numerous fibers which have proliferated from the longitudinal fibrous layer. Posterior to the fibrous area there is in 8 or 10 day-old cysticercoids a fairly large space devoid of cells or nuclei, and filled with a very fine, granular material. This space gradually becomes smaller as the cysticercoids grow older and the tail assumes the shape characteristic for *H. nana*. The peripheral areas of the tail contain numerous spherical or elongate cells as well as nuclei.

DISCUSSION

Comparison of the histologic structure of *Hymenolepis microstoma* with that of *H. nana* shows that there exists a close similarity between the cysticercoids. They resemble each other in shape and size, in the organization of the fibrous layers and, to some extent, in the size and shape of cellular elements. There are, however, certain differences between the two species. One of these concerns the space underlying the external membrane. This space is filled with an acellular substance of uniform appearance in *H. microstoma* and is apparently empty in *H. nana* cysticercoids of comparable age and manner of preparation. A more pronounced difference is observed in the tail which in *H. microstoma* may be very long and variable in shape. The frequently very large and well delimited acellular space in *H. microstoma* has not been observed in *H. nana*. Furthermore, the extensive proliferation of fibers from the longitudinal fibrous layer into the tail does not occur in *H. nana*. In view of these characteristics the two species can be differentiated on the basis of cysticercoid histology although the similarities between them are much more pronounced than are the differences.

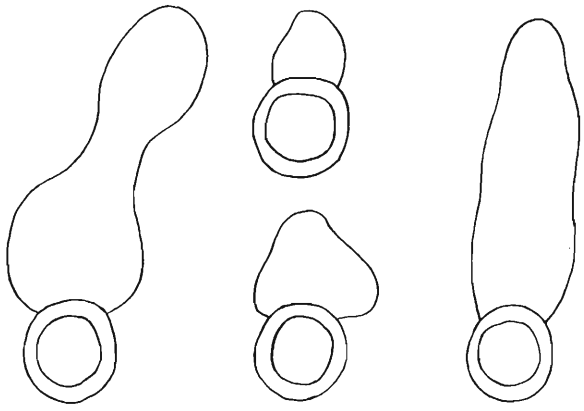

Fig. 2. Variation in size and shape of the tail in cysticercoids of *H. microstoma*. All sketches made from eight day-old, living cysticercoids.

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Dentostomella grundmanni n. sp. (Nematoda: Oxyuridae) from *Eutamias quadrivittatus* (Say, 1823)

M. B. CHITWOOD

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In August 1955, Dr. Albert Grundmann, University of Utah, forwarded to the Beltsville Parasitological Laboratory for identification some specimens of an unusual oxyurid from the western chipmunk, *Eutamias quadrivittatus*. The chipmunk was collected in the Dewey Bridge area of the Great Salt Lake Desert in Utah. These nematodes consist of three males and a tail fragment, and four females of a new species of the genus *Dentostomella* Shul'ts and Krepkogorskaia, 1932. The following is a report of a new geographical locality, as well as a new host record, for the genus.

Dentostomella grundmanni n. sp.

DIAGNOSIS: *Dentostomella*. Cuticle in both sexes thick, transparent, coarsely striated, appearing annular when contracted, cephalic inflation present. Head bearing four small submedian cuticular projections, each bearing one papilla; one papilla immediately internal to each projection. Six minute papillae of internal circle near small round mouth, (Fig. 4). Amphidial pore opening in cup-like depression, (Fig. 1). Lips absent, buccal capsule shallow with median tooth on anterior tip of each esophageal sector; esophagus very short, muscular, enlarged at both ends; esophago-intestinal valve in enlarged foregut.

FEMALES: Length 13.4-17.8 mm, maximum width in vulvar region 0.6-0.8 mm, longer specimens narrower than short ones. Esophagus 0.33-0.35 mm long; nerve ring 0.2 mm, excretory pore 3.7-4.1 mm, and vulva 7.5-9.1 mm from anterior end. Anus 0.8 mm from tip of bluntly conical tail. Reproductive system opisthodelphic. Vagina vera muscular, directed cephalad, vagina uterina directed cephalad in part or entirely (Fig. 7), reflexing near junction with common egg chamber which divides into two posteriorly directed uteri confined to posterior half of body. A large sperm reservoir (Fig. 2) lies between each ovary and oviduct, one pre, one post-vulvar. Both ovaries anterior to vulva, eggs 0.13-0.14 × 0.04-0.05 mm.

MALES: Length 4-8 mm, width 0.18-0.33 mm; esophagus 0.23 mm long. Tail with cuticular inflation reaching almost to tip without supporting rays but with plaque-like markings on ventral surface. Single spicule 0.26 long, lightly sclerotized, distal tip bidentate. Four pairs caudal papillae; 1 pair

adanal, one pair on postanal protuberance flanked by pair of smaller laterals, and one pair asymmetrically arranged, about 0.12 mm from tip of tail (Fig. 3).

HOST: *Eutamias quadrivittatus.*

LOCATION: Intestine.

TYPE LOCALITY: Great Salt Lake Basin, Utah.

HOLOTYPE, Female: U.S.N.M. Helm. Coll. No. 38931.

PARATYPES: U.S.N.M. Helm. Coll. No. 38932.

OTHER SPECIES: *D. translucida* Shul'ts and Krepkogorskaia, 1932, and *D. kuntzi* Myers, 1961.

DISCUSSION: *Dentostomella grundmanni* differs from both *D. translucida* and *D. kuntzi* in having only one esophageal tooth per sector, whereas *D. translucida* has five and *D. kuntzi* three; in body conformation (Fig. 5), *D. grundmanni* is very stout especially in the postvulvar region, whereas *D. translucida* is longer, more evenly proportioned and *D. kuntzi* is long, very slender, and bears an unusually large cephalic inflation. The vulva in the females of *D. translucida* and *D. kuntzi* is slightly anterior to median while in *D. grundmanni* it is post-median but, in all three species, the muscular vagina is directed anteriad (Fig. 6) reflexing at or near the junction of vagina uterina and uterine tube. In *D. grundmanni,* the uterine tube

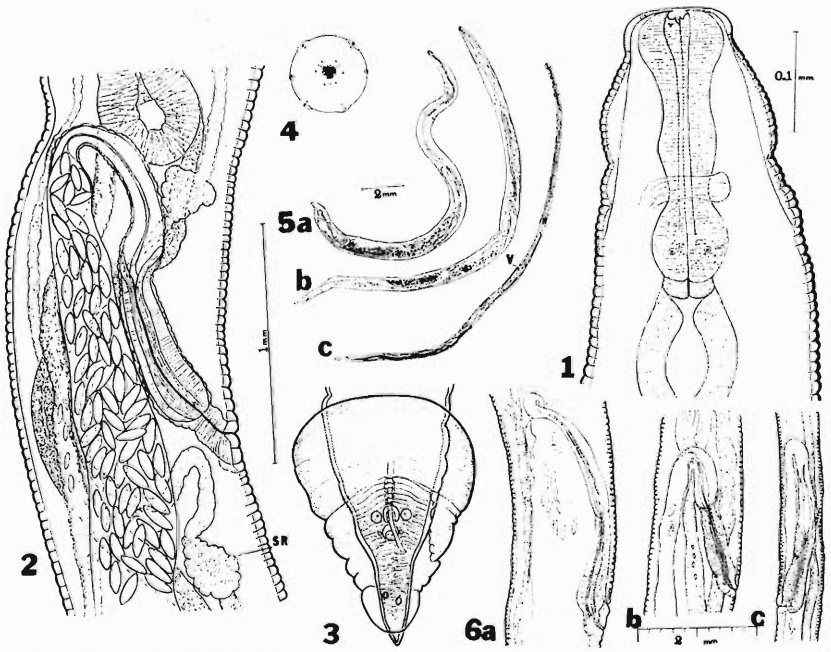

Fig. 1. *Dentostomella grundamnni,* anterior end of female.

Fig. 2. *Dentostomella grundmanni,* vulvar region of female showing muscular vagina, egg chamber, and sperm reservoir (SR).

Fig. 3. *D. grundmanni,* male tail.

Fig. 4. *D. grundmanni en face.*

Fig. 5a. *D. grundmanni,* 5b. *D. translucida,* 5c. *D. kuntzi.* Comparison of body contour of the three species.

Fig. 6 a, b, and c. Mid-section of Fig. 5 a, b, and c. Slightly higher magnification.

merges almost immediately into a large common egg chamber but in *D. translucida* and *D. kuntzi* the tube remains narrow to the level of the vulva (Fig. 6) where it becomes greatly expanded, eventually dividing into two posteriorly directed uteri that turn forward near the rectum.

The males of *D. grundmanni* are comparatively smaller in proportion to the females and bear a large protuberance directly behind the anal opening whereas the males of *D. translucida* and *D. kuntzi* bear a single post-anal papilla. No sensory endings appear on the circumanal ridge comparable to those shown for *D. kuntzi*. The host of *D. grundmanni* is a sciurid whereas the hosts of *D. translucida* and *D. kuntzi* are microtine rodents.

The genus *Dentostomella* was erected by Shul'ts and Krepkogorskaia, 1932, for an unusual oxyurid from the large intestine of *Rhombomys opimus* Licht, collected in Kazakhstan, Middle-East Asia and until Myers, 1961, described *D. kuntzi* from *Accomys* spp. from Egypt, no other species of this genus had been reported. The material on which the present description is based is so variable in measurements that the writer was for years reluctant to describe it as a new species. However, two female specimens identified as *D. translucida,* from *Mastomys fumatus* collected by Dr. R. E. Kuntzi in Yemen, were presented to the U.S.N.M. as were the types of *D. kuntzi,* and from the comparison of these three sets of material, an improved concept of the specific and generic characters emerged.

The members of this genus are fairly large oxyurids characterized by an extremely short, thick, muscular esophagus without valvular apparatus. The males are much smaller than the females. The cuticle is thick, transparent, and coarsely striated with fine longitudinal markings on each striation. A large lateral cervical inflation is present on *D. kuntzi,* and small inflated areas are present on each of the other two species. Although no inflation is described or shown by Shul'ts and Krepkogorskaia for *D. translucida,* it is probably characteristic of the genus. Lips are absent, and the mouth opens into a small cavity into which three or more esophageal teeth project. Vulva is near mid body.

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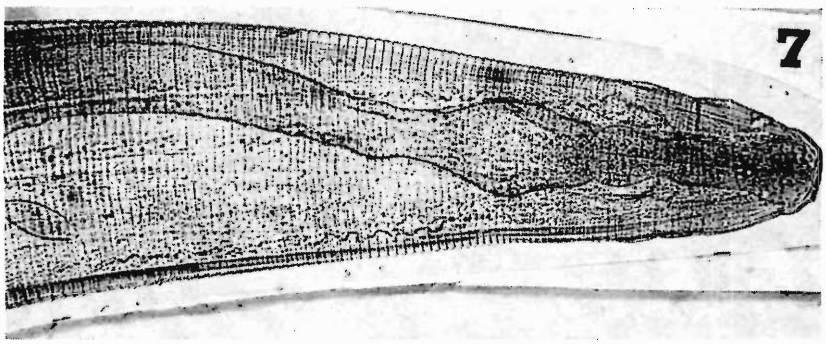

Fig. 7. *Dentostomella grundmanni,* photomicrograph of anterior part of female.

A new Genus and Two New Species of Nematodes from Newport, Oregon

D. G. MURPHY*

Two new species of marine nematodes, viz. *Pomponema polydonta* n. sp. and *Phyllolaimus tridentatus* n. gen. n. sp. were collected 5 October 1960 from an open beach at Newport, Oregon, and a third undescribed form, *Prochromadora trisupplementa* n. sp. was encountered in the same region on 1 April 1960. *Cyatholaimus dentatus* Wieser, 1959 is representative of the new genus and is established as *P. dentatus* (Wieser, 1959) n. comb.

Specimens were fixed in 2% formalin and mounted in glycerin for study. The value of *en face* studies is manifested in two of the described species in that accurate count and distribution of teeth in *Pomponema polydonta* and the elaborate labial structure of *Phyllolaimus tridentatus* could not be ascertained from lateral views.

Type material (holotypes, allotypes, and paratypes) of new species are maintained in the general nematode collection at Oregon State University on slides of collection OSC OM 69, for *P. polydonta* n. sp. and *P. tridentatus* n. gen. n. sp. and OSC OM 56 for P. trisupplementa n. sp.

Pomponema polydonta n. sp. (Fig. 1)

MEASUREMENTS: female (2): L = 1.83-1.98mm, a = 46.6-47.6, b = 5.9-6.0, c = 13.4-12.8, V = 63.8-60.0%, Ov (1 spec.) = 16.6 & 15.2%; males (4): L = 1.80mm (1.55-1.87mm), a = 55.1 (43.1-63.2), b = 6.3 (5.4-7.4), c = 11.4 (9.9-12.5).

Cuticle prominently annulated with coarse punctation, lateral lines become distinguishable on level with base of esophagus as two (sometimes four) rows of slightly larger punctations. Labial papillae 12, six setose cephalic papillae. Cephalic setae in one circle of six and four, being 23 and four microns respectively; there is indication of segmentation and articulation of larger setae on some specimens at a point one-third to one-half of the length from the base; somatic setae not observed; caudal setae present. Head diameter at level of cephalic setae 26.0 microns; stoma cyathiform, armed with single large dorsal tooth opposed by two or three sets of subventral teeth and two rows of denticles. Amphid a spiral of 4½ turns located adjacent to base of dorsal tooth, occupying 35% of corresponding cervical diameter. Esophagus cylindrical, of moderate musculature; cardia not pronounced; nerve-ring 35% of esophagus; width of nematode at base of esophagus 26.5 microns. Excretory pore not observed. Females didelphic, ovaries reflexed. Males with heavily sclerotized spicula, 55 microns long; gubernaculum complex, bearing thin lateral extensions; 24 uniformly spaced, complex supplements present, the one posteriad being adjacent to the cloacal opening. Tails elongate-conical, female tail 5.2 anal diameters long; male tail 6.0 anal diameters long, with two prominent, subterminal setae.

DIAGNOSIS: *P. polydonta* n. sp. is closely related to *P. stomachor* Wieser, 1954 (and may be placed in B. 2. of W. Wieser's key to the genus, 1954, p. 8). The two species can be readily distinguished on the basis of a greater number of teeth in *P. polydonta* and fewer turns in amphids of males (4.5 vs. 6-6.5).

TYPE LOCATION: Newport, Oregon, from intertidal beach sand exposed to moderate wave action.

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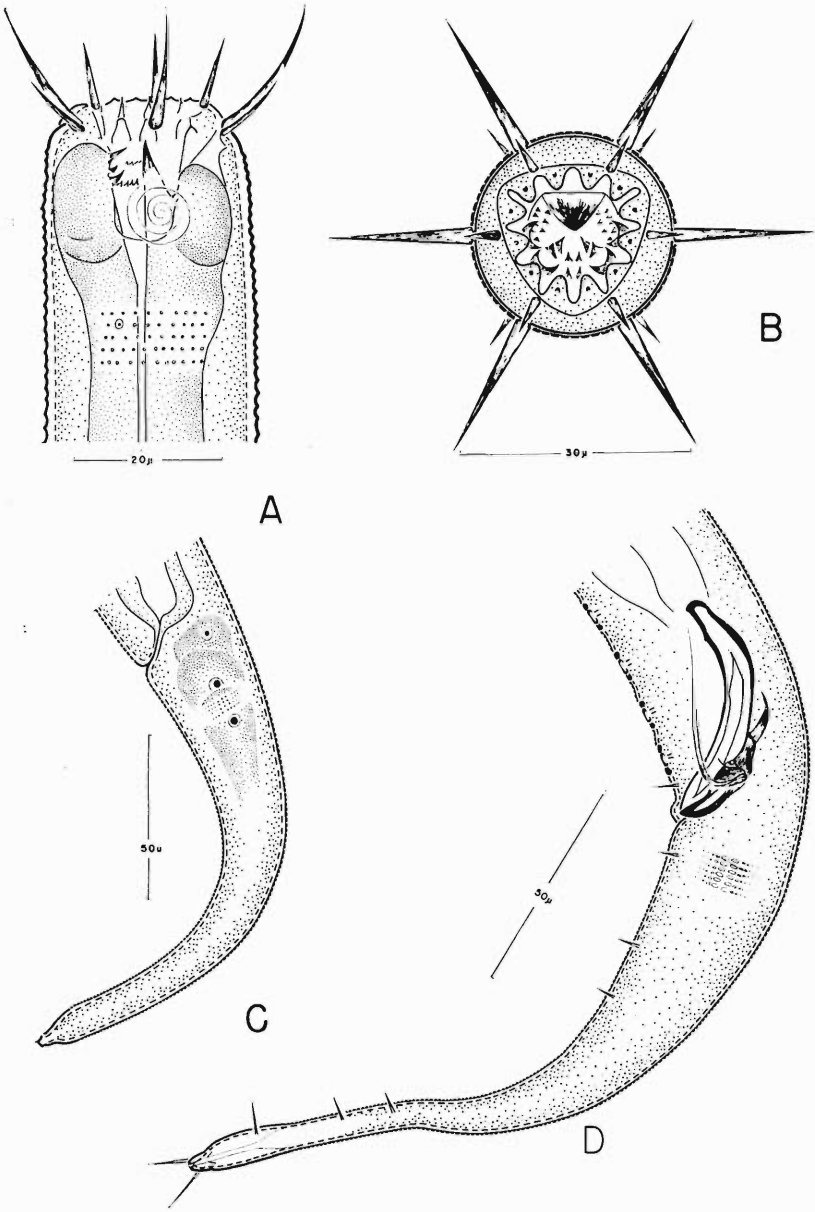

Fig. 1. *Pomponema polydonta* n. sp. A, anterior region of male. B, face view of male. C, female tail. D, male tail.

Phyllolaimus n. gen.

Cyatholaimidae (Cyatholaiminae). Buccal cavity cyathiform with prominent, elongate dorsal tooth; additional teeth may or may not be present. Lips with distinctive foliaceous development, (processes of labial rugae), retrorse. Six (?) or ten cephalic setae. Esophagus without basal bulb. Cuticle homogeneous, annules resolvable into dots; no longitudinal striae.

REMARKS: This genus is erected to accommodate two closely related species, *Phyllolaimus* dentatus (Wieser 1959, p. 39) n. comb. and *P. tridentatus* n. gen. n. sp. The two species represent a taxon distinct from *Cyatholaimus* and other genera of the Cyatholaiminae.

Cyatholaimus dentatus Wieser, 1959, was described (p. 39) with "buccal diadema . . . provided distally with a pair of thread-like appendages." The appendages noted by Wieser are interpreted as the same labial elaboration characterizing *P. tridentatus,* which in conjunction with striking similarity of detailed morphology warrants establishment of *P. dentatus* (Wieser, 1959) n. comb.

Phyllolaimus tridentatus n. gen., n. sp. (Fig. 2)

MEASUREMENTS: female (1) L = 1.60mm, a = 38.9, b = 4.3, c = 10.6, V = 54.3, Ov = 15.2 & 14.3%: male (1): L = 1.54mm, a = 50.5, b = 4.6, c = 10.6.

Cuticle finely annulated, evidenced primarily as transverse rows of dots, with numerous cuticular pores; homogeneous. Six cephalic setae, about 26 microns long, possibly four additional small setae adjacent to subventral and subdorsal setae; few short cervical setae; numerous caudal setae on male; no somatic setae observed. Amphids spiral, of five turns, lowest extremity level with base of buccal musculature. Lips retrorse, bearing elaborate foliaceous structure; six setose labial papillae directed backward because of lip positioning. Head diameter at level of cephalic setae 25 microns. Stoma cyathiform, armed with a long, protruding dorsal tooth opposed by two smaller latero-ventral teeth. Esophagus long, irregular, with moderate buccal musculature and slight basal enlargement; cardia not distinct; nerve-ring not observed; width of nematode at base of esophagus 30 microns. Excretory pore 130 microns from anterior end. Female didelphic, ovaries reflexed. Male with three postanal papillae, possibly a series of minute preanal papillae; spicula arcuate, 38 microns long; gubernaculum long, distal end complex and heavily sclerotized. Tails conical, terminating with poorly defined spinneret; female tail 4.3 anal diameters long; male tail 3.5 anal diameters long, with a cluster of four subterminal setae.

DIAGNOSIS: *P. tridentatus* is distinguished from *P. dentatus* (Wieser 1959) by possessing two latero-ventral teeth and the amphid describing five rather than four turns. The apparent difference in number of cephalic setae (6 vs. 10) is questionable. If four additional cephalic setae are present on *P. tridentatus* they are either very short and narrow or have become indistinguishable from adjacent setae, perhaps in the process of fixation and dehydration.

TYPE LOCATION: Newport, Oregon, from intertidal beach sand exposed to moderate wave action.

Prochromadora trisupplementa n. sp. (Fig. 3)

MEASUREMENTS: female (2): L = 0.79-0.82mm, a = 23.4-23.8, b = 6.8-6.4, c = 7.1-8.1, V = 46.3-48.2%, Ov = 15.3-14.2%, Ov 2 = 15.4-16.2%: male:

L = 0.57mm, a = 22.6, b = 5.4, c = 6.3.

Cuticle annulated, bearing a homogeneous, scale-like pattern; no longitudinal rows. Four cephalic setae, slightly greater in length than one-half head diameter; cervical and somatic setae present, scattered. Amphids oval, five microns in width, positioned opposite dorsal tooth. Twelve lips bearing total of six papillae. Head diameter at level of cephalic setae 10 to 11 microns. Stoma cyathiform, bearing large, solid, dorsal tooth. Esophagus cylindrical, terminating in a distinct bulb; cardia not prominent; nerve-ring at 60% of esophagus; width of nematode at base of esophagus 25 microns. Excretory pore opens 17 microns from anterior end; ventral gland prominent,

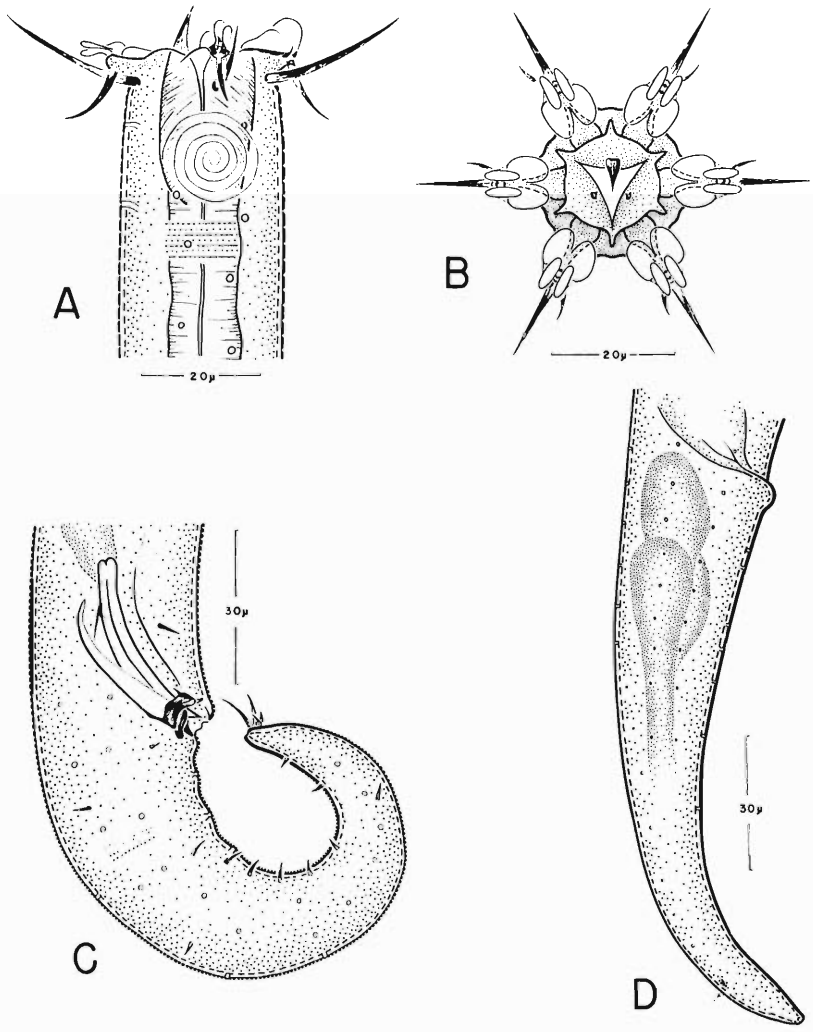

Fig. 2. *Phyllolaimus tridentatus* n. sp. A, anterior region of male. B, face view of male. C, male tail. D, female tail.

with distinct proximal cap-cell. Four contiguous cells comprise the circumference of the intestine. Females didelphic, ovaries reflexed; spermatheca large. Males with three, large, cup-shaped preanal supplements; details of gubernaculum unclear, may have posterior apophysis; spicula narrow, sharply bent, 23 microns long. Tails conical with strong ventral curling; female tail 5.8 anal diameters long; male tail 4.4 anal diameters long.

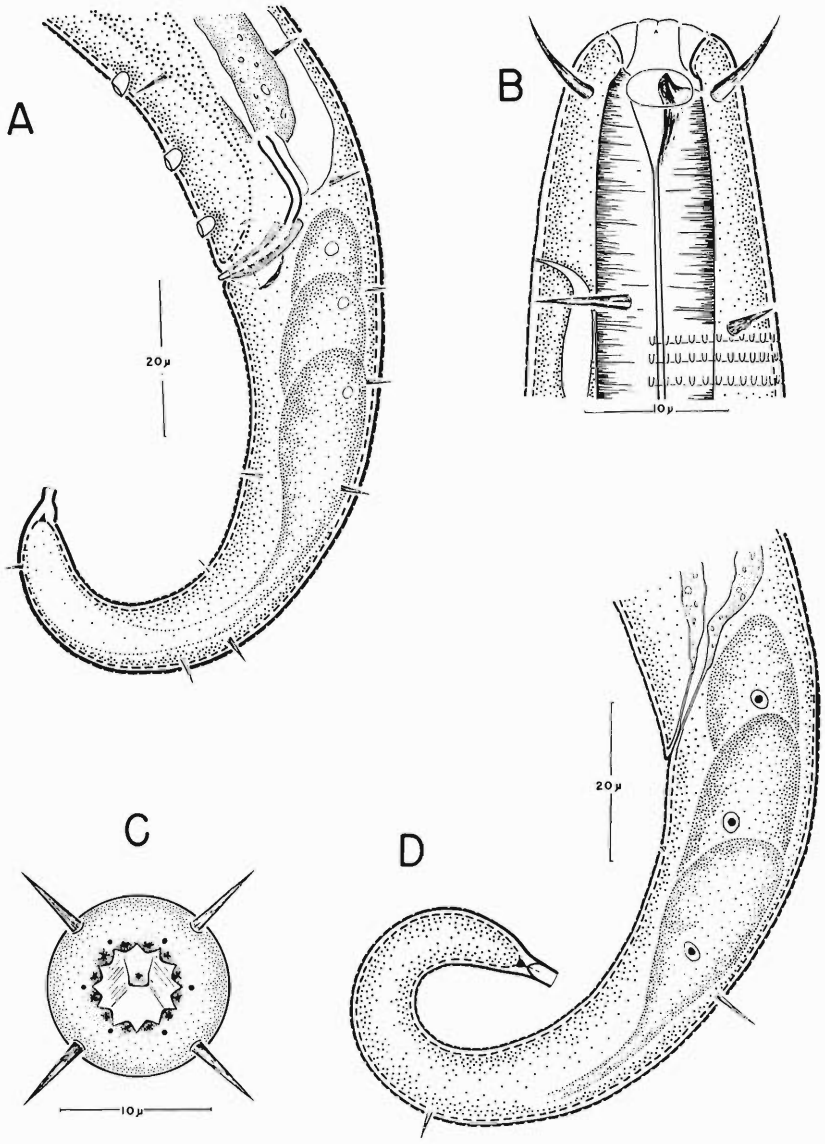

Fig. 3. *Prochromadora trisupplementa* n. sp. A, male tail. B, anterior region of female. C, face view of male. D, female tail.

DIAGNOSIS: *P. trisupplementa* n. sp. is readily separated from previously described species of the genus on the basis of possessing only three supplements. There is some indication that the new species may have two apexes on the dorsal tooth, a possible indication of affinities to *Punctodora* Filipjev 1930.

TYPE LOCATION: Yaquina Head, Newport, Oregon. Collected from epiphytic filamentous algae encompassing the stipe of Egregia menziessii (Turner, 1808) Areschoug, 1876.

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Trematode parasites of fishes from Egypt. Part III. Six new Hemiuridae*

JACOB H. FISCHTHAL and ROBERT E. KUNTZ

The Hemiuridae of this report are part of a collection of fish trematodes made by R. E. Kuntz while serving as a member of the U. S. Naval Medical Research Unit No. 3, Cairo, Egypt. Whole mount specimens were fixed, stained, and mounted as reported by Fischthal and Kuntz (1959). All measurements are in millimeters.

Manter and Pritchard (1960a) recognized the subfamily Lecithochiriinae Lühe, 1901, declaring the subfamily Sterrhurinae Looss, 1907, a synonym. They (1960a, 1960b) characterized the group as hemiurids with ecsoma, non-plicated cuticle, and compact, lobed or digitate to winding vitellaria, and listed 21 genera. They (1960b) listed 4 genera in the subfamily Dinurinae Looss, 1907, characterizing the group as hemiurids with ecsoma, plicated cuticle, and long, winding vitellaria. The present authors concur in their conclusions.

Dinurus gizae, n. sp. (Fig. 1-2)

DIAGNOSIS (based on single specimen): Dinurinae. Body elongate, with ecsoma; body proper, length 1.889, width (at testes) 0.323; ecsoma 0.508 × 0.312, slightly retracted; total length 2.397, maximum width 0.370; distance from posterior margin of acetabulum to ecsoma 1.367. Cuticular plications extending from level of poterior region of acetabulum to immediately postuterine. Oral sucker diameter 0.105; conspicuous preoral lobe 0.018. Acetabulum one-fifth length of body proper from anterior end, one-sixth to one-seventh total length; length 0.304, dorso-ventral depth 0.285. Ratio of

*Contribution from the Department of Biology, Harpur College, State University of New York. (J. H. Fischthal).

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The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Navy Department.

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lengths of suckers 1:2.9. Pharynx diameter 0.062. Esophagus short, sac-like. Ceca ascending at sides of pharynx to oral sucker, then turning caudad and entering ecsoma two-fifths length of latter. Excretory pore terminal, median stem ascending ecsoma.

Testes diagonal, in contact, transversely oval, anterior testis 0.099 × 0.119, posterior testis 0.112 × 0.132, distance from posterior margin of acetabulum to anterior testis 0.158, to posterior testis 0.238. Vasa efferentia joining to form short vas deferens. Seminal vesicle starting well posterior to acetabulum at level of anterior margin of anterior testis and terminating at posterior margin of acetabulum, thin-walled, tripartite, posterior chamber 0.102 × 0.072, middle chamber 0.094 × 0.039, anterior chamber 0.046 × 0.027. Pars prostatica long, starting at level of posterior portion of acetabulum, with distinct dorsal loop immediately upon origin from seminal vesicle; prostatic gland cells along entire length, less abundant in narrow area for posterior portion, more abundant and wider area for anterior portion. Hermaphroditic duct preacetabular, formed by union of ventral metraterm with pars prostatica at anterior extremity of prostatic gland cells and terminating at level of pharynx, 0.093 × 0.019, enclosed in narrow, thin-walled sinus sac 0.163 × 0.029, duct narrowing anteriorly and terminating in egg-shaped, muscular bulb, bulb 0.036 × 0.029, projecting free into genital atrium. Genital atrium tubular, 0.070 × 0.017, leading to genital pore near antero-ventral margin of oral sucker.

Ovary transversely oval, 0.152 × 0.191, larger than either testis, median, posttesticular, in contact and in tandem with posterior testis, distance from posterior margin of acetabulum to ovary 0.337. Vitellaria of 9 tubular lobes, 4 right and 5 left, one lobe extending anteriorly to posterior margin of anterior testis while remainder extending laterally and posteriorly, terminating well in advance of ecsoma, some of lobes lying both dorsal and ventral to ovary. Uterus winding, dorsal to vitellaria, ovary and testes, descending to approximately half way between ends of vitellaria and ecsoma, ascending limb on right; metraterm ventral to pars prostatica, joining it preacetabular to form hermaphroditic duct. Eggs numerous, 10 measuring 0.0185 (0.018-0.019) × 0.0115 (0.011-0.012).

HOST: *Hydrocyon forskalii* (Characidae).

HABITAT: Small intestine.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATE: November 22, 1952.

TYPE: U. S. Nat. Mus. Helm. Coll., No. 59678 (1 whole mount slide of type).

Dawes (1946, 1947) declared *Dinurus barbatus* (Cohn, 1903) Looss, 1907, *D. breviductus* Looss, 1907, and *D. longisinus* Looss, 1907, as synonyms of the type species *Dinurus tornatus* (Rudolphi, 1819) Looss, 1907. Manter (1947) recognized all the above as valid; he considered *D. coryphaenae* Yamaguti, 1934, a synonym of *D. longisinus*. Yamaguti (1954) listed all the above as valid species in addition to listing *D. euthynni* Yamaguti, 1934, *D. magnus* Manter, 1931, *D. nanaimoensis* McFarlane, 1936, *D. pinguis* Linton, 1940, *D. rubeus* Linton, 1910, and *D. scombri* Yamaguti, 1934. Earlier, Manter (1947) had placed *D. magnus* and *D. rubeus* in the genus *Stomachicola*, and *D. nanaimoensis* and *D. pinguis* in the genus *Tubulovesicula*. Yamaguti

(1958) now listed these changes, and continued to recognize *D. coryphaenae*. Sogandares-Bernal and Hutton (1959) recognized the validity of *D. longisinus*, showing that it could be easily separated from *D. tornatus*.

Dinurus gizae most closely resembles *D. scombri*. It differs from the latter in having the acetabulum nearly 3 times longer than the oral sucker rather than the same size, the cuticular plications postacetabular only rather than over the entire body proper, the seminal vesicle tripartite rather than quadripartite, the ceca entering the ecsoma for two-fifths length of the latter rather than to its posterior extremity, and the hermaphroditic duct terminating in a muscular bulb rather than lacking one.

Lecithocladium aegyptensis, n. sp. (Fig. 3)

DIAGNOSIS (based on 12 specimens from 1 host, 6 measured): Dinurinae. Body elongate, with ecsoma; body proper, length 1.725 (1.571-1.914), width (at testes) 0.231 (0.178-0.251); ecsoma 1.162 (1.069-1.321) × 0.188 (0.139-0.231), extended; total length 2.886 (2.640-3.083), maximum width 0.275 (0.211-0.323); distance from anterior end of body to acetabulum 0.579 (0.521-0.653). Cuticular plications on entire body proper. Oral sucker elongate, measurements of both length and width in 4 specimens 0.311 (0.271-0.350) × 0.226 (0.198-0.277), length in 6 specimens 0.303 (0.257-0.350); with a pair of distinct, deep, submedian incisions on ventral border forming a lip; no preoral lobe. Acetabulum approximately two-fifths length of body proper from anterior end, one-fifth to one-fourth total length; measurements of both length and width in 3 specimens 0.196 (0.172-0.211) × 0.194 (0.172-0.211), length in 6 specimens 0.174 (0.132-0.211). Ratio of length of suckers 1:0.5-0.6.

Pharynx much elongated, anterior end occasionally enlarged, extending from oral sucker almost to acetabulum in well-extended specimens but overlapping acetabulum in contracted ones, 0.242 (0.211-0.290) × 0.107 (0.099-0.112). Esophagus short, sac-like. Ceca ascending sides of pharynx short distance, then turning caudad and extending almost to posterior end of ecsoma.

Testes usually round, approximately same size, slightly oblique but almost tandem, in contact with very slight overlapping but occasionally separated in well-extended specimens, approximately at mid-body level, distance from posterior margin of acetabulum to anterior testis 0.503 (0.370-0.634), to posterior testis 0.585 (0.445-0.70), anterior testis 0.103 (0.083-0.123) × 0.094 (0.083-0.099), posterior testis 0.099 (0.078-0.120) × 0.090 (0.083-0.093). Vasa efferentia short, joining to form very short vas deferens. Seminal vesicle saccular, elongate, 0.205 (0.152-0.244) × 0.094 (0.083-0.105); walls thick, muscular, 0.014 (0.007-0.018); distance from posterior margin of acetabulum to seminal vesicle 0.347 (0.165-0.436), very slightly overlapping anterior testis, filling most of intercecal space. Pars prostatica very long, sinuous, terminating at middle of acetabulum dorsum in contracted specimens to preacetabular in extended ones, with short posterior loop immediately upon leaving seminal vesicle; prostatic gland cells large, abundant around pars prostatica from origin at seminal vesicle to level of posterior fourth of acetabulum, then abruptly seemingly stopping but remainder appears actually with very few scattered small gland cells. Hermaphroditic duct long, slender following along left ventral side of pharynx, commencing at middle of ace

B, terminal muscular bulb of hermaphroditic duct; G, genital atrium; GP, genital pore; HD, hermaphroditic duct; PG, prostatic gland cells; PP, pars prostatica; PV, prostatic vesicle; SS, sinus sac; SV, seminal vesicle.

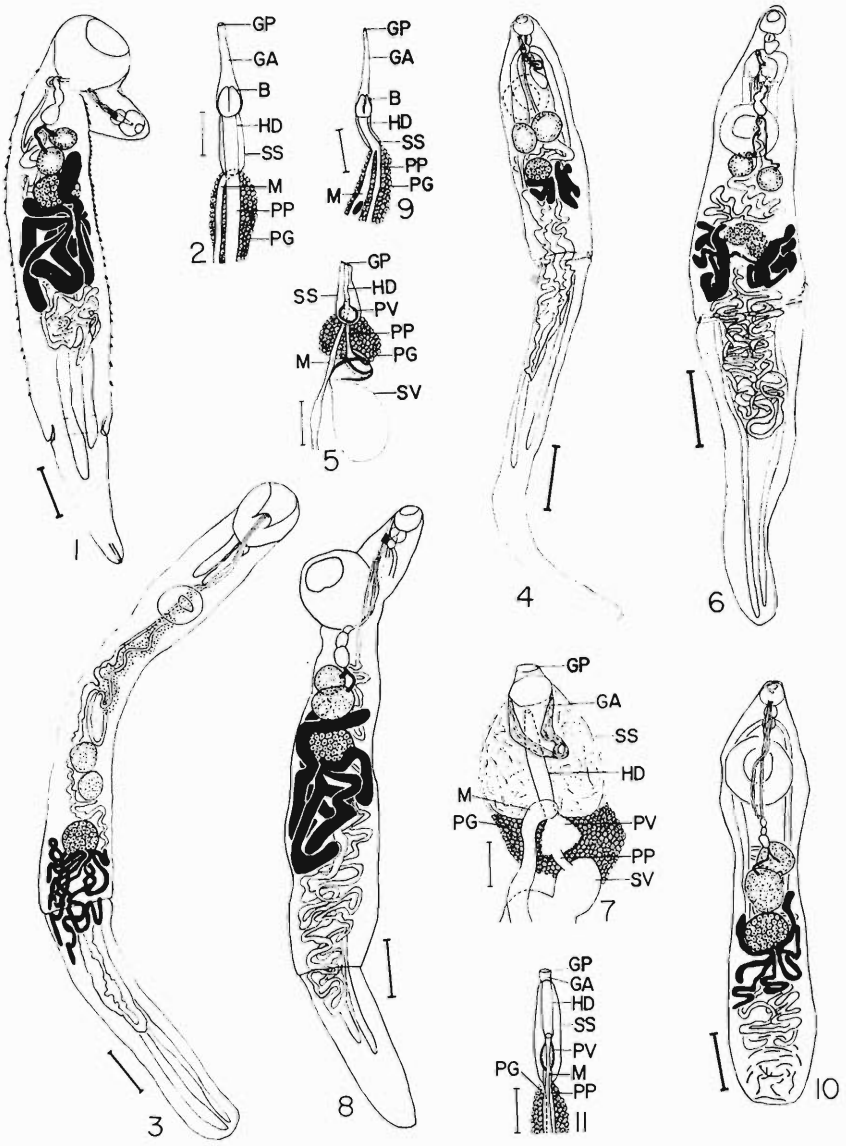

Figure 1. *Dinurus gizae,* adult worm, hindbody in ventral view, forebody in dorsal view. Scale 0.2 mm.
Figure 2. *D. gizae,* dorsal view of terminal genital ducts. Scale 0.05 mm.
Figure 3. *Lecithocladium aegyptensis,* adult worm, ventral view. Scale 0.2 mm.
Figure 4. *Sterrhurus magnicaudatus,* adult worm, dorsal view. Scale 0.5 mm.
Figure 5. *S. magnicaudatus,* dorsal view of terminal genital ducts. Scale 0.1 mm.
Figure 6. *Paraplerurus sauridae,* adult worm, ventral view. Scale 1.0 mm.
Figure 7. *P. sauridae,* ventral view of terminal genital ducts. Scale 0.1 mm.
Figure 8. *Erilepturus africanus,* adult worm, ventral view. Scale 0.2 mm.
Figure 9. *E. africanus,* ventral view of terminal genital ducts. Scale 0.05 mm.
Figure 10. *Prosterrhurus labeonis,* adult worm, ventral view. Scale 0.2 mm.
Figure 11. *P. labeonis,* ventral view of terminal genital ducts. Scale 0.05 mm.

tabulum dorsum in contracted specimens to preacetabular from postbifurcal level to posterior portion of pharynx in extended specimens, enclosed in very thin-walled sinus sac. Genital atrium short. Genital pore median, at anterior margin of ventral lip of oral sucker.

Ovary usually transversely oval, median, 0.094 (0.065-0.115) × 0.107 (0.085-0.147), separated from posterior testis by uterine fold, distance from posterior margin of acetabulum to ovary 0.80 (0.640-0.990), usually located anterior to body-ecsoma junction but may be at junction or entirely in ecsoma just posterior to junction. Ootype complex immediately postovarian, ventral to beginnings of vitellaria. Vitellaria consisting of 7 long, slender, winding, tubular lobes, arranged 3 right and 4 left, two main vitelline masses located at postero-ventral portion of ovary with lobes extending laterally, then some proceeding very slightly anteriorly before turning caudad with few lobes entering ecsoma short distance; vitellaria entirely in ecsoma when ovary entirely ecsomal. Uterus very winding, descending limb along right side reaching into ecsoma one-third to two-thirds length of latter, ascending limb along left side, crossing diagonally between ovary and posterior testis to right of testes and seminal vesicle, then medially from this point joining sinus sac beside pars prostatica and forming hermaphroditic duct. Eggs numerous, 20 measuring 0.015 (0.012-0.018) × 0.008 (0.007-0.009).

Excretory pore terminal, excretory arms extending far anteriorly, uniting dorsal to posterior region of oral sucker.

HOST: *Pomadasys olivaceus* (Pomadasyidae).

HABITAT: Small intestine.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATE: August 9, 1952.

TYPE: U. S. Nat. Mus. Helm. Coll., No. 59679 (1 whole mount slide of type, and 2 whole mount slides of 1 paratype each).

Yamaguti (1954) listed 16 species in the genus *Lecithocladium* Lühe, 1901. Later (1958) he listed 19, 15 of which were the same as recorded in 1954; he had removed *L. johnii* Yamaguti, 1938, from the genus, and added *L. crenatum* (Molin, 1859) Looss, 1907, *L. cristatum* (Rud., 1819) Looss, 1907, *L. gulosum* (Linton, 1901) Looss, 1907, and *L. seriolellae* Manter, 1954. Earlier Dawes (1946, 1947) had declared *L. excisiforme* Cohn, 1902, and the first 3 species added in 1958 by Yamaguti as synonyms of *L. excisum* (Rud., 1819) Lühe, 1901. Manter (1954) concurred in this view; in addition he declared *L. pagrosomi* Yamaguti, 1934, a synonym of *L. magnacetabulum* Yamaguti, 1934, and Manter and Pritchard (1960a) reaffirmed this. In the latter publication a new species *L. chingi* was described. Therefore, there appears to be 15 valid species in the genus *Lecithocladium*. These are *L. augustiovum* Yamaguti, 1953, *L. annulatum* Chauhan, 1945, *L. brevicaudum* Srivastava, 1937, *L. carultum* Chauhan, 1945, *L. chingi*, *L. excisum*, *L. glandulum* Chauhan, 1945, *L. harpodontis* Srivastava, 1937, *L. magnacetabulum*, *L. megalaspis* Yamaguti, 1953, *L. parviovum* Yamaguti, 1953, *L. pisicola* (Srivastava, 1935) Yamaguti, 1954, *L. psenopsis* Yamaguti, 1934, *L. scombri* Yamaguti, 1953, and *L. seriolellae*.

L. aegyptensis appears to be most similar to *L. excisum* (Rud., 1819) Lühe, 1901. It is distinguishable from the latter in being much smaller in all respects. Additionally, it differs in lacking a neck-hump, in the more posterior position of the seminal vesicle, and in the deep lateral incisions of the ventral lip rather than just notches.

Comparisons were made with descriptions of *L. excisum* recorded by Looss

(1907a, 1907b), Yamaguti (1934), Linton (1940), and Dawes (1947); the latter author compared the data given by Johnstone in 1906, Looss in 1907, and Markowski in 1933.

The genus *Lecithocladium* as characterized by Yamaguti (1958) is inconsistent in four respects with the morphology of the species included therein, and therefore, needs emendation.

Lecithocladium Lühe, 1901. Char. emend.

SYNONYM: *Clupenurus* Srivastava, 1935

DIAGNOSIS: Hemiuridae. Dinurinae. Body elongate, small to medium-sized, with comparatively long, sometimes short ecsoma. Oral sucker often cup-shaped, pharynx elongate, esophagus very short, ceca usually extending into ecsoma and usually terminating at or near posterior end. Acetabulum prominent, near anterior extremity. Testes diagonal or tandem, usually anterior to mid-body, occasionally posterior to it. Seminal vesicle simple, usually with thick muscular wall, antero-dorsal to testes. Pars prostatica long, winding. Hermaphroditic duct long, slender. Genital pore ventral to oral sucker. Ovary at or near midbody. Vitellaria consisting of seven to nine long winding tubules. Uterus usually extending into ecsoma. Excretory arms uniting dorsal to oral sucker. Stomach and intestinal parasites of marine fishes.

TYPE SPECIES: *L. excisum* (Rudolphi, 1819) Lühe, 1901.

The generic diagnosis by Yamaguti differs in stating "ceca terminating at or near posterior end of tail." However, in *L. brevicaudum* Srivastava, 1937, the ceca do not enter the ecsoma, while in *L. seriolellae* Manter, 1954, they may or may not enter the ecsoma but not more than half its length. Additionally, he differs in stating that the genital pore is ventral to the oral sucker "near its anterior end." The genital pore is near the posterior end of the oral sucker in *L. augustiovum* Yamaguti, 1953, *L. megalaspis* Yamaguti, 1953, *L. parviovum* Yamaguti, 1953, *L. piscicola* (Srivastava, 1935) Yamaguti, 1954, and *L. scombri* Yamaguti, 1953. He differs further in stating that the vitellaria consist of "seven" lobes. The vitellaria consist of 7 or 8 lobes in *L. magnacetabulum* Yamaguti, 1934, 8 in *L. carultum* Chauhan, 1945, *L. glandulum* Chauhan, 1945, and *L. harpodontis* Srivastava, 1937, and 9 in *L. brevicaudum*. Finally, he differs in stating "uterus extending into tail." In *L. brevicaudum* and *L. seriolellae* the uterus does not enter the ecsoma.

Sterrhurus magnicaudatus, n. sp. (Fig. 4-5)

DIAGNOSIS: Lecithochiriinae. Body smooth, elongate, with ecsoma; ecsoma slightly shorter to 1½ times longer than body proper in well extended specimens, most frequently partially or completely retracted into body. Some specimens with few to many large, elongate, black pigmented areas contained in dorsal and ventral parenchyma cells, may be distributed from level of esophagus to posterior end of body proper. Oral sucker transversely oval; preoral lobe prominent. Acetabulum round, approximately one-fourth to one-third length of body proper from anterior end. Ratio of lengths of suckers 1:1.93-2.29. No preacetabular pit or concavity. Pharynx globular. Esophagus short, inflated into round vesicle. Ceca extending into ecsoma approximately two-fifths to four-fifths length of latter, usually ½.

Testes globular, separated to slightly overlapping one another, symmetrical or slightly oblique with left testis usually more anterior, slightly overlapping acetabulum dorsum to slightly postacetabular; relationship of testes to one another and to acetabulum greatly dependent on degree of extension from

or retraction into body proper of ecsoma. Seminal vesicle median to submedian, starting at middle or anterior to middle of acetabulum dorsum; tripartite, posterior chamber elongate, thin-walled and saccular, middle chamber small with thick muscular wall and saccular to tubular, anterior chamber immediately postbifurcal, dorso-ventrally oriented and therefore usually seen in cross section, thicker walled than middle chamber, composed of thinner inner compact muscular layer and outer thicker granular layer. Pars prostatica short, straight, extending anteriorly from anterior chamber of seminal vesicle to a position ventral to esophagus, then entering posterior end of sinus sac and enlarging into prostatic vesicle; vesicle round, lined with some transparent cell-like structures; prostatic gland cells numerous, resting on distal two-thirds of anterior chamber of seminal vesicle, surrounding pars prostatica, and entering sinus sac to surrounded prostatic vesicle. Ejaculatory duct leading anteriorly from prostatic vesicle very short distance before being joined by metraterm to form hermaphroditic duct leading to genital pore. Hermaphroditic duct thick-walled, muscular, protrusible through genital pore. Sinus sac elongate, pyriform, ventral to esophagus and pharynx. Genital pore a transverse slit, median to slightly submedian, ventral to oral sucker-pharynx junction.

Ovary round to transversely elongate, posttesticular, well separated from testes in specimens with ecsoma well extended or may contact testes in specimens with ecsoma completely retracted; amphitypic, with ovary on right or left or median to submedian. Ootype complex immediately postovarian, may slightly overlap ovary. Vitellaria usually consisting of 7 short, stumpy lobes not much longer than wide, usually 4 right and 3 left, in region of ovary, not extending posteriorly to any extent and far removed from ecsoma; variations in number of lobes occurring, 3-3, 4-4, 3-5. Uterus descending with much winding, entering ecsoma 6-38 per cent length of latter, then ascending with much winding to testes, ascending acetabulum dorsum to its anterior third as straight median or submedian duct, there becoming metraterm, sphincter at utero-metraterm junction, when aligned uterus-metraterm lying ventral to seminal vesicle. Metraterm thick-walled, larger in diameter than uterus preceding it, but narrowing more anteriorly, ascends ventral to seminal vesicle and pars prostatica, entering postero-ventral end of sinus sac, passing ventral to prostatic vesicle, and joining ejaculatory duct anteriorly. Eggs small, numerous.

Excretory pore terminal; vesicle in ecsoma may have several constrictions, arms uniting dorsal to oral sucker-pharynx.

Mean measurements (with minima and maxima in parentheses) of 10 whole mount adults from *Saurida undosquamis* are: total length 4.039 (3.025-5.395); body proper, length 2.029 (1.550-2.530), width (at ovary) 0.524 (0.420-0.640); ecsoma, length 2.010 (1.475-3.205), width (at end of uterus) 0.290 (0.240-0.350); preoral lobe, length 0.021 (0.015-0.036); oral sucker, 0.157 (0.136-0.189) × 0.177 (0.143-0.213); pharynx, 0.105 (0.090-0.115) × 0.108 (0.088-0.131); esophagus, 0.064 (0.046-0.090) × 0.081 (0.061-0.097); acetabulum, 0.332 (0.270-0.410) × 0.335 (0.270-0.430); distance from anterior end of body to acetabulum, 0.470 (0.410-0.560); right testis, 0.232 (0.169-0.256) × 0.203 (0.157-0.242); left testis, 0.204 (0.145-0.244) × 0.186 (0.131-0.242); distance from acetabulum to right testis, overlapping-0.180; distance from acetabulum to left testis, overlapping-0.119; posterior chamber of seminal vesicle, 0.185 (0.128-0.218) × 0.109 (0.073-0.140); anterior chamber of seminal vesicle, diameter 0.066 (0.058-0.075); anterior chamber of

seminal vesicle, thickest portion of wall 0.016 (0.011-0.024); prostatic vesicle, 0.044 (0.036-0.056) × 0.041 (0.026-0.056); hermaphroditic duct, 0.071 (0.056-0.085) × 0.028 (0.022-0.034) sinus sac, 0.136 (0.106-0.162) × 0.054 (0.044-0.068); ovary, 0.157 (0.121-0.194) × 0.171 (0.143-0.203); distance from acetabulum to ovary, 0.314 (0.125-0.530); 25 older intrauterine eggs, 0.021 (0.019-0.024) × 0.012 (0.011-0.014); distance uterus extends into ecsoma, 0.495 (0.125-0.990); distance ceca extend into ecsoma, 1.146 (0.705-1.655).

Measurements of 2 whole mount adults from *Platycephalus townsendi* are: total length, 2.310 (ecsoma mostly retracted)-3.692 (ecsoma fully extended); body proper, 1.617-1.683 × 0.515-0.528; ecsoma, 0.627 (mostly retracted)-2.075 (fully extended) × 0.277-0.297; preoral lobe, 0.021-0.023; oral sucker, 0.145 × 0.152-0.178; pharynx, 0.096-0.102 × 0.099-0.109; esophagus, 0.038-0.048 × 0.071-0.081; acetabulum, 0.284-0.330 × 0.297-0.363; distance from anterior end of body to acetabulum, 0.396-0.459; right testis, 0.198-0.205 × 0.205; left testis, 0.198-0.231 × 0.198-0.205; posterior chamber of seminal vesicle, 0.158-0.20 × 0.10-0.120; anterior chamber of seminal vesicle, antero-posterior diameter 0.057-0.075, lateral diameter 0.060-0.068; anterior chamber of seminal vesicle, thickest portion of wall 0.010-0.023; prostatic vesicle, 0.033-0.038 × 0.038-0.045; hermaphroditic duct, 0.058-0.061 × 0.025-0.029; sinus sac, 0.105 × .049-0.053; ovary, 0.152-0.165 × 0.178-0.185; distance from acetabulum to ovary, 0.198-0.297; 13 older intrauterine eggs, 0.019 (0.017-0.020) × 0.013 (0.011-0.013); distance uterus extends into fully extended ecsoma, 0.720; distance ceca extend into fully extended ecsoma, 1.345.

Measurements of 1 whole mount adult from *Labeo forskalii* are: total length, 1.334 (ecsoma mostly retracted); body proper 1.084 × 0.345; ecsoma, 0.60 (including retracted portion, only 0.250 extending beyond body proper) × 0.190; preoral lobe, 0.015; oral sucker, 0.097 × 0.099; pharynx, diameter 0.065; esophagus, 0.029 × 0.044; acetabulum 0.194 × 0.206; distance from anterior end of body to acetabulum, 0.275; right testis, 0.092 × 0.121; left testis, 0.109 × 0.104; posterior chamber of seminal vesicle, 0.085 × 0.048; anterior chamber of seminal vesicle, diameter 0.035; anterior chamber of seminal vesicle, thickest portion of wall 0.010; prostatic vesicle, diameter 0.023; hermaphroditic duct, 0.043 × 0.015; sinus sac, 0.080 × 0.032; ovary, diameter 0.086; distance from acetabulum to ovary, 0.080; 4 older intrauterine eggs, 0.021 (0.019-0.022) × 0.012 (0.011-0.013).

HOSTS: Type, *Saurida undosquamis* (Synodontidae*); *Platycephalus townsendi* (Platycephalidae); *Labeo forskalii* (Cyprinidae).

HABITAT: Small intestine.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATES: October 25 and November 22, 1952.

TYPES: U. S. Nat. Mus. Helm. Coll., No. 59680 (from *Saurida,* 1 whole mount slide of type and several paratypes, and 2 whole mount slides with several paratypes each); No. 59681 (from *Platycephalus,* 2 whole mount slides with 1 paratype each); No. 59682 (from *Labeo,* 1 whole mount slide of 1 paratype).

The above description is based on the study of several hundred immature to mature specimens from 3 *Saurida undosquamis,* 2 mature specimens from 1 *Platycephalus towsendii,* and 1 mature specimen from 1 *Labeo forskalii.*

The diagnosis of the genus *Sterrhurus* Looss, 1907, and therefore, the designation of species to be included therein, seems to be in a confused state.

*In the first article of this series by Fischthal and Kuntz (1959) the fish host *Synodontis schall* was erroneously listed as belonging to the family Synodontidae. It should have been the family Mochokidae.

Difficulty also exists in defining valid criteria for distinguishing *Sterrhurus* from *Lecithochirium* Lühe, 1901. Additionally, *Synaptobothrium* v. Linstow, 1904, *Plerurus* Looss, 1907, and *Separogermiductus* Skrjabin and Guschanskaja, 1955, are variously accepted as valid or reduced to synonomy, the latter with *Sterrhurus* and the other two with *Lecithochirium*. Manter and Pritchard (1960a) presented a summary of this problem. The present authors are following their conclusions by recognizing all these genera as valid, and by separating the species of *Sterrhurus* from *Lecithochirium* on the basis of the absence or presence of a preacetabular pit.

It would appear that the new species under consideration fits best into the genus *Sterrhurus*. *S. magnicaudatus* is most similar to *S. lotellae* Manter, 1954, on the basis of the short, stumpy vitelline lobes, the extension of the intestinal ceca into the ecsoma, and the tripartite seminal vesicle with its thick-walled, muscular anterior chamber. It differs from the latter species in having its uterus extending into the ecsoma rather than remaining entirely within the body, the middle chamber of the seminal vesicle also thick-walled and muscular as in *S. amplus* Manter, 1961, rather than thin-walled, the sinus sac elongate and pyriform rather than ovoid, the genital pore at the level of the oral sucker-pharynx junction rather than the intestinal bifurcation, and a sucker ratio of 1:2.03-2.57 rather than 1:1.42.

Paraplerurus, n. gen.

DIAGNOSIS: Hemiuridae. Lecithochiriinae. Body smooth, elongate, with long ecsoma. Preacetabular pit absent. Oral sucker surmounted by preoral lobe. Acetabulum larger than oral sucker, anterior to middle of body proper. Ceca extending almost to posterior extremity of ecsoma. Testes diagonal, near posterior margin of acetabulum. Seminal vesicle tripartite, thin-walled, extending preacetabular from antero-dorsal region of acetabulum. Pars prostatica very short, preacetabular, distal end entering prostatic vesicle. Sinus sac consisting of only strands of muscles in parenchyma, surrounding part of genital atrium, large hermaphroditic duct, ejaculatory duct, anterior tip of prostatic vesicle, and extreme distal end of metraterm; latter joining ejaculatory duct immediately anterior to prostatic vesicle to form hermaphroditic duct. Genital atrium large, muscular, eversible. Genital pore immediately postbifureal. Ovary median, in posterior third of body proper, may be superficially divided by connective tissue band(s). Ovary and ootype complex enclosed together within single conspicuous common connective tissue sheath, some of figers separating from sheath to encircle ovary posteriorly and ootype anteriorly. Vitellaria in two widely separated lateral groups, usually with 7 digitate lobes, sometimes more. Uterus descends into ecsoma. Intestinal parasite of marine fish.

Paraplerurus sauridae, n. sp. (Fig. 6-7)

Diagnosis (based on 13 specimens from 2 hosts; 6 measured): Body smooth, large, elongate, with ecsoma two-thirds length to slightly more than length of body proper; body proper, length 4.016 (3.754-4.264), width (at ovary) 1.298 (1.051-1.534); ecsoma, length 3.579 (2.738-4.296), width (at uterus end) 0.956 (0.629-1.419); total length, 7.545 (6.787-8.541); distance from anterior end of body to acetabulum, 1.153 (0.947-1.334). Some specimens with few to many small round to large elongate black pigmented areas contained in dorsal and ventral parenchyma cells, beginning at level of acetabulum and extending posteriorly to end of ecsoma. Oral sucker round, subterminal, 0.363 (0.331-0.416) × 0.363 (0.313-0.422); preoral lobe, 0.061

(0.037-0.079). Acetabulum transversely oval, 0.694 (0.621-0.805) × 0.745 (0.675-0.828); approximately one-third to two-fifths length of body proper from anterior end. Ratio of lengths of suckers 1:1.69-2.04. Pharynx slightly elongate, 0.144 (0.125-0.166) × 0.129 (0.110-0.144). Esophagus short, sac-like, 0.132 (0.118-0.144) × 0.122 (0.088-0.147). Ceca extending into ecsoma almost to posterior extremity, 3.550 (2.385-4.112).

Testes round, smooth, slightly diagonal; right testis usually anterior, anterior testis usually overlapping acetabulum dorsum, and slightly smaller than posterior testis; right testis, 0.307 (0.204-0.384) × 0.309 (0.228-0.391); left testis, 0.338 (0.224-0.414) × 0.317 (0.228-0.376); distance from acetabulum to anterior testis, overlapping-0.085; distance from acetabulum to posterior testis, overlapping-0.210. Vasa efferentia long, arising from antero-dorsal surface of testes, ascending to anterior portion of acetabulum dorsum before uniting to form very short vas deferens entering posterior end of seminal vesicle. Seminal vesicle tripartite, all chambers thin-walled, overlapping anterior one-fourth to two-fifths acetabulum and extending preacetabular; posterior chamber, 0.245 (0.191-0.346) × 0.131 (0.063-0.184); middle chamber, 0.129 (0.092-0.169) × 0.119 (0.070-0.155); anterior chamber, 0.102 (0.063-0.150) × 0.108 (0.074-0.150). Pars prostatica extremely short, entering postero-ventral end of prostatic vesicle. Prostatic vesicle oval to elongate ovoid with posterior end flat, traces of cells lining inner wall, usually sperm filled, 0.128 (0.085-0.151) × 0.099 (0.083-0.132). Prostatic gland cells abundant, overlying anterior half of anterior chamber of seminal vesicle, pars prostatica, and prostatic vesicle. Ejaculatory duct extremely short, leading from anterior end of prostatic vesicle and joined ventrally almost immediately by ventral metraterm to form hermaphroditic duct. Hermaphroditic duct very long 0.192 (0.148-0.221), thick-walled, muscular, opening into genital atrium; parenchymatous tissue surrounding duct containing abundant muscular element and appearing very compact. Genital atrium wide, long, muscular, inverted; eversible through genital pore. Sinus sac wide, width 0.204 (0.195-0.210), consisting of few parenchymal muscle strands enclosing part of genital atrium, hermaphroditic duct, ejaculatory duct, and anterior tip of prostatic vesicle; in specimens with genital atrium protruding through genital pore sinus sac may be partially displaced anterior and lateral to pore. Genital pore median to submedian, immediately postbifurcal.

Ovary 0.462 (0.325-0.605) × 0.491 (0.353-0.629), broadly reniform with concavity facing posteriorly, smooth; may be superficially subdivided into 2 or 3 large regions by connective tissue band(s), usually submedian to left, behind and separated from left posterior testis; larger than either testis; distance from acetabulum to ovary, 0.630 (0.253-1.076). Ootype complex fitting into posterior concavity of ovary, being slightly overlapped dorsally or ventrally or both by ovary; 0.247 (0.218-0.350) × 0.291 (0.227-0.385). Ovary and ootype complex enclosed together within single conspicuous common connective tissue sheath, giving false appearance of entire structure being an ovary; some of fibers separate from common sheath to separately encircle ovary posteriorly and ootype complex anteriorly; ovary-ootype complex 0.543 (0.414-0.621) × 0.491 (0.353-0.629). Uterus usually descending on left with windings, into ecsoma 1.513 (1.035-1.994) or approximately one-third to one-half its length, ascending on right with windings, becoming median between testes, ascending acetabulum dorsum median to submedian; dorsal to vitellaria, ovary, posterior testis, and either dorsal or ventral to anterior testis. Metraterm commencing approximately at level of posterior

third to middle of acetabulum dorsum, thick-walled ,ventral to seminal vesicle, pars prostatica, and prostatic vesicle, joining ejaculatory duct immediately anterior to prostatic vesicle. Vitellaria in two widely separated lateral groups, ventral to postero-lateral margins of ovary; lobes longer than wide, usually 7 in number (4 left, 3 right), occasionally 1 to 3 smaller accessory lobes come off common mass or lobes; lobes may ascend body to level of anterior margin of ovary and other lobes may descend body almost to ecsoma or may just enter ecsoma; usually single vitelline duct passing medially from each common vitelline mass and joining to form common vitelline duct ventral to ootype complex; one specimen with 2 vitelline ducts emerging from right vitelline mass and joining with one from left mass to form common vitelline duct. Eggs numerous, 12 measuring 0.019 (0.018-0.020) × 0.010 (0.008-0.011).

One specimen decidedly amphitypic, with left testis anterior and slightly smaller than right, ovary submedian to the right behind right posterior testis, uterus descending on right and ascending on left, and vitelline lobes 3 left, 4 right.

HOST: *Saurida undosquamis* (Synodontidae).

HABITAT: Small and large intestines.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATES: October 25 and November 22, 1952.

TYPES: U. S. Nat. Mus. Helm. Coll., No. 59684 (1 whole mount slide of type, and 2 whole mount slides of 1 paratype each).

The new genus *Paraplerurus* most closely resembles *Plerurus* Looss, 1907. It differs in having a large, muscular, eversible genital atrium, connective tissue band(s) superficially dividing the ovary, and a single conspicuous common connective tissue sheath enclosing the ovary and ootype complex together.

Erilepturus africanus, n. sp. (Fig. 8-9)

DIAGNOSIS (based on 2 specimens from two hosts): Lecithochiriinae. Body smooth, elongate, with ecsoma; body proper, length 1.710-1.760, width (at testes) 0.260-0.305; ecsoma 0.450-0.640 × 0.195-0.285; total length 2.210-2.350, maximum width 0.315-0.405; distance from posterior margin of acetabulum to ecsoma 1.110-1.175. Oral sucker globular, 0.097-0.143 × 0.093-0.131; preoral lobe 0.007-0.018. Acetabulum globular, 0.270-0.335 × 0.270-0.325; approximately one-fourth length of body proper from anterior end, one-fifth total length. Ratio of lengths of suckers 1:2.34-2.78. Pharynx globular, 0.055-0.085 × 0.058-0.073. Esophagus short, sac-like. Ceca not ascending sides of pharynx, extending into ecsoma approximately one-half length of latter. Excretory pore terminal; median vesicle ascending ecsoma.

Testes diagonal, slightly separated to overlapping, anterior testis 0.090-0.104 × 0.085-0.111, posterior testis 0.109-0.114 × 0.121-0.133, distance from posterior margin of acetabulum to anterior testis 0.121-0.138, to posterior testis 0.182-0.208. Vasa efferentia joining to form short vas deferens. Seminal vesicle starting 0.121-0.152 posterior to acetabulum, overlapping both anterior testis and acetabulum, relatively thin-walled, tripartite, chambers overlapping one another, in one specimen-posterior chamber 0.077 × 0.062, middle chamber 0.059 × 0.043, anterior chamber 0.044 × 0.031, longitudinal extent of complete vesicle 0.139. Pars prostatica long, relatively straight, starting at level of posterior portion of acetabulum; distal portion with prostatic gland cells commencing at antero-dorsal region of acetabulum. Hermaphroditic

duct preacetabular, 0.077-0.085 × 0.010-0.015, formed by union of metraterm with pars prostatica at anterior extremity of prostatic gland cells and terminating at level of pharynx, enclosed in narrow, thin-walled sinus sac 0.015-0.020 in width; duct narrowing anteriorly and terminating in a bulbous, egg-shaped, muscular region, muscular bulb 0.029-0.039 × 0.022-0.024, projecting free into genital atrium. Genital atrium tubular, 0.048-0.058 × 0.010-0.012, leading to genital pore near postero-ventral margin of oral sucker.

Ovary 0.157-0.182 × 0.152-0.223, larger than either testis, median, posttesticular, separated from posterior testis by vitelline lobe and uterine fold, distance from posterior margin of acetabulum to ovary 0.325-0.346. Vitellaria of 7 tubular lobes, 4 right and 3 left, some lobes extending anteriorly overlapping posterior testis while remainder extending laterally and posteriorly, terminating well in advance of cecoma, ventral to ovary and posterior testis. Uterus much coiled, dorsal to vitellaria, ovary and testes, folds numerous posterior to vitellaria, descending into cecoma a short distance, ascending as straight duct dorsal to acetabulum, metraterm joining pars prostatica preacetabular to form hermaphroditic duct. Eggs numerous, 10 measuring 0.020 (0.018-0.021) × 0.013 (0.012-0.014).

HOST: *Pomadasys olivaceus* (Pomadasyidae).

HABITAT: Small intestine.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATES: September 20 and October 12, 1952.

TYPE: U. S. Nat. Mus. Helm. Coll., No. 59683 (1 whole mount slide of type, and 1 whole mount slide of paratype).

Manter (1947) recognized the validity of the genera *Erilepturus* Woolcock, 1935 (without cuticular plications) and *Ectenurus* Looss, 1907 (with cuticular plications). In *Erilepturus* he included the type species *E. tiegsi* Woolcock, 1935, and *E. hamati* (syn. *Ectenurus h.* Yamaguti, 1934), *E. paralichthydis* (syn. *Ectenurus p.* Yamaguti, 1934), and *E. lemeriensis* (syn. *Ectenurus* Tubangui and Masilungen, 1936). *Ectenurus* included the type species *E. lepidus* Looss, 1907, and *E. virgulus* Linton, 1910. Yamaguti (1954) listed *Erilepturus* as a synonym of *Ectenurus*, allocating to the latter the six species listed by Manter (1947) for both genera in addition to *Ectenurus platycephali* Yamaguti, 1934. Skrjabin and Guschanskaja (1954) recognized *Erilepturus*, but created the genus *Uterovesiculurus* for *U. hamati* (type), *U. paralichthydis*, and *U. platycephali* inasmuch as each possessed an uterine swelling immediately before the union with the pars prostatica. Yamaguti (1958) continued to list *Erilepturus* as a synonym of *Ectenurus*. He allocated to the latter *E. lepidus*, *E. lemeriensis*, *E. tiegsi*, and *E. virgulus*, and recognized *Uterovesiculurus* and the three species contained therein. Manter and Pritchard (1960b) declared *Uterovesiculurus* a synonym of *Erilepturus*, transferring the three species contained therein to the latter genus.

From the foregoing account it appears that the genus *Erilepturus* contains five species: *E. tiegsi* (type), *E. hamati*, *E. lemeriensis*, *E. paralichthydis*, and *E. platycephali*.

Erilepturus africanus appears to be most similar to *E. tiegsi*. It can be distinguished from the latter in being half as long, in the more anterior position of the acetabulum, in having the genital pore situated near the postero-ventral margin of the oral sucker rather than at the posterior edge of the pharynx, in the ceca extending into the cecoma approximately one-half the length of the latter rather than to its posterior extremity, and in the seminal vesicle being tripartite rather than bipartite.

Prosterrhurus, n. gen.

DIAGNOSIS: Hemiuridae. Lecithochiriinae. Body smooth, elongate, with ecsoma. Preacetabular pit absent. Oral sucker surmounted by preoral lobe. Acetabulum larger than oral sucker, near anterior end of body. Testes diagonal, postacetabular. Seminal vesicle tripartite, thin-walled, entirely postacetabular. Pars prostatica very long, postacetabular to immediately preacetabular, entire length surrounded by prostatic gland cells, distal end entering sinus sac. Sinus sac distinct, elongate, enclosing distal ends of pars prostatica and metraterm, a cell-lined prostatic vesicle, and ejaculatory duct and hermaphroditic ducts; metraterm joining ejaculatory duct immediately anterior to prostatic vesicle to form hermaphroditic duct. Genital pore at postero-ventral region of oral sucker. Ovary median, posterior to middle of body proper. Vitellaria with 7 long, slender lobes. Intestinal parasite of freshwater fish.

Prosterrhurus labeonis, n. sp. (Fig. 10-11)

DIAGNOSIS (based on single specimen): Lecithochiriinae. Body smooth, elongate, with ecsoma completely retracted; body proper, 1.516 × 0.260 (at ovary). Oral sucker round, 0.080 × 0.085; preoral lobe small, 0.006. Acetabulum round, 0.244 × 0.242, close to anterior end of body, distance from anterior end of body to acetabulum 0.202, approximately one-fifth length of body proper from anterior end. Ratio of lengths of suckers 1:3.05. Pharynx round, 0.048 × 0.051. Esophagus short, sac-like, round, 0.039 × 0.041. Ceca probably extending into ecsoma in fully extended specimens as posterior ends bent medially at more than right angles by retracted ecsoma near posterior extremity of body proper.

Testes slightly diagonal, overlapping slightly, well removed from acetabulum, both tests with dorsally projecting dorso-sinistral lobes; anterior testis 0.123 × 0.131, posterior testis 0.157 × 0.145; distance from posterior margin of acetabulum to anterior testis 0.126, to posterior testis 0.220. Vasa efferentia relatively long, one arising mid-dorsally from dorso-sinistral lobe of anterior testis and other from right antero-ventral portion of posterior testis; joining to form vas deferens. Vas deferens short, dorsal to anterior testis, entering posterior end of seminal vesicle. Seminal vesicle tripartite, straight, median, entirely postacetabular, posterior chamber slightly overlapping anterior testis dorsally, chambers small, thin-walled, slightly overlapping one another, ventral to ascending limb of uterus; posterior chamber, diameter 0.039, middle chamber 0.039 × 0.027, anterior chamber 0.031 × 0.022. Pars prostatica very long, straight, median, commencing immediately postacetabular and ending immediately preacetabular, entering posterior end of sinus sac and proceeding 0.016 before enlarging into prostatic vesicle; vesicle small, 0.024 × 0.016, lined with some transparent cell-like structures; prostatic gland cells along entire length of pars prostatica, narrower and less abundant for posterior half while broader and more abundant anteriorly. Ejaculatory duct very short, being joined anteriorly by ventral metraterm to form hermaphroditic duct. Hermaphroditic duct preacetabular, 0.041 × 0.017, muscular, thick-walled, opening into genital atrium. Genital atrium short, tubular, diameter 0.012. Sinus sac immediately preacetabular, long, relatively narrow, 0.097 × 0.024. Genital pore transverse slit, at postero-ventral region of oral sucker.

Ovary 0.140 × 0.152, posttesticular, in tandem with and only slightly separated from posterior testis, approximately same size as latter, distance from

posterior margin of acetabulum to ovary 0.380. Vitellaria of 7 long, slender lobes, 3 right and 4 left, base of each mass ventral and posterior to posterior region of ovary, several lobes extending antero-laterally as far as middle of posterior testis while others passing postero-laterally and posteriorly, probably would not enter ecsoma in fully extended specimens. Uterus entirely dorsal to vitellaria, ovary, testes and seminal vesicle, much coiled posterior to ovary, probably would enter ecsoma in fully extended specimens as posterior coils pushed anteriorly and flattened by retracted ecsoma, straightens out immediately anterior to anterior testis and ascends acetabulum in midline, metraterm entering postero-ventral end of sinus sac to join ejaculatory duct forming hermaphroditic duct. Eggs numerous, 10 measuring 0.021 (0.021-0.022) × 0.0125 (0.012-0.013).

HOST: *Labeo forskalii* (Cyprinidae).

HABITAT: Small intestine.

LOCALITY: Giza Fish Market, Giza Province, Egypt.

DATE: October 12, 1952.

TYPE: U. S. Nat. Mus. Helm. Coll., No. 59865 (1 whole mount slide of type).

The new genus *Prosterrhurus* most closely resembles *Sterrhurus* Looss, 1907, as characterized by Manter (1947) and Manter and Pritchard (1960a). It differs in having the seminal vesicle entirely postacetabular rather than preacetabular or antero-dorsal to the acetabulum, and in having a very long pars prostatica, with surrounding gland cells, commencing postacetabular and ending immediately preacetabular rather than a short one preacetabular.

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Neoechinorhynchus prolixoides n. sp. (Acanthocephala) From North American Fishes*

WILBUR L. BULLOCK

While studying the acanthocephalan parasites of the fishes of northern New England over 440 catostomid fishes were examined, from 27 ponds and streams in New Hampshire, and all of the drainage system of the state. Two of twelve fish examined from Lake Massasecum, Bradford, N. H., on June 12, 1959 had 25 immature neoechinorhynchids in the intestine. On the basis of their very active behavior these worms were recognized as a species which had not been previously collected in New Hampshire. Detailed study of stained whole mounts indicated that it was a species similar to but separate from *Neoechinorhynchus prolixus* Van Cleave and Timmons, 1952. In further collections, mature worms were taken from Pawtuckaway Pond in Nottingham, N. H., and from Winona Lake in West Center Harbor, N. H. All specimens were relaxed in distilled water, fixed in Demke's alcohol-formalin-acetic mixture, and stained with Lynch's precipitated borax carmine stain. Measurements were made of stained and mounted specimens and of eggs removed from the body cavity of mature females and mounted in Ringer's solution. All measurements are in millimeters unless otherwise indicated.

The holotype male and the allotype female, as well as paratypes, of *N. prolixus* were studied and measured for comparison. These specimens were obtained through the courtesy of Dr. David Lincicome and Dr. Allen McIntosh.

Neoechinorhynchus prolixoides n. sp. (Figs. 1-8)

GENERAL DESCRIPTION: With the characteristics of the genus *Neoechinorhynchus*. Body long and narrow in both sexes, oval in cross section, and tapering gradually toward both extremities. Anterior trunk with a conspicuous fold short distance behind cuticular fold; this differentiation is apparently the result of the insertion of the neck retractor muscles into the body wall posterior to the cuticular fold. Proboscis small, almost globular. Lemnisci markedly different in size; binucleate leminiscus about twice the length of uninucleate lemniscus and about half the length of body. Dorsal body wall thicker than ventral. Apical organ of the proboscis longer than proboscis and with two giant nuclei usually arranged in tandem. Hooks of basal series larger than those of middle series; width of hook thorn 4.4 to 7.1 microns for middle circle and 6.1 to 8.7 microns for the basal circle.

FEMALES: 6 to 15 long; maximum diameter of 0.36 to 0.77. External presoma 0.158 to 0.171 long; proboscis 0.110 to 0.148 long by 0.126 to 0.148 wide. Anterior row of proboscis hooks 0.055 to 0.065; middle circle 0.031 to 0.038; basal circle 0.034 to 0.046. Apical organ 0.149 to 0.217 long. Binucleate lemniscus 3.8 to 6.5 long; uninucleate lemniscus 1.7 to 3.0 long. Proboscis receptacle 0.46 to 0.67 long. Total length of female genitalia 0.46 to 0.84. Posterior extremity simple, without lateral lobes of trunk wall. Embryonated eggs in body cavity of mature female 0.036 to 0.045 by 0.018 to 0.027; measured fresh in Ringer's solution 0.040 to 0.045 by 0.025 to 0.035; middle layer with numerous very fine tube-like structures.

MALES: 4 to 9 long with a maximum diameter of 0.35 to 0.57. External presoma 0.124 to 0.143 long; proboscis 0.107 to 0.131 long by 0.104 to 0.129 wide. Anterior row of proboscis hooks 0.055 to 0.058; middle circle 0.031

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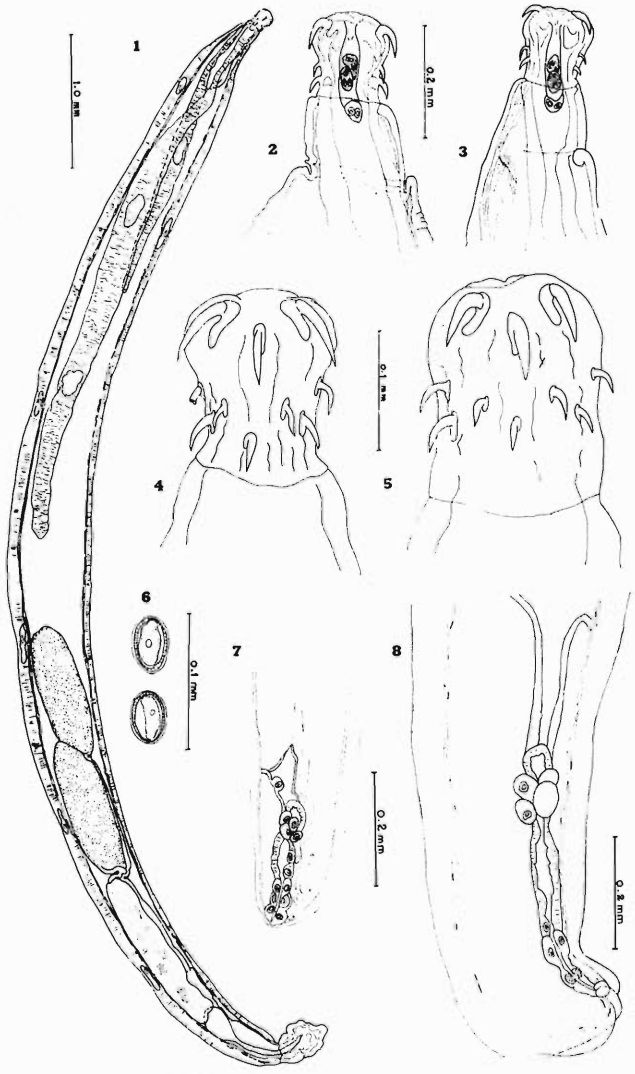

Fig. 1. Holotype male of *Neoechinorhynchus prolixoides*, n. sp.

Fig. 2. Anterior end of allotype female. Note the length of the apical organ and the two conspicuous folds, an anterior fold (the cuticular fold) separating the presoma from the trunk and a posterior fold at the point of attachment of the neck retractors.

Fig. 3. Anterior end of holotype male.

Fig. 4. Proboscis of holotype male showing the hook arrangement. Note the larger size of the hooks of the basal circle as compared with the middle circle.

Fig. 5. Proboscis of a paratype male of *Neoechinorhynchus prolixus* Van Cleave and Timmons, 1952. Note the enlarged hook on the ventral side of the basal circle (lower left of the figure).

Fig. 6. Mature ova of *N. prolixoides*.

Fig. 7. Posterior extremity of an immature paratype female of *N. prolixoides*. Note the absence of any cuticular lobes near the genital opening.

Fig. 8. Posterior extremity of mature paratype female of *N. prolixus* showing cuticular lobes on either side of the genital opening.

to 0.036; basal circle 0.034 to 0.045. Apical organ 0.106 to 0.175 long. Binucleate lemniscus 2.6 to 4.6 long; uninucleate lemniscus 1.3 to 2.2 long. Proboscis receptacle 0.46 to 0.64 long. Testes wide enough to fill body cavity; anterior testis 0.50 to 0.97 long; posterior testis 0.56 to 1.09 long. Cement gland with 8 giant nuclei; 0.66 to 1.54 long; cement reservoir 0.17 to 0.34 long. Total length of genitalia (from anterior end of the anterior testis to the posterior end of the trunk) 1.75 to 3.72.

TYPE MATERIAL: U.S.N.M. Helm. Coll. No. 59718, holotype male, allotype female, and paratypes from *Erimyzon oblongus* (chub sucker) and No. 59719 paratypes from *Catostomus commersoni* (common sucker). Other paratypes in the collection of Wilbur L. Bullock, Durham, New Hampshire.

TYPE LOCALITY: Pawtuckaway Pond, Nottingham, New Hampshire.

TYPE HOST: Chub sucker (*Erimyzon oblongus*); also found in the common sucker (*Catostomus commersoni*).

COMPARISONS: *N. prolixoides* is the sixth species of *Neoechinorhynchus* reported from North America in which there is marked difference in size between the two lemnisci. The most distinctive feature of *N. prolixoides* is the relative sizes of the hooks of the basal and middle circles; the hooks of the basal circle are always as large as or larger than those of the middle circle. The only other species of this genus in which this has been reported is *N. tylosuri* Yamaguti, 1939, but this is a very elongate form from Japan. *N. prolixoides* somewhat resembles *N. cristatus* but comparison of the new species with specimens of *N. cristatus* from both Washington and New Hampshire shows that *N. cristatus* is less slender and has a thicker dorsal subcuticula than does *N. prolixoides*. The collection data suggest that *N. prolixoides* is associated with large suckers in large ponds; *N. cristatus* commonly occurs in small suckers in streams. *N. cristatus* is more sluggish in its behavior than is *N. prolixoides*.

N. prolixoides most closely resembles *N. prolixus*. Both species have the same body proportions, and the same conspicuous fold in the anterior trunk region (this fold was illustrated but not mentioned by Van Cleave and Timmons). Both are parasites of catostomid fishes although there is a considerable gap in their geographic distribution as reported thus far. These species differ in that *N. prolixoides* has a slightly larger proboscis, the embryos are larger and more broadly oval, the apical organ is longer than the proboscis, and the basal row of hooks is larger than the middle row. A further difference can be noted in the posterior extremities of the females of the two species (figs. 7 and 8). *N. prolixus* has moderately developed integumentary lobes on either side of the genital pore. Such lobes are absent in *N. prolixoides*.

DISCUSSION

Study of the holotype male, the allotype female, and several paratypes of *N. prolixus* revealed a distinctive feature of *N. prolixus* that was overlooked by Van Cleave and Timmons in their original description. These authors, describing the probiscis hooks, said "those of middle and basal series of practically equal length (usually 0.028 mm.)." This is true, however, for only the dorsal and lateral hooks. The two ventral hooks of the basal circle are decidedly larger than either the dorsal and lateral hooks of that circle or any of the hooks of the middle circle. Results of measurements of proboscis hooks are shown in Table 1.

Lincicome (1948) and Van Cleave and Bullock (1950) showed that the

Table 1. Measurements of dorsal and ventral hooks of *Neoechinorhynchus prolixus* and *N. prolixoides*. All measurements are in microns. The figures in parentheses are averages.

	Dorsal hooks	Ventral hooks
	Length	
N. prolixus		
Middle row	24.9-32.0 (28.1)	26.7-32.0 (28.5)
Basal row	19.6-28.5 (25.8)	23.8-42.7 (37.0)
N. prolixoides		
Middle row	35.6-39.2 (36.1)	32.0-37.4 (35.1)
Basal row	35.6-48.1 (40.1)	35.6-46.3 (40.8)
	Width	
N. prolixus		
Middle row	4.4-7.0 (5.7)	4.4-7.0 (5.4)
Basal row	4.4-7.0 (5.3)	7.0-8.7 (7.5)
N. prolixoides		
Middle row	4.4-7.0 (5.3)	4.4-6.1 (5.2)
Basal row	7.0-8.7 (7.9)	7.0-8.7 (7.8)

lateral hooks of the anterior row in *N. emydis* (=*N. pseudemydis*?) were distinctly larger than the dorsal and ventral hooks of that circle. These observations have been confirmed for all turtle acanthocephalans by Cable and Hopp (1954) and by Fisher (1960). The most extreme departure from the assumed radial symmetry of the neoechinorhynchid proboscis is that of *N. doryphorus* Van Cleave and Bangham (1949). Van Cleave (1939) discussed some of the problems of hook measurements in the Acanthocephala. At that time he emphasized the difficulty of obtaining accurate measurements on any hooks that could not be seen in full side view. The measurements on the proboscis hooks of *N. prolixus* and *N. prolixoides* confirm this difficulty. It must be emphasized that the only hook measurements that are accurate and valid are those of hooks seen in full side view, with the base of the thorn and the tip of the thorn in the same focal plane, and measured from the base of the thorn to the tip. Measurements of the length of hooks in any other position must always be interpreted carefully. On this basis, due to the small size and globular nature of the proboscis of *N. prolixus* and *N. prolixoides* it was not possible to determine any departure from the radial symmetry in the anterior circle of either of these species.

The same problems are involved in measurements of the hooks of the other circles. However, it was possible to get a series of measurements that confirmed the presence of enlarged hooks on the ventral side of the basal row. (See Table 1.) This difference was further substantiated by measurements of the width of the thorn of hooks of the middle and basal rows. These measurements (shown in Table 1) confirm that in *N. prolixoides* the basal row of hooks is larger than the middle row and that there is no dorso-ventral or lateral differentiation; they further confirm that in *N. prolixus* there is an enlargement of the two ventral hooks of the basal circle that makes them larger than any in either the basal or middle circles.

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On two new trematodes (Family: Allocreadiidae Stossich, 1903) from the intestine of fresh-water fishes of Banaras, U.P.

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Abstract. *Eucreadium cameroni* sp. nov. and *Allocreadium makundi* sp. nov. are described from fresh water fishes of *Chela gora* and *Barbus sarana*. A key to the Indian species of the genus *Allocreadium Looss*, 1900 is given.

Eucreadium cameronii n. sp. (Figs. 1-2)

MATERIAL: One specimen.
HOST: *Chela gora*.
LOCATION: Small intestine.
LOCALITY: Banaras.

DESCRIPTION: Body elongate, unarmed, rounded at extremities, 3.16 × 0.88 mm. in size. Oral sucker nearly spherical, 0.32 × 0.31 mm. in size. Ventral sucker larger than oral sucker, pre equatorial, 0.41 mm. in diameter and lies at 0.82 mm. from anterior extremity. Prepharynx small; Pharynx muscular, 0.14 × 0.15 mm. in size; Oesophagus short, tubular and slightly curved, about 0.1 mm. long; Intestinal caeca simple, narrow, not close to lateral margins of body, extending through zone of posterior testis. Excretory pore at posterior end of body. Excretory bladder tubular reaching to posterior testis. Genital pore 0.71 mm. from anterior extremity, median, and a little posterior to bifurcation of intestinal caeca. Testes lobed, directly tandem, intercaecal and nearly in post equatorial region of body. Testes in same field, their zones contiguous. Anterior testis 0.52 × 0.52 mm. in size and 1.46 mm. from anterior extremity. Posterior testis 0.71 × 0.46 mm. in size and 0.42 mm. from hind end. Cirrus sac elongated, lying closely on right side of ventral sucker and extends from genital pore to middle region of ventral sucker measuring 0.76 × 0.09 mm. in size and divisible into two parts, posterior cylindrical and N-shaped while anterior curved into an elongated tube to right side of body. Vesicula seminalis at basal part of cirrus sac and

divided into two parts transversely; posterior part large, N-shaped and cylindrical 0.56 × 0.083 mm. in size while anterior smaller and globular, 0.12 × 0.09 mm. in size; opens into a tubular pars prostatica, 0.08 × 0.04 mm. in size, which runs transversely towards left and surrounded by prostate gland cells, then continued forward into a backwardly directed narrow tubular ejaculatory duct, 0.46 mm. long, opens at genital pore. Ovary entire, oval, between ventral sucker and anterior testis, 0.34 × 0.19 mm. in size at a distance of 1.31 mm. from anterior extremity. From its median side arises oviduct uniting with oötype. Receptaculum seminis pear shaped, 0.3 × 0.19 mm. in size, lying on right side of body a little distance apart from ventral sucker and opens at oötype. Laurer's canal present. Vitelline follicles numerous, small, extending from middle region of oral sucker to posterior end of body. Vitelline follicles run mostly lateral but confluent in posterior terminal part of body. Two transverse vitelline ducts unite in front of anterior testis forming yolk reservoir. Uterine coils extending posteriorly parallel to ovary, winding anteriorly up to middle of ventral sucker, turning posteriorly running between ovary and ventral sucker and then extending anteriorly to genital pore. Eggs oval and operculated, 0.04-0.08 × 0.035-0.055 mm. in size.

DISCUSSION: This species closely resembles *E. eucreadium* Dayal, 1950* the only other species reported from *Eutropiichthys vacha* but differs in the extension of vitellaria from middle of oral sucker up to hind end of body instead from pharynx region, in having ovary entire instead divided into 4 or 5 lobes, in having genital pore median instead a little to the right of median line, in having receptaculum seminis on the right side of body instead behind the ovary, in the absence of pointed shell at opercular end of egg and in the structure and position of cirrus pouch. In the new species the cirrus pouch extends to middle of ventral sucker on right side instead in front and the posterior portion of vesicula seminalis is cylindrical and N-shaped and much larger in size.

It is accordingly regarded a new species with the specific name of *E. cameroni* sp. nov.

The new species is named in honor of Professor Thomas W. M. Cameron, Director, Institute of Parasitology, McGill University, Macdonald College, P.O. Que. Canada.

Allocreadium makundi n. sp. (Fig. 2)

MATERIAL: One specimen.

HOST: Barbus sarana.

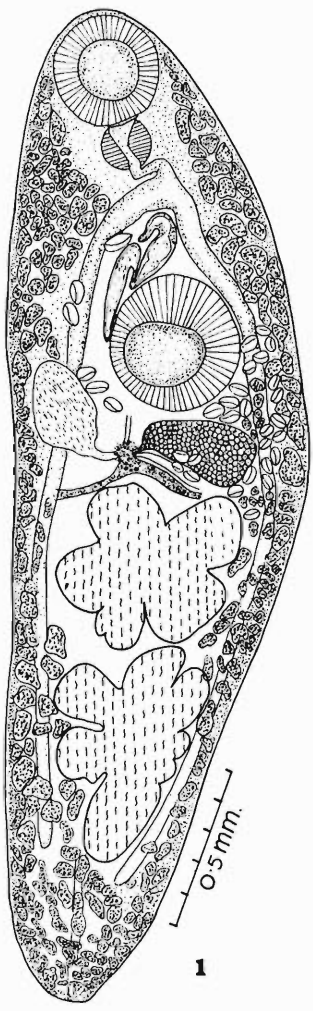
LOCATION: Small intestine.

LOCALITY: Banaras.

DESCRIPTION: Body elongated, smooth, devoid of spines with rounded extremities, 2.6 × 0.6 mm. in size. Oral sucker terminal, 0.3 mm. in diameter. Prepharynx absent. Pharynx nearly spherical, 0.16 × 0.15 mm. in size. Oesophagus short and bifurcates some distance in front of ventral sucker into two intestinal caeca terminating midway between posterior testis and hind end of body. Ventral sucker, 0.3 mm. in diameter, nearly equal to oral sucker and lies at 0.6 mm. from anterior extremity. Excretory pore terminal at posterior end of body. Excretory bladder tubular. Testes spherical, tandem, nearly equal in size and postequatorial. Anterior testis 1.46 mm. from anterior extremity and measures 0.29 mm. in diameter. Posterior testis close

*See Literature Cited.

to anterior testis and measures 0.29 × 0.26 mm. in size. Cirrus sac flask shaped lying on right side of ventral sucker extending from genital pore to middle of ventral sucker, 0.39 × 0.09 mm. in size. Coiled tubular vesicula seminalis 0.29 mm. long lies at basal part of cirrus sac. An elongated tubular pars prostatica present, about 0.09 mm long and located anterior to vesicula seminalis. Pars prostatica opens through narrow ejaculatory duct into long muscular cirrus. Vesicula seminalis and pars prostatica surrounded by large



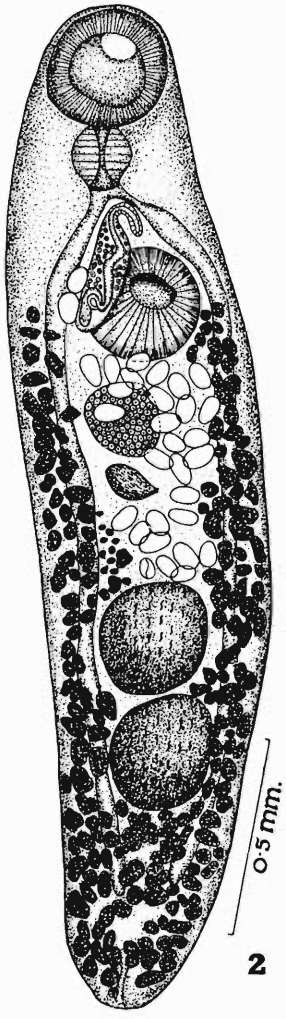


Fig. 1. *Eucreadium cameroni* sp. nov. Ventral view.

Fig. 2. *Allocreadium makundi* sp. nov. Dorsal view.

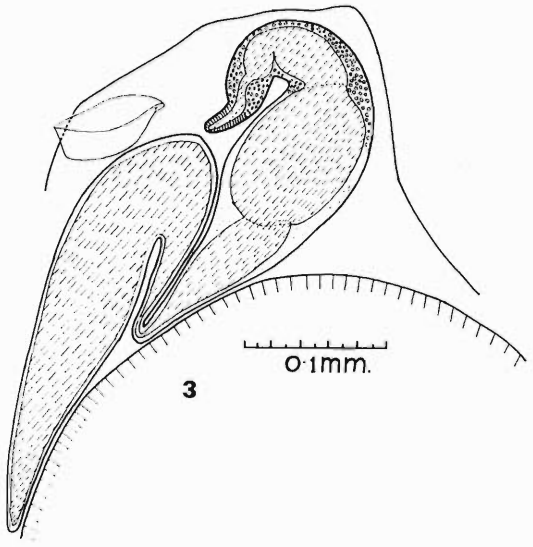


Fig. 3. Cirrus pouch and ventral sucker enlarged.

number of prostate gland cells. Ovary somewhat spherical, median, post acetabular, lying in front of receptaculum seminis, 0.19 mm. in diameter, and lies at 0.95 mm. from anterior extremity. Receptaculum seminis pear shaped or oval, posterior to ovary, 0.14 × 0.08 mm. in size. Vitelline glands follicular and extending from middle of ventral sucker to hind end of body, mainly lateral covering intestinal caeca and back of posterior testis filling intercaecal space. Uterus forms few coils between anterior testis and ventral sucker. Eggs oval, measure 0.06-0.08 × 0.03-0.05 mm. in size.

DISCUSSION: Only 11 species of the genus *Allocreadium* Looss, 1900 have been described from fresh water fishes of India viz. *A. annandeli Southwell,* 1913*; *A. handiai* Pande, 1937*; *A. koshia* Pande, 1938*; *A. mahseri* Pande, 1938*; *A. nicolli* Pande, 1938*; *A. schizothoracis* Pande, 1938*; *A. nemachilus* Kaw, 1950*; *A. thapari* Gupta, 1950*; *A. kamalai* Gupta, 1956*; *A. meharai* Gupta, 1956*; and *A. ophiocephali Srivastava,* 1960*.

A. makundi sp. nov. differs from *A. kamalai, A. meharai, A. nemachilus* and *A. schizothoracis* in having suckers nearly of equal size instead of oral sucker smaller than ventral sucker. Further the new species also differs from *A. thapari, A. handiai, A. koshia, A. nicolli* and *A. ophiocephali* in not having oral sucker larger than ventral sucker. The new form resembles closely *A. annandeli* and *A. mahseri* in having suckers and testes of equal size. The new form however differs from *A. mahseri* in having genital pore intercaecal and in front of ventral sucker instead anterior to intestinal bifurcation and in the extension of vitellaria from middle region of ventral sucker instead in front of it up to hind end of body. Further *A. makundi* sp. nov. differs from *A. annandeli* in the possession of an oesophagus, in not having intestinal caeca up to hind end of body, in not having testes to extreme posterior end, and not having ovary just in front of testes and in many other features.

*See Literature Cited.

The new species is named in honor of Prof. Makund B. Lal, F.N.I. Professor and Head of the Zoology Department, Lucknow University, Lucknow U.P. India.

Key to the Indian species of *Allocreadium* Looss, 1900

1. Oral sucker larger than ventral sucker 2
   Oral sucker almost equal to or smaller than acetabulum 6
2. Anterior testis smaller than posterior testis 3
   Testes nearly equal ..... *A. nicolli* Pande, 1938.
3. Vitellaria extend from hind end of ventral sucker up to hind end of body 4
   Vitellaria extend from middle of acetabulum to hind end of body ..... *A. koshia* Pande, 1938.
4. Receptaculum seminis lying postero dorsal to ovary just in front of anterior testis and partly overlapping it ..... *A. thapari* Gupta, 1950.
   Receptaculum seminis on postero lateral to ovary and in front of anterior testis 5
5. Oesophagus slightly larger than pharynx ..... *A. handiai* Pande, 1937.
   Oesophagus smaller than pharynx ..... *A. ophiocephali* Srivastava, 1960.
6. Oral sucker and ventral sucker of equal size 7
   Oral sucker smaller than ventral sucker 9
7. Oesophagus present 8
   Oesophagus absent ..... *A. annandeli* Southwell, 1913.
8. Genital pore behind intestinal bifurcation ..... *A. makundi* n. sp.
   Genital pore anterior to intestinal bifurcation ..... *A. mahseri* Pande, 1938.
9. Vitellaria extend from ventral sucker to hind end of body 10
   Vitellaria extend from pharynx to hind end of body ..... *A. kamalai* Gupta, 1956.
10. Anterior testis smaller than posterior testis 11
    Testes almost equal in size. ..... *A. schizothoracis* Pande, 1938.
11. Genital pore in front of acetabulum and excretory bladder tubular ..... *A. mehrai* Gupta, 1956.
    Genital pore in the proximity of pharynx and excretory bladder spherical ..... *A. nemachilus* Kaw, 1950.

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Histological and Histochemical Studies on the Effects of Parasitism of *Musculium partumeium* (Say) by the Larvae of *Gorgodera amplicava* Looss*

THOMAS C. CHENG

The life history of *Gorgodera amplicava* Looss, 1899, a bladder fluke of various species of frogs, was first reported by Krull (1933, 1935). It was later confirmed by Goodchild (1948) who contributed additional details concerning the bionomics and development of the larval stages of this parasite. Krull (1935) reported that the cystocercous cercariae of *G. amplicava* are produced in sporocysts. Goodchild (loc. cit.) reported two sporocyst generations both of which are found anchored to the gill tissue of the bivalve host *Musculium partumeium* (Say). A list of known natural and experimental intermediate and definitive hosts for this trematode is given by Cheng (1963).

During the summers of 1961 and 1962, over 500 specimens of *Musculium partumeium* were collected in a branch of Trout Creek in Slatedale, Lehigh County, Pennsylvania. Of some 200 specimens collected during 1961, 68 percent were found to be infected with the larvae of *Gorgodera amplicava* while of the some 300 collected in 1962, only 18.7 percent were infected with this parasite. This difference in the percentages of infection is attributed to the extremely dry summer in eastern Pennsylvania during 1962. The bivalves were found embedded in small isolated areas of moist earth and since their infection is dependent on their contact with the miracidia of *G. amplicava,* which require water for swimming, it is not surprising the heavily infected populations of *M. partumeium* were not found.

Cheng and Snyder (1962a) have reported on the degree of histapathology caused by the sporocysts and escaping cercariae of *Glypthelmins pennsylvaniensis* Cheng in the hepatopancreas of *Helisoma trivolvis* (Say) and Cheng and Snyder (1962a, 1963) reported that the developing trematode larvae derive their carbohydrate nutrients from the hepatopancreatic glycogen of the snail host. The present paper reports the investigations on the histopathology and the carbohydrate source for glycogen synthesis in *Gorgodera amplicava,* the sporocysts and developing cercariae of which are not situated in the mollusc's hepatopancreas but between the inner and outer gill lamellae.

MATERIALS AND METHODS

Ten specimens of infected and 10 of uninfected *Musculium partumeium* were removed from their shells and fixed in Carnoy's (6:3:1) fixative while 5 infected and 5 uninfected specimens were fixed in Zenker's. Both series were embedded in paraffin and sectioned at 8 microns in both longitudinal- and cross-sections. Alternating slides of the Carnoy's fixed sections were stained with Mallory's triple connective tissue stain and Delafield's haematoxylin for histological studies. The Zenker's fixed sections were treated with the periodic acid-schiff (PAS) reaction according to the technique described previously (Cheng and Snyder, 1962a) with alternating slides treated with diastase for control.

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RESULTS

HISTOLOGICAL: The sporocysts of *Gorgodera amplicava* enclose developing cercariae and were seen only in the water tubes between the inner and outer lamellae of both gills. In addition to sporocysts, free cercariae also are found therein. Within this space, the parasites are in intimate contact with the gill epithelium (fig. 1). In heavily infected bivalves, this space is greatly distended and in some instances one or both of the lamellae are ruptured (fig. 1, 2). Distension of the water tubes is accomplished primarily by the stretching of the undulating surfaces of the lamellae. The surface evaginations of the lamellae of uninfected bivalves are very acute (fig. 3) forming long V-shaped extensions. In infected specimens, the V-shaped extensions are distorted markedly and the length of the evaginations are reduced greatly.

No cytolysis or necrosis of intact gill epithelium was seen even in extremely heavy infections. In areas where the epithelium and the underlying connective tissue stroma are ruptured, the damage is strictly mechanical and results from the pressure exerted by the large number of motile sporocysts and escaping cercariae.

In areas where sections of gill tissue had been mechanically ruptured, the cytoplasm of the epithelial cells are less intensely stained with both Mallory's and Delafield's and the nuclei appear pienotic. These symptoms suggest necrosis.

HISTOCHEMICAL: In uninfected *Musculium partumeium,* there is no detectable PAS-positive material in the gills or in the epithelium (fig. 4); however, the young bivalves in the brood chamber were specifically and differentially demonstrated to be rich in PAS-positive material (fig. 5). This material, although PAS-positive, is not glycogen since it is not digested on the diastase-treated control sections.

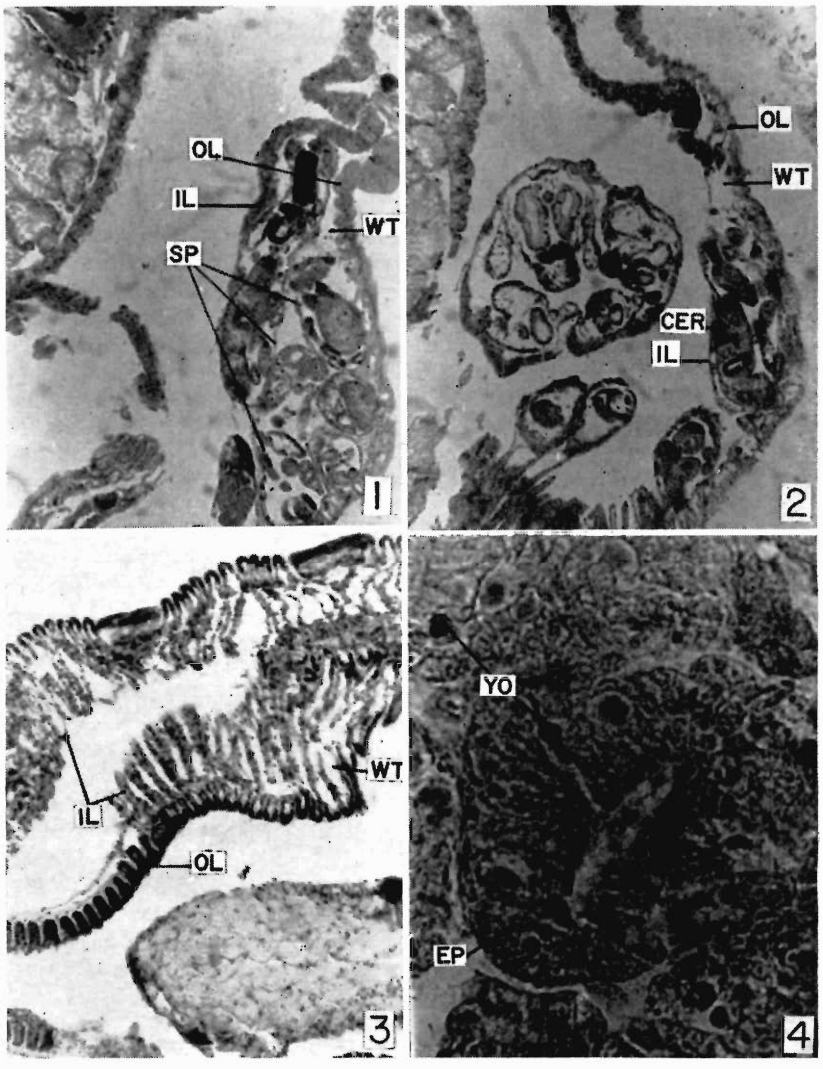
In infected *M. partumeium,* traces of PAS-positive material are visible in young developing cercariae and in the walls of daughter sporocysts (fig. 6, 7). The amount and distribution of this material increases in older cercariae. With the initiation of sucker morphogenesis, the PAS-positive material is situated primarily in the area of the presumptive suckers (fig. 8). In fully developed cercariae, the body proper is rich in PAS-positive material, especially in the posterior portion of the body. The anterior cystic portion of the tail and the length of the tail, however, show only faint traces of PAS-positive material (fig. 9). The PAS-positive material found in cercariae is glycogen since it cannot be seen in diastase-digested sections.

DISCUSSION AND CONCLUSIONS

The literature pertaining to host-parasite relationships between larval trematodes and their molluscan hosts has been reviewed by Cheng and Snyder, (1962a, b). As pointed out in these papers, it is quite evident that trematode larvae which are situated intertubularly in the hepatopancreas of gastropod hosts utilize the host's hepatopancreatic glycogen as a carbohydrate nutrient source. The utilization of the host's glycogen is not accomplished by direct absorption, rather, as shown by Cheng and Snyder (1963),

EXPLANATION OF FIGURES

CER= cercaria, CT = cystic portion of cercarial tail. EP = gill epithelium, IL = inner gill lamella, ODC = older developing cercaria, OL = outer gill lamella, SP = sporocyst, SPW = sporocyst wall, TA = elongate portion of cercarial tail, WT = water tube, YDC = young developing cercaria, YO = young bivalve.



Photomicrographs

Fig. 1. Longitudinal section through gill lamellae of *Musculium partumeium* showing sporocysts of *Gorgodera amplicava* enclosing developing cercariae in water tube between inner and outer lamellae. Notice the close contact between parasites and lamellae. (Delafield's hematoxylin; 10x obj.).

Fig. 2. Longitudinal section through gill lamellae of *M. partumeium* showing breaks in gill lamellae and sporocysts and free cercariae of *G. amplicava*, in water tube and between right and left gills. (Delafield's hematoxylin; 10x obj.).

Fig. 3. Longitudinal section through gills of uninfected *M. partumeium* showing deep folds of the inner and outer lamellae of both gills. (Mallory's triple; 10x obj.).

Fig. 4. Portion of gill epithelium of uninfected *M. partumeium* showing absence of PAS+ material except for that incorporated in young bivalves. (PAS reaction; 40x obj.).

the glycogen molecule is first broken down to glucose molecules which are then absorbed by the parasites and resynthesized as glycogen within their bodies. In addition to utilizing the host's hepatopancreatic glycogen, both mechanical and yltic damage to host cells are affected, the latter by cercarial excreta.

The data presented herein indicate that in the case of the sporocysts and cercariae of *Gorgodera amplicava,* which are not situated in the molluscan host's hepatopancreas but between the gill lamellae, the glycogen accumulated in the sporocyst walls and in the bodies of developing cercariae is not derived from the gill epithelium with which the parasites are in close contact since no demonstrable glycogen is present in such cells of infected *Musculium partumeium* and those of uninfected control bivalves. It is postulated that the parasites' glycogen is synthesized from the host's blood sugar since the gills are richly supplied with blood.

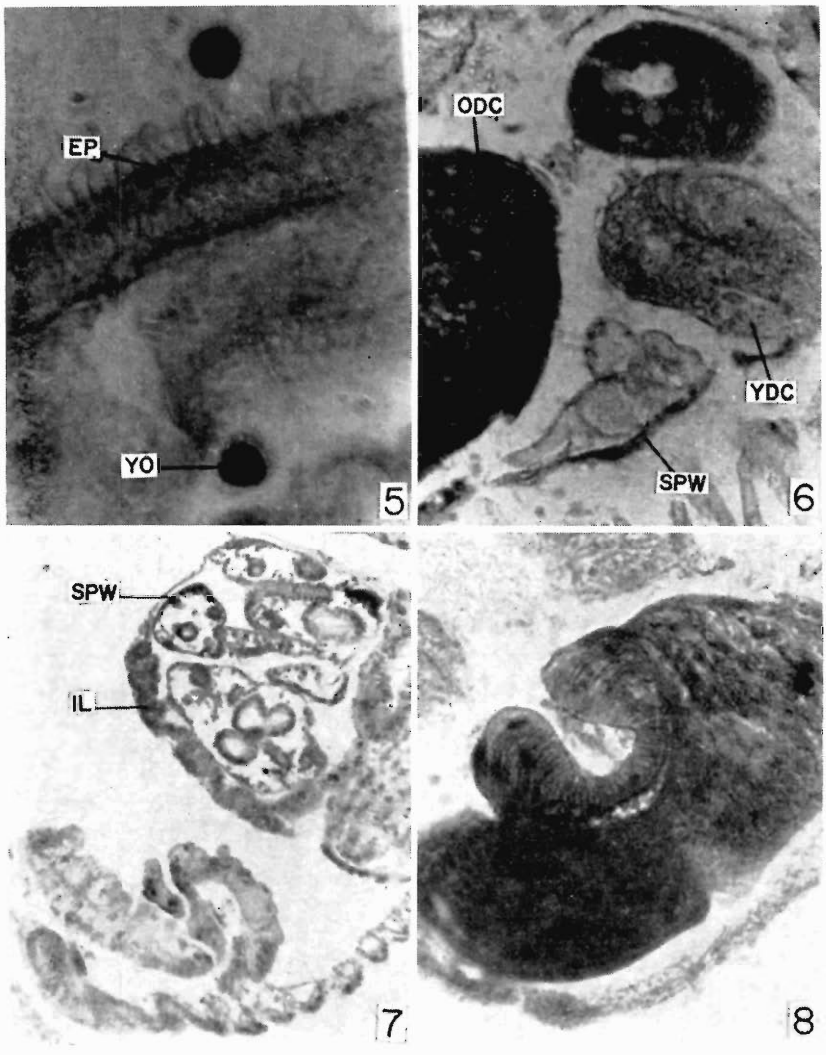
The accumulation of glycogen in the bodies of developing cercariae is quite apparent. As in the case of *Glypthelmins pennsylvaniensis* cercariae (see Cheng and Snyder, 1962a), the area of the developing suckers is extremely rich in glycogen. However, in fully developed cercariae, glycogen is not uniformly distributed throughout the cercaria as in *G. pennsylvaniensis,* rather the posterior portion of the body proper includes a greater concentration of the polysaccharide. Relative to the tail, the anterior cystic portion of the cystocercous cercaria only includes trace quantities of glycogen as does the elongate portion of the tail. These observations may be interpreted to mean that since the body proper is the only portion of the cercaria which continues to develop in the second intermediate host as the metacercaria while the tail is lost, the physiological need for a stored carbohydrate source in the tail is not present and hence very little glycogen storage is appreciated in this structure.

Relative to the histopathological picture, the damage inflicted by the larvae of *Gorgodera amplicava* on the gill lamellae of *Musculium partumeium* appears to be purely mechanical. No symptoms of cytolysis or necrosis are present in intact gill epithelia. Since it is known that the cytolytic effect of trematode larvae is contributed by the parasites' excreta (Faust, 1920; Hurst, 1927; Rees, 1934; Cheng and Snyder, 1962a), it appears reasonable that one does not find this type of destruction in the bivalve studied since the gill lamellae are continuously bathed in water and what excreta emitted by the parasites are immediately diluted and removed.

In the case of portions of gill epithelia which had been mechanically severed, symptoms of necrosis, *i.e.* decrease in staining affinities of cytoplasm and nucleus, occur. This condition, however, should not be attributed directly to the parasites, rather it is interpreted to represent cellular atrophy resulting from disaffiliation with the normal circulation and support associated with intact cells. This interpretation is favored despite the fact that it could be argued that even severed cells in the environment are presumably bathed in blood. Since it has been indirectly demonstrated that the parasites utilize nutrients in the blood, specifically blood sugars, it is suggested that the isolated cells are in unfavorable competition with the trematode larvae which are larger and more numerous.

SUMMARY

Sporocysts and free cercariae of *Gorgodera amplicava* are found in the water tubes between the inner and outer lamellae of both gills of *Musculium*



Photomicrographs

Fig. 5. Portion of ciliated edge of gill epithelium. Notice lack of PAS+ material in gill tissue but presence of PAS+ material in young bivalves. (PAS reaction; 90x obj.).

Fig. 6. Cross-section through sporocyst of *G. amplicava* showing deposition of PAS+ material in older developing cercaria and sporocyst wall and the lack of PAS+ material in young developing cercaria. (PAS reaction; 40x obj.).

Fig. 7. Cross-section through gill of *M. partumeium* showing *G. amplicava* sporocysts between inner and outer lamellae. Notice deposition of PAS+ material in sporocyst wall. (PAS reaction; 10x obj.).

Fig. 8. Longitudinal section through body of developing cercaria of *G. amplicava*. Notice presence of PAS+ material in area of sucker and heavy concentration in posterior portion of body. (PAS reaction; 40x obj.).

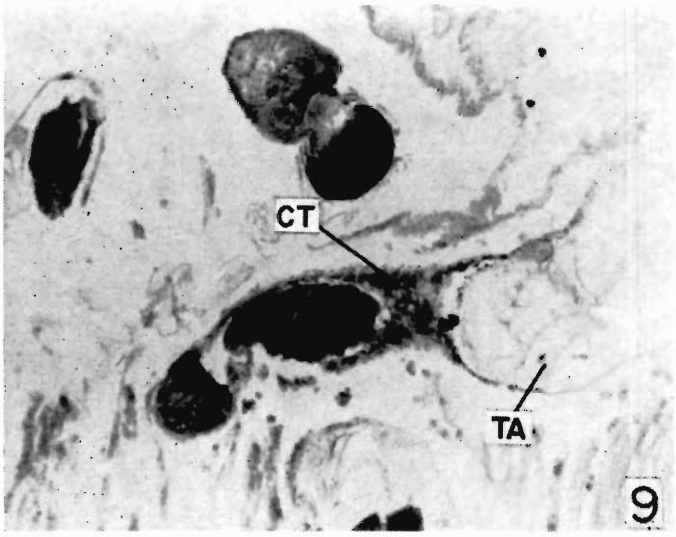


Fig. 9. Photomicrograph of longitudinal section through fully developed cercariae of *G. amplicava*. Notice heavy concentration of PAS+ material in body proper and less PAS+ material in cystic and elongate portions of tail. (PAS reaction; 10x obj.).

partumeium. Damage to the gill lamellae of *M. portumeium* caused by the larvae of *G. amplicava* is strictly mechanical in the form of distention of the inner and outer lamellae and occasional ruptures. Necrosis is only found in gill epithelia which had been mechanically severed. No glycogen is found in gill epithelia of infected and uninfected *M. partumeium*. Young clams are rich in a PAS-positive material which is not glycogen. Glycogen is present in the sporocyst wall and in the bodies of developing cercariae. The amount of glycogen in cercariae increases with the degree of development. Only trace quantities of glycogen are present in the cyst portion and in the elongate portion of the cystocercous cercariae. These portions are lost during metacercarial development. Glycogen found in the parasites is postulated to have been synthesized from the hosts' blood sugars.

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Helminths of North Carolina Vertebrates III. The Synonymy of *Phagicola diminuta* (Stunkard and Haviland, 1924) and *Phagicola lageniformis* Chandler, 1941 (Trematoda: Heterophyidae)*

GROVER C. MILLER and REINARD HARKEMA

The examination of raccoons from the coastal areas of North and South Carolina revealed large numbers of small heterophyid trematodes belonging to the *Phagicola-Ascocotyle* complex. These were identified as *Phagicola diminuta, P. longa* and a new species of *Ascocotyle*. The latter is being described in a separate paper. Studies on specimens of *P. diminuta* and the type specimens of *P. lageniformis* indicate to us that these two species are identical.

The status of *Phagicola* is still unsettled. Faust (1920) erected the genus *Phagicola* to contain *Phagicola pithecophagicola* a parasite from the intestine of the monkey-eating eagle (*Pithecophaga jefferyi*) of the Philippine Islands. Stunkard and Haviland (1924), apparently unaware of the description of *Phagicola* Faust, 1920, created the subgenus *Parascocotyle* of the genus *Ascocotyle* to include a new species from the rat. Witenberg (1929) raised *Parascocotyle* to generic status. Travassos (1930) followed Stunkard and Haviland and recognized two subgenera in *Ascocotyle;* however, he suppressed *Parascocotyle* as a synonym of *Phagicola* and included all previously described species in the genus *Ascocotyle* and arranged them in the two subgenera *Ascocotyle* and *Phagicola*. The original description of *Phagicola* was inadequate and Price (1932a, 1935), after studying the original material, validated the genus *Phagicola* even though Faust and Nishigori (1926) had transferred the original *Phagicola pithecophagicola* Faust, 1920, to the genus *Ascocotyle*. Price (1932a) also suppressed *Parascocotyle* but accepted *Ascocotyle* and *Phagicola* as distinct genera. Recently Hutton and Sogandares-Bernal (1958) re-established the genus *Parascocotyle* to include those forms which have—"an incomplete second

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row of from two to four accessory spines." Burton (1958) pointed out the close similarity of the genera *Phagicola* and *Ascocotyle* and gave an excellent review of the problem. He demonstrated that *Phagicola* can be separated from *Ascocotyle* only on the basis of the distribution of the vitellaria. Yamaguti (1958) also used this criterion. We concur with Price, Burton, and Yamaguti in accepting *Phagicola* and *Ascocotyle* as distinct genera.

Phagicola diminuta (Stunkard and Haviland, 1924) Price, 1932

Synonyms: *Ascocotyle* (*Parascocotyle*) *diminuta* Stunkard and Haviland, 1924. *Parascocotyle diminuta* (Stunkard and Haviland) Witenberg, 1929. *Phagicola lageniformis* Chandler, 1941, *Ascocotyle* (*Phagicola*) *diminuta* (Stunkard and Haviland, 1924) Stunkard and Uzmann, 1955.

P. diminuta was described by Stunkard and Haviland (1924) from *Rattus norvegicus*, collected on the waterfront in New York City. Apparently the specimens were not too good as they reported that the oral spines were missing in all the stained specimens. A single row of 16 oral spines was included in their description on the basis of observations on living specimens. They missed the two additional dorsal spines in the second row. This *lapsus* was corrected by Stunkard and Uzmann (1955) with a complete redescription of this form.

In the light of recent studies it now appears evident that *Phagicola lageniformis* is a synonym of *P. diminuta*. Chandler (1941) described *P. lageniformis* from specimens found "in moderate numbers only in one rat (muskrat), from Chambers County, Texas." Since *P. diminuta* was inadequately described at that time, Chandler was justified in describing a new species. Since then, however, Stunkard and Uzmann (1955) redescribed *P. diminuta* and Martin (1953) redescribed *P. lageniformis*. Both of the latter papers also gave clues to the life cycle. The information can best be summarized in tabular form as presented in table I. Variations in size and descriptions may be attributed to different degrees of worm maturity and to the various definitive hosts. A salient feature is the presence of 16 oral spines arranged in a single row with an additional two dorsal spines in a "second row."

In addition to the material shown in table I, there are other minor similarities which further substantiate the synonymy of *P. lageniformis* with *P. diminuta*. These are the cuticular spination, the diffuse eye spot pigment persistent in the adult, and the size of the oral spines. Also the arrangement of the seminal vesicle and seminal receptacle is practically identical. The available evidence on the life history is similar as shown in table I. In addition to the distribution shown in table I, *P. diminuta* has also been recorded from *Butorides* sp. from Puerto Rico (Price 1932b) and probably from the muskrat in Louisiana (Byrd and Reiber, 1942) although Byrd and Reiber identified it as *Phagicola nana* (Ransom, 1920). Hutton and Sogandares-Bernal (1960) recorded *P. diminuta* from the Florida cormorant and Louisiana heron as well as a new intermediate host, the Gulf killifish, *Fundulus similis*. Sogandares-Bernal and Bridgman (1960) record new definitive hosts as *Nycticorax nycticorax*, black-crowned night heron, from Florida and *Procyon lotor*, the raccoon, from Florida and Louisiana. Additional intermediate hosts are also given.

Table 1: Summary of Data Presented for Phagicola diminuta
(Measurements in Microns)

	Ascocotyle (Parascocotyle) diminuta Stunkard, Haviland, 1924	*Ascocotyle (Phagicola) diminuta* Stunkard, Uzmann, 1955	*Phagicola lageniformis* Chandler, 1941	*Phagicola lageniformis* Martin, 1953	*Phagicola diminuta* (this paper)
Length	250-300	200-440	450-630	250-560	422-538
Width (max.)	80-100	110-240	230-260	200-310	163-218
Oral sucker	37-45	25-42	44-55	37-68	46-56
Length with oral cecum	90-100	——	90-140	70-140	99-129
Pharynx	24-32 × 21-24	19 to 25	33-38 × 30-33	28-46 × 19-34	36-46 × 36-43
Esophagus	20 to 25	——	very short	usually shorter than pharynx	13-23
Ceca	to posterior level of acetabulum	to posterior level of acetabulum	not traceable beyond acetabulum	to posterior level of acetabulum	to posterior level of acetabulum
Acetabulum	38 to 43	30 to 40	40 to 50	28-46 × 37-56	40-46 × 50-53
Rt. Testis	19-24 × 20-33	30-50 × 40-70	35-60 × 70-90	37-62 × 56-99	46-59 × 53-73
Lt. Testis	same	same	same	31-62 × 62-99	36-53 × 53-56
Ovary	22 to 32	30-35 × 40-56	slightly smaller than testes	31-62 × 55-110	40-46 × 40-46
Eggs	20 × 12	16-20 × 10-11	20-21 × 10-12	16-17 × 8-11	17-20 × 10-13
Oral Spines	16-single row (error-corrected, 1955)	16 + 2 dorsal	16 + 2	16 + 2	16 + 2
Gonotyl	(?) genital pore preacetabular, sinus elongate transversely	variable, protrusible, with small spines probably six	——	thick-walled, folded Structure, may serve as gonotyle	thick-walled sinus, elongate transversely
Vitellaria	few large follicles front of and lateral to testes	illustrated as lateral to testes and slightly anterior to testes	two groups, usually 7 follicles each	irregular follicles lateral to testes	irregular follicles lateral to testes reaching to ovary
Definitive Hosts	*Rattus norvegicus*	Rats, mice, hamsters, gulls, herons	muskrat	chicks	Raccoons, gulls
Intermediate Hosts	——	*Fundulus heteroclitus* *Fundulus majalis*	——	*Fundulus pallidus*	——
Location	New York City	Milford, Conn.	Southeast Tex.	Brownsville, Tex.	Coastal North and South Carolina

On the basis of the evidence presented, *Phagicola lageniformis* Chandler, 1941 is considered a synonym of *Phagicola diminuta* (Stunkard and Haviland, 1942). Sogandares-Bernal and Bridgman (opp. cit.) mentioned that on morphological grounds there is little doubt that *P. diminuta* and *P. lageniformis* are identical but they chose not to take a stand regarding the synonymy because of the possibility of physiological species. Utilizing the key to the genus *Phagicola* provided by Burton (1958), *P. diminuta* will key out as *P. lageniformis*. There are at least five illustrations of *P. diminuta* by the authors mentioned above; therefore, further illustration seems unnecessary.

SUMMARY

The genus *Parascocotyle* Stunkard and Haviland, 1924 is regarded as a synonym of *Phagicola* Faust, 1920. *Phagicola lageniformis* Chandler, 1941 is synonymized with *Phagicola diminuta*. New localities, Coastal North and South Carolina, are reported for *P. diminuta*.

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The Genera *Gyrocoelia* Fuhrmann, 1899 and *Infula* Burt, 1939 with Observations on the Histochemistry of the Egg Membranes.*

WILLIAM H. COIL**

A number of the cestodes parasitizing Charadriiform birds, and their allies, lack the typical vaginal opening (the vagina may be completely lacking) common in other tapeworms found in the order Cyclophyllidea. Almost without exception, these worms which lack the vagina or vaginal opening, possess an oversized cirrus and, just as in the case of some other taxa of tapeworms, the genitalia may be paired with various degrees of completeness. But, probably the most interesting feature of these bizarre worms is the dioecious condition found in a number of the species. About the only reliable criterion available at the present time to show general relationships among these diverse worms is the fact that they parasitize birds, some of which are more or less closely related.

These cestodes which lack the complete vagina and/or which possess the dioecious condition have been placed in at least three different families (Acoleidae Ransom, 1909, Diploposthidae Poche, 1926, and Dioecocestidae Southwell, 1930). As one might expect in groups with poorly defined relationships, some of the genera have been shifted from family to family and, in consequence, we are still seeking clear-cut criteria which might be useful in indicating relationships.

The two genera discussed in this study (*Gyrocoelia* Fuhrmann, 1899 and *Infula* Burt, 1939) have been placed in the families Dioecocestidae and Acoleidae. Yamaguti (1959) included them in the former family. A superficial examination of the specimens relegated to these two genera would indicate that they differ mainly in the nature of the rostellum. Representatives of the genus *Gyrocoelia* bear a capitate rostellum which carries a unique zig-zag row of hooks (Fig. 3), while worms in the genus *Infula* have an unarmed rostellum (Fig. 4). However, a close examination of the egg membranes and other features revealed differences certainly of the generic level and possibly of importance in separating the higher taxa.

The genus *Gyrocoelia* apparently contains about eight species some of which are poorly known and therefore of doubtful status. The case of *G. milligani* Linton, 1927 is typical of the genus. Here we have a problem complicated by an inadequate description and incomplete type material. Cable et al (1956) reviewed the history of *G. milligani* and noted that it might be conspecific with *G. pagollae* Cable and Myers, 1956.

The genus *Infula* contains only the two species: *I. burhini* Burt, 1939 from Ceylon and *I. macrophallus* Coil, 1955, collected in Mexico.

For this study specimens of *Gyrocoelia pagollae* were collected from the Wilson Plover (*Charadrius wilsonia*) taken in North Carolina and Texas. *Infula macrophallus* was collected from the Black-necked Stilt (*Himantopus mexicanus*) taken in Texas.

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METHODS

Worms for this study were taken from freshly-killed or iced hosts and placed in saline or sea water. Promptness was essential in order to avoid the loss of the rostellar hooks which loosen within 10 or 20 minutes after the death of the host in warm climates. Carnoy's alkaline formalin, and corrosive sublimate were used as fixatives. Storage was in 70 percent ethyl alcohol. Sectioned material was treated with the following stains a) Heidenhain's iron haematoxylin (Iron Haem.), counterstained with fast green, b) Azure B (Az. B) buffered at pH 4.0 and differentiated in tertiary butyl alcohol overnight, c) Toluidine blue (Tol. Bl.) dehydrated in acetone and cleared in cedarwood oil and xylene, d) Periodic acid Schiff (PAS), e) Feulgen nucleal method for DNA, f) Methyl green-pyronin, g) Malachite green dehydrated in the ethanol series with prolonged destaining in 100 percent alcohol. Ribonuclease (RNase) was prepared from malt diastase. Specimens for whole mounts were stained in Harris' haematoxylin and Semichon's carmine and mounted in piccolyte. All measurements are in millimeters.

THE GENERA *Gyrocoelia* and *Infula*

SCOLEX: In the genus *Gyrocoelia,* the scolex is a unique structure, capitate in shape and armed with a zig-zag row of hooks (Fig. 3). The row of hooks is composed of 6 "V"'s and apparently, this number does not vary. There seems to be, consistently, an "anchor hook" in the angles of the "V". The anchor hooks at the anterior end are shorter than those at the posterior end. Some variation in the total number of hooks seems to occur. As many as five hooks were counted between the anchor hooks on one side of the "V". If this pattern were constant around the entire rostellum, *G. pagollae* would possess 72 hooks. As few as three hooks were counted on one side of a "V", but this was not the pattern for that rostellum. In some cases there were different numbers of hooks in the adjacent "V"'s, but this number varied only by a single hook.

The hooks are lost very easily and it is not unusual to find the rostellum completely bare in specimens which have remained in the intestine of the host for more than 30 minutes after the death of the host. In order to obtain the worms in the best possible condition, some worms were removed from the bird's intestine in the field and fixed immediately.

Cable and Myers (1956) described the rostellum of *G. pagollae* as armed with 66 hooks. In view of the results obtained here from a study of more extensive material, it seems very likely that the number of hooks would be a number within 10 digits of 66.

The rostellum of *Infula* is rudimentary and unarmed. Typically, it is a fusiform structure which appears to be nonprotrusible (Fig. 4).

FEMALE REPRODUCTIVE SYSTEM: In both of these genera the female system develops early with no sign of testes in the female strobila at any stage. A typical vagina is lacking and there is no evidence or trace of it during the development of the worm. The uterus is annular in shape and it develops quite early. The uterine primordia can be seen as a string of cells forming a circle around the ovary and vitelline gland.

Both genera possess the large and powerful cirrus in the female strobila. In the very early development of the proglottid, a thin, delicate duct (or primordium of a duct) connects the proximal end of the cirrus with the thin-walled seminal receptacle which is located in the region of the vitelline gland.

In the case of *G. pagollae,* the duct from the cirrus to the seminal receptacle leads from the proximal end of the cirrus directly posteriorly to the seminal receptacle which is a bifid structure (Fig. 8). *I. macrophallus* possesses a connecting duct which circles around the primordial uterus and leads into the seminal receptacle from its aporal end (Fig. 7). Here the seminal receptacle is a simple tubular structure which undulates around the Mehlis gland. The duct which connects the seminal receptacle and the cirrus is very thin and therefore difficult to see. It seems only a remote possibility that it functions in the reproduction of these worms (Coil, 1955). When the proglottids are somewhat older, the duct is no longer visible. It may well be that we have here a vestigial organ which is a holdover from other times and/or conditions. It is difficult to speculate how this condition might be compared with those species of *Gyrocoelia* (*G. perrersa*) in which the dioecious condition is not clear-cut.

As with most other cestodes of birds, the primordium of the cirrus appears early in the development of the proglottid and the cirrus is retained, apparently unchanged, in the fully gravid segments. Except for the uterus and cirrus, other reproductive organs are missing from the gravid segments. The retention of this plainly male organ in the female proglottid is something of a curiosity.

EGG MEMBRANES (Table No. 1)
Gyrocoelia pagollae Cable and Myers, 1956 (Fig. 2)

OUTER MEMBRANE: During the development of the oncosphere a thin outer membrane is formed from the vitelline globules. Apparently, the outer membrane is formed by a quinone tanning system which is common to most cestodes and trematodes. Johri et al (1956) and Ogren (1959) have noted that both malachite green and bromphenol blue combine with and stain the basic proteins which occur in both the vitelline globules and in the outer membrane of the oncosphere before the tanning is complete.

The outer membrane here stained with PAS and fast green in the mature oncosphere, and, in the case of the young oncosphere, the outer membrane stained with malachite green. Just inside the outer membrane there are PAS positive granules.

When the eggs are passed in the feces, this outer shell is usually lost. In life, the shell is ballooned out into a very thin, transparent, and permeable membrane; however, during the preparation of sectioned materials, it loses this turgid appearance and becomes shrunken and wrinkled.

These findings are partly in contrast to those of Ogren (1959) who noted that the shell in the mature oncosphere still stained intensely with "bromphenol blue, green with malachite green, purple to dull red with the allochrome periodic acid Schiff procedure, and bright red with the aniline acid fuchsin procedure" in *Dilepis undula.*

COLLOIDAL AREA: Just under and apparently connected to the outer shell is the colloidal layer (Ogren, 1959). This layer is negative to azure B, but positive to toluidine blue and PAS (light). Since the response to these tests was either negative or weak, this is considered to be a case of simple basophilia. In the living worm, this area between the outer shell and the inner capsule is filled with hyaline, spherical bodies which give the general appearance of oil droplets. Ogren (1961) noted this layer in *H. diminuta,* and he observed the staining reactions in *Dilepis undula* (1959). He found this layer to be PAS positive and metachromatic. The large RNA granules char-

TABLE 1. Reactions of the egg membranes and associated parts to various staining reactions. The number of plus marks indicates the intensity of the staining reaction. VA, colloidal area; IC, inner capsule; OC, outer capsule. A key to the abbreviations of the various stains is found in the methods.

	PAS	PAS+ Saliva	Tol. Blue	Tol. Bl. +RNase	Azure B	Az. B+ RNase	Iron Haem.	Fast Green
Gyrocoelia pagollae Cable and Myers, 1956								
Outer Capsule	+	+	+	+	−	−	−	+
OC granules	+	+	−	−	−	−	−	+
Colloidal Area	+	+	++	+	−	−	−	−
CA granules	−	−	−	−	−	−	−	−
Inner Capsule	−	−	−	−	−	−	−	+
IC layers	+	+	−	−	−	−	+	−
Inside IC								
Polar granules	+	+	+	−	+	−	−	−
Polar nuclei		−	−	+	+	+	+	−
Oncosphere	+++	+	++	+	++	+	+	+
Infula macrophallus Coil, 1955								
Outer Capsule	+	+	−	−	−	−	−	+
OC granules	+	+	−	−	−	−	−	−
Colloidal Area								
Outer layer	+	+	−	−	−	−	−	−
Inner layer	++	+	+	−	+	−	−	+
Inner Capsule								
Cylinder	−	−	−	−	−	−	−	−
Plugs	−	−	−	−	−	−	+	−
Cups	−	−	−	−	−	−	−	+
Inside IC								
Polar nuclei	−	−	+	+	+	+	+	−
Oncosphere	+++	+	++	+	++	+	+	+

acteristic of the colloidal layer in *Infula* are not found here.

INNER CAPSULE: The origin of this membrane, apparently, is from "macromeres situated outside the morula. They enclosed the morula, providing an early protective layer. Later, however, these macromeres lost their visible cytoplasm and their nuclei become part of the granular capsule enclosing the developing oncosphere." (Ogren, 1959). This is a heavy and relatively thick membrane (0.0024 in the living egg) which is ellipsoidal in shape. It stains only with fast green. In some instances irregular layers of material (azure B and PAS positive) are found on the outside of the capsule, but they did not appear to be a part of the capsule.

On the inside and at each end of the inner capsule there are granules (called polar granules here) which appear to be associated with the degenerate nuclei alluded to in Ogren's quotation above. In order to test this hypothesis, sections were subjected to acid hydrolysis and Feulgen's fuchsin; a test for DNA. The positive reaction to this test indicated that some of the granules were of nuclear origin or were nuclei. In the same polar region with the nuclear material is another type of granule. There is a large quantity of other granular material. These granules were determined to be RNA by the use of toluidine blue, azure B, malt diastase ribonulease and appropriate control slides (Lillie, 1954). Ogren (1957) noted that the inner capsule is composed of a "protein gel" and it is expected that the residue of nuclei and cytoplasm from the macromeres which form the inner capsule should contain considerable quantities of RNA (used in protein synthesis).

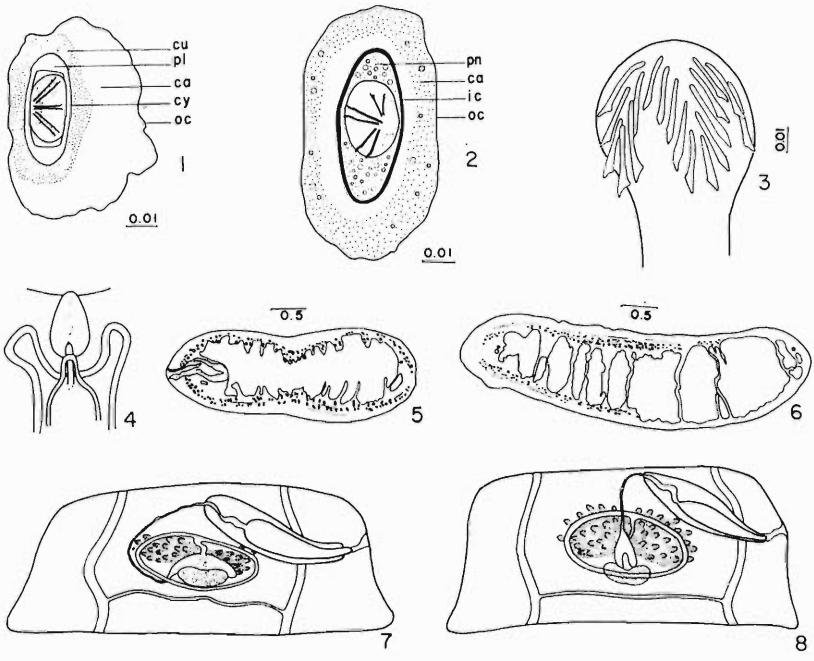

Fig. 1. Egg of *Infula macrophallus* drawn with the aid of a camera lucida.
Fig. 2. Egg of *Gyrocoelia pagollae* drawn with the aid of a camera lucida.
Fig. 3. Rostellum of *Gyrocoelia pagollae*.
Fig. 4. Rostellum excretory ducts of *Infula macrophallus*. Freehand sketch.
Fig. 5. Cross section of gravid proglottid of *G. pagollae*.
Fig. 6. Cross section of gravid proglottid of *I. macrophallus*.
Fig. 7. Freehand sketch of very young female proglottid of *I. macrophallus*.
Fig. 8. Freehand sketch of very young female proglottid of *G. pagoilae*.
Abbreviations: CA, collodial area; CU, cup; CY, Cylinder; IC, inner capsule; OC, outer capsule; PL, plug; PN, polar nuclei, and granules.

Infula macrophallus Coil, 1955 (Fig. 1)

The eggs of the two specimens studied here exhibit several differences. Morphologically, the main difference is the size and shape of the inner capsule and in the size of the glands of the oncosphere. Histochemically, there are a number of differences to be noted in the reactions of the various egg membranes. These will be noted below.

OUTER MEMBRANE: The outer membrane here differs from that of *G. pagollae* in that it is negative to toluidine blue. This reaction does not seem completely untoward when one considers the capricious nature of this stain. The presence of basic proteins in the vitelline gland and in the outer membrane of the young oncosphere was not demonstrated with malachite green. There is no reason to believe that this reaction was not due to faulty techniques.

COLLOIDAL AREA: The area between the outer and inner membranes is composed of two layers which are greatly different. The outer layer appears to be almost homogeneous and it colors only with PAS; it was clearly negative to the other stains used. The inner layer shows a contrast to this in that it

is composed of both large and small granules and other finer materials which are positive to PAS, toluidine blue, azure B and fast green. When subjected to saliva for 15 minutes at room temperature, the PAS positive parts were removed indicating that at least glycogen is present in this inner layer. The large and small granules in the inner layer which stained dark blue were determined to be RNA with the use of RNase. The enzyme was prepared from malt diastase according to Lillie (1954). The sections were incubated at 50° C for about 40 minutes. The removal of the fraction which stained with toluidine blue and azure B by the enzyme RNase, in contrast to appropriate control slides, is considered to be good evidence that this fraction is composed of RNA.

INNER CAPSULE: The capsule here can be divided into three parts on the basis of staining reactions. The capsule itself is composed of two main parts. I have given the following names to these structures: The central part or cylinder which surrounds the oncosphere, the rounded plugs at each end of the cylinder, and the cups which are external to and attached to the plugs.

The cylinder did not react to any of the stains used here. The plugs stained only with Heidenhain's iron haematoxylin. The plugs do not appear to be a separate unit from the cylinder except by the use of this stain. Polar to each of the plugs are the cups which stain only with fast green. The cup is homogeneous and it is not greatly dissimilar in shape to a common sucker. There is little evidence here to use in speculation as to the formation or function of the inner capsule and the cups.

In the case of *Infula,* the RNA granules which are polar to the oncosphere and inside the inner capsule, appear to be lacking. However, there are one or two small spots of material which gave the same reactions as the nuclear remnants which were noted in *Gyrocoelia.* This is considered to be one of the very significant differences between the oncospheres of these two genera.

When saliva is used to remove the large amounts of PAS positive materials (mainly glycogen) from the oncospheres, one can see two large glands. The glands contain numerous, large granules positive to PAS and toluidine blue. The main difference here between the two genera lies in the size of the glands. Comparatively, in *Infula* they are much larger. Both oncospheres contain a large amount of RNA in granular form.

The muscles are of little help in differentiating these two genera. From the cross sections of the gravid proglottids, it was apparent that there are two layers of large, longitudinal muscle bundles (Figs. 5, 6).

Cable and Myers (1956) reviewed the systematic position of *Gyrocoelia* and they lamented, along with others, the unsatisfactory state of the taxonomy of the Acoleidae. They suggested the use of life history studies to gain evidence of relationships. Ogren (1957) has established the fact that various families of cestodes may have characteristic oncospheres and egg membranes. In view of this and the information presented in this study, it is felt that the genera *infala* and *Gyrocoelia* belong to different taxa higher than the generic level. Further investigations are now underway on other dioecious cestodes to determine whether the morphology of the oncosphere can be used in the formulation of a more natural classification.

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Trichostrongylus longispicularis in Cattle from California

MARY TERESA MULLEE*

In December 1961 four of the feeder cattle autopsied in an anthelmintic trial at the University of California six days post-treatment were found to have harbored the nematode *Trichostrongylus longispicularis*. The animals had been previously purchased from a ranch in the Orland area, Glenn County, California. The cattle had been ranged on irrigated pasture. The original source of the cattle is not known.

It is believed that this is the first report of the natural occurrence of *T. longispicularis* in cattle in California.

One year after the description of *T. longispicularis* from sheep in Australia by Gordon (1933), Andrews (1934) first reported the same species from the abomasum of cattle in Jeanerette, Louisiana and on an additional specimen sent to him from the abomasum of a cow from Florida (Andrews, 1935). The third report of the occurrence in the United States of this nematode appeared in 1956. Animals from a New Mexican herd of barbary sheep, an exotic animal but resident in the United States for years, bore *T. longispicularis* at postmortem (Allen *et al.*, 1956). Georgia and Mississippi are listed by Becklund (1958) and Knight (1962) respectively as the other areas of America in which *T. longispicularis* has been isolated from cattle.

Gordon (1933), Roberts (1938, 1939), and Sommerville (1956) record the presence of *T. longispicularis* from Australia. Sommerville (*op. cit.*) stated that it was common in certain areas and can occur as a pure infection.

Rose (1959, 1960) added *T. longispicularis* to the list of gastro-intestinal parasites of cattle in Britain.

Lai and Palmas (1957) and Palmas (1957) were the first to publish the incidence of *T. longispicularis* in continental Europe. They encountered *T. longispicularis* in cattle at various times of the year in Sardinia. However, it apparently had been recognized earlier in Europe as Sarwar, (1956) states that Dr. R. Sivieretra of the Institute of Parasitology and Parasitic Diseases, Utrecht, Holland, had showed him specimens which had been collected from Holland.

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This study was conducted as part of Western Regional Project (W-35), "Nematode Parasites of Ruminants," and supported in part by regional research funds of the USDA. This investigation was carried out during the tenure of a predoctoral fellowship from the Division of General Medical Sciences, United States Public Health Service.
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Sarwar (1956), as Gordon (*op. cit.*), lists the sheep as a host. He includes *T. longispicularis* among the parasites of ruminants from the Indo-Pakistan subcontinent and referred to Schulz and Kadenatazii (1950) who list the Far Eastern goral as a host in Russia.

CALIFORNIA SPECIMENS: The worm burden of the four cattle ranged from 27,500 to 96,400 nematodes in the abomasa and 5,270 to 54,600 trichostrongyles in the small intestines. The number was determined by a sample dilution method.

Ostertagia ostertagi was the predominant species in the abomasa, while *Cooperia punctata* was the nematode which occurred in the largest number in the small intestines. *Cooperia oncophora* in the small intestines and *Trichostrongylus axei* in the abomasa were present in small numbers. *T. longispicularis* was only sparcely represented. Thirty-three specimens of *T. longispicularis* were identified from 1185 male trichostrongyles randomly selected from the four animals. One male worm was encountered in the abomasal sample of one of the infected cattle. No attempt to speciate females was made.

The measurements of the 33 California specimens are as follows: total length 4.7 to 6.5 mm, mean 5.7 mm; body width immediately anterior to bursa 73.3 to 126.7 microns, mean 105 microns; width of head 6.7 to 13.3 microns, mean 10.1 microns; length of right spicule 163 to 193 microns, mean 176 microns; length of left spicule 163 to 200 microns, mean 184 microns; and length of gubernaculum 83 to 103 microns, mean 93 microns. The measurements were in agreement with previous reports.

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Three New Species of *Belonolaimus* (Nematoda: Tylenchida) with Additional Data on *B. longicaudatus* and *B. gracilis*.

GEORGE J. RAU*

The genus *Belonolaimus* was established by Steiner in 1949 with *B. gracilis* as the type species. A second species, *B. longicaudatus*, was described by Rau in 1958. In 1961 Rau redescribed both these species from specimens collected at the type and other locations. In these collections, three new species of *Belonolaimus* were found** These are described herein and measurements of new collections of *B. longicaudatus* and *B. gracilis* are given.

Belonolaimus euthychilus n. sp.† (Fig. 1 A-L)

MEASUREMENTS OF FEMALES:†† Length 1.850 ± 0.113 ml. (1.426-2.094 mm.). a = 45 (39-62); b = 5.7 (5.2-6-1); c = 20 (15-27). V = 53% (50-57%). Stylet = 154 ± 7 microns (131-168 microns).

The length of the body anterior to the vulva is 0.985 ± 0.064 mm. (0.762-1-122 mm.); and length posterior to the vulva is 0.865 ± 0.060 mm. (0.684-1.002 mm.). The length of the complete stylet is 154 ± 7 microns (131-168 microns); the length of the prorhabdions is 114 ± 6 microns (95-126 microns); and length of the meso- and metarhabdions is 40 ± 2 microns (35-45 microns). Tail length is 88 ± 10 microns (56-148 microns). One hundred percent of the population have stylets as long as or longer than tails.

Total length, anterior length, posterior length, stylet length, tail length, and percentages are the averages for 192 females; the measurements of the stylet, together with its parts, are averages for 130 females and a, b and c are averages for 62 females.

MEASUREMENTS OF MALES: Length—1.5 mm. (1.0-1.7 mm.); a = 50 (39-59); b = ?; c = 18 (14-25). These are the averages for 57 males. The tail was measured laterally along the chord.

DESCRIPTION: Female annulation 2.4 microns wide anteriorly, 1.6 microns in the caudal region. Lip region not set off from body, bearing 9 to 11 annules and a terminal cap. Male lip region set off by a deep constriction, oval shaped, with 9 to 11 annules and a terminal cap. Female stylet with rounded basal knobs, 2.1 microns by 6.4 microns; dorsal gland outlet approximately 3.5 microns from base of stylet; median esophageal bulb 19 microns (17-21 microns) wide by 20 microns (18-21 microns) long, that is, nearly spherical. Male stylet rudimentary, the forward part apparently a meandering tube which is generally indistinct, the posterior extension poorly developed with weak basal knobs. Median bulb and esophagus poorly developed, the median bulb showing only sclerotized valve structures. Female hemizonid two or more annules long, anterior to excretory pore; excretory pore less conspicuous than hemizonid, 235 microns (195-251 microns) from anterior end. Male hemizonid readily seen, two or more annules long, immediately anterior to excretory pore; excretory pore 180 microns (151-213 microns) from anterior end. Ovaries didelphic, outstretched, anterior ovary 23%, posterior ovary 28% of total body length; spermathecae apparently weakly developed or

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**In 1960 Colbran described a species, *Belonolaimus hastulatus*, having a total length of 920 to 1110 microns, a stylet 30-33 microns long, and four incisures in each lateral field. Since these characters are at variance with those of the type species of the genus, *B. hastulatus* should probably be placed in another genus.

†From the Greek euthys = straight and chilus = lip.

‡Here and elsewhere in this paper, the first figure is the average and the figures in parentheses are the minimum and maximum; the figure preceded by ± is the standard deviation.

absent. No opposing paired sclerotized pieces in the vagina. Testis outstretched. Spicules arcuate, 31.8 microns (28.0-39.2 microns) long measured laterally on chord of arc. Gubernaculum 14.7 microns (11.2-16.0 microns) long with a short anterior flexure 2.9 microns (1.4-4.2 microns) long. Female tail hemispherical with the terminus 8.4 microns (7.0-9.8 microns) from the protoplasmic portion of the tail. Tail length 2.7 (1.6-3.8) times anal body width; phasmid 58 microns (48-67 microns) from tip of tail. Male tail (measured laterally along the chord) about 2.5 times longer than anal body width. Phasmid 44 microns (35-53 microns) from tip of tail. Lateral alae in the adults appear as one line extending from the lip region to terminus of tail in both sexes.

IMMATURE STAGES: Larval stages emerge from eggs with three lateral lines, the central line extending from the tip of the head to the end of the tail, the other two beginning twelve to eighteen annules from the neck and extending to the end of the tail. Larvae emerge from the eggs after 4 or 5 days at room temperature.

HOLOTYPE: Female collected by Rau December 12, 1958.

ALLOTYPE: Male from same collection as holotype.

Both deposited in the U. S. Department of Agriculture Nematode Collection, Beltsville, Maryland. Slide Nos. *T-28t* and *T-29t*, respectively.

PARATYPES: Data same as holotype. Also deposited in the U. S. Department of Agriculture Nematode Collection, Beltsville, Maryland, and the Nematode Collection, Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABITAT: Around roots of *Pinus palustris* Mill. growing on Lakewood sand, in which *B. gracilis* was also present.

TYPE LOCALITY: 150 feet south of State Highway 40, 11 miles west of Juniper Springs, Ocala National Forest, Florida.

ADDITIONAL HOSTS AND LOCALITIES: Collections made from the roots of *Pinus elliottii* Engelm. (*P. caribaea* Morelet) and *P. clausa* (Chapm.) Vasey in the same area as type locality on Lakewood sand (none found on *Pinus rigida serotina* Michx. and *Pinus taeda* L. growing in swamps or alluvial heavy soils). Common on the roots of *Pinus palustris* growing on Leon soil at Sanford, Paola, Rock Springs, Flagler, and Lake City, Florida. Common on the roots of *Quercus laevis* Walt. growing on Leon and St. John's soil at Paola and Rock Springs, Florida, and a street tree (*Quercus nigra* L.) Sanford, Florida. Collections made from roots of *Lobelia cardinalis* L. and *Carya cordiformis* (Wangenh) K. Koch at Flagler, Florida. Several hundred females, but no males, were found around the roots of *Pinus palustris* growing on St. Johns' soil at John's Island, near Charleston, South Carolina, October 12, 1959.

DIAGNOSIS: Female lip region not offset. Spermathecae apparently weakly developed or absent. All other described species of *Belonolaimus* with lip region offset and spermathecae generally well developed. Male stylet, stylet knobs, median esophageal bulb and esophagus rudimentary or poorly developed, gubernaculum with anterior flexure 2.9 microns (1.4-4.2 microns) long.

IMMATURE STAGES: *B. euthychilus* is separated from *B. longicaudatus* in the larval stages emerging from the eggs by the absence of constriction in the neck region and the central lateral line extending from the tip of the head to the end of the tail, while the other two lateral lines begin 12 to 18 annules from the neck and extend to the end of the tail. In larval stages of *B. longicaudatus* there is a constriction in the neck region and the central lateral line is present in the head, absent in the first 8 to 10 annules from

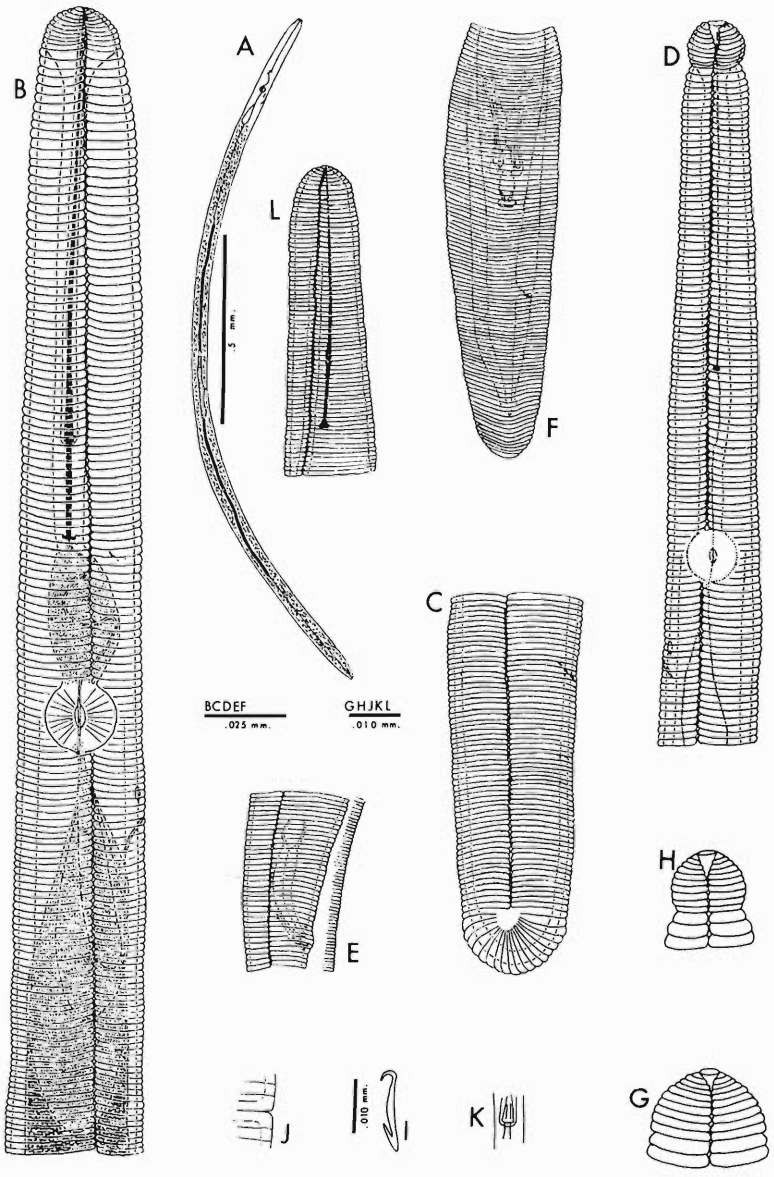

Figure 1. *Belonolaimus euthychilus*. A—Female. B—Anterior portion of female body. C—Female tail. D—Anterior portion of male body. E—Spicule and gubernaculum. F—Male tail, ventral view. G—Female lip region. H—Male lip region. I—Gubernaculum. J—Vulva. K—Thickened portion at base of forward stylet shaft. L—Anterior portion of larva after emerging from egg.

the head and begins again extending to the end of the tail; the other two lateral lines begin 40 to 50 annules from the neck constriction.

B. euthychilus is easily separated from *B. gracilis* by the qualitative characters but appears to be generally similar to it in the measurements of total, anterior, posterior, stylet and tail lengths. However, analysis of variance of these characters indicate the differences are significant at the 95% level.

Both the neotype collection of *B. gracilis* and the type collection of *B. euthychilus* were made from the roots of the same host, in the same locality and at the same time. It is interesting to note that the two species are very close to each other in their measurements of total, anterior, posterior, stylet and tail lengths as well as the measurements of their other body structures although they can be easily distinguished by their qualitative characters. It brings up the question as to whether convergent evolution has taken place in the quantitative characters or mutation is responsible for the changes in the qualitative characters.

Belonolaimus maritimus n. sp. (Fig. 2 A-J)

MEASUREMENTS OF FEMALES: Length 2.489 ± 0.173 mm. (2.052-2.994 mm.); a = 54 (43-67); b = 7.7 (6.6-8.7); c = 21 (17-24). V = 52% (47-56%). Stylet = 149 ± 7 microns (119-171 microns).

The length of the body anterior to the vulva is 1.303 ± 0.090 mm. (1.092-1.602 mm.); and length posterior to the vulva is 1.186 ± 0.098 mm. (0.960-1.500 mm.). The length of the complete stylet is 149 ± 7 microns (119-165 microns); the length of the prorhabdions is 107 ± 6 microns (87-119 microns); and length of the meso- and matarhabdions is 42 ± 2 microns (32-49 microns). Tail length is 120 ± 13 microns (83-155 microns). Ninety-eight percent of the population have stylets as long as or longer than tails.

Total length, anterior length, posterior length, stylet length, tail length, and percentages are the averages for 290 females; the measurements of the stylet, together with its parts, are averages for 194 females and a, b and c are averages for 96 females.

MEASUREMENTS OF MALES: Length—2.1 mm. (1.7-2.4 mm.); a = 59 (49-73); b = 7.6 (6.8-8.6); c = 17 (14-20). These are the averages for 38 males. The tail was measured laterally along the chord.

DESCRIPTION: Female annulation 2.4 microns wide anteriorly, 1.5 microns wide in the caudal region. Lip region set off from body by a shallow constriction, bearing 8 to 10 annules and a terminal cap. Male lip region semi-constricted, more conspicuous than in female bearing 8 to 10 annules and a terminal cap. Female stylet with rounded basal knobs approximately 2.8 microns by 7.0-8.4 microns; dorsal gland outlet about 2.8-4.2 microns from base of stylet; median esophageal bulb elongate 24 microns (21-28 microns) wide by 29 microns (24-32 microns) long. Male stylet 140 microns (129-153 microns) long with rounded basal knobs; median esophageal bulb elongate, 21 microns (15-28 microns) wide by 25 microns (21-29 microns) long. Female hemizonid two or more annules long anterior to excretory pore; excretory pore inconspicuous, about 248 microns from anterior end. Male hemizonid about two annules long, anterior to excretory pore, which is more conspicuous than in female and located 226 microns (207-241) from anterior end. Ovaries didelphic, outstretched, anterior ovary 18%, posterior ovary 17% of total body length, spermathecae approximately 126 microns anterior and 135 microns posterior to vulva, containing spermatoza. Vagina with large heavily sclerotized paired opposing pieces. Testis outstretched. Spicules arcuate, 50

microns (43-56 microns) long measured laterally on chord of arc; gubernaculum 21 microns (18-22 microns) long with anterior flexure 5.5 microns (4.2-7.0 microns) long. Female tail hemispherical; tail length 3.2 (2.6-4.3) times anal body width. Phasmid 80 microns (66-95 microns) from tip of tail. Male tail (measured laterally along the chord) about 4 times longer

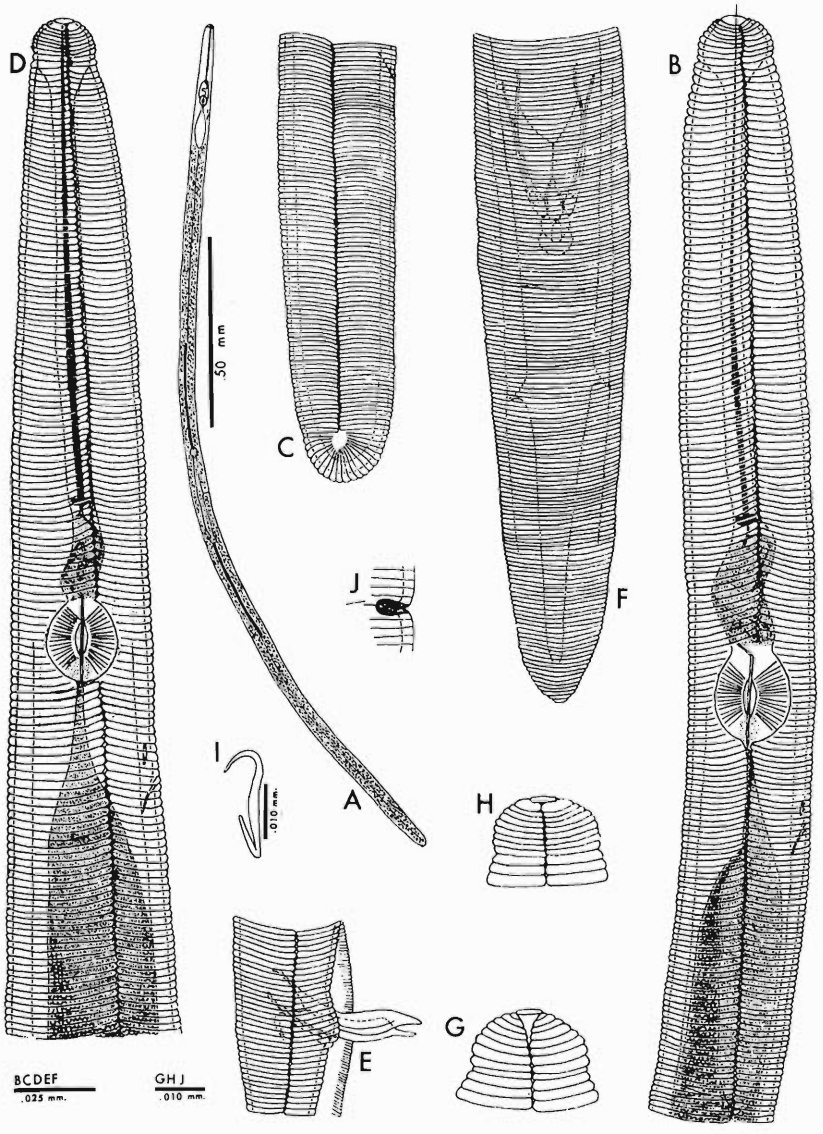

Figure 2. *Belonolaimus maritimus*. A—Female. B—Anterior portion of female body. C—Female tail. D—Anterior portion of male body. E—Spicule and gubernaculum. F—Male tail, ventral view. G—Female lip region. H—Male lip region. I—Gubernaculum. J—Vulva.

than anal body width. Phasmid 86 microns (62-116 microns) from tip of tail. Lateral alae in the adults appears as one line extending from the lip region to terminus of tail in both sexes (three lines in larval stage emerging from eggs). Larvae emerge from eggs after 4 or 6 days at room temperature.

HOLOTYPE: Female collected by Rau December 16, 1958.

ALLOTYPE: Male from same collection as holotype.

Both deposited in the U. S. Department of Agriculture Nematode Collection, Beltsville, Maryland. Slide Nos. *T-30t* and *T31t,* respectively.

PARATYPES: Data same as holotype. Also deposited in the U. S. Department of Agriculture Nematode Collection of Beltsville, Maryland, and the Nematode Collection of the Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABITAT: Around the roots of sea oats, *Uniola paniculata* L. growing on beach sand with large quantities of broken red coquina shell.

TYPE LOCALITY: Near highway 4.5 miles north of Daytona Recreation Pier on the beach side of the road.

DIAGNOSIS: *B. maritimus* is easily distinguished from most populations of *B. longicaudatus* by the shallow constriction separating the lip region from the rest of the body in both sexes. Sclerotization of the larger paired opposing pieces in the vagina tend to be more conspicuous in *B. maritimus* than in the weaker and smaller paired opposing pieces in the vagina of *B. longicaudatus.*

In the type population approximately 98% of the specimens have stylets as long or longer than the tails. Other populations from sea oats growing in sand with large quantities of red crushed coquina shell where the stylets were as long as or longer than the tails were collected from the type area August 8, 1960, 98% (n = 46), a few miles south of type area August 8, 1960, 100% (n = 19). Other populations from sea oats growing in either damp smooth gray or white sand with large quantities of crushed shell made at Edisto and Pawley Beach, South Carolina, showed 100% (n = 37), and 98% (n = 61) with stylets as long as or longer than tails, respectively. Three out of four populations from Bull's Island, South Carolina, where the damp smooth gray sand contains large quantities of crushed shell had 94.7% (n = 52), 92.9% (n = 14), 82.3% (n = 55) with stylets as long as or longer than the tails, respectively. In the Bull's Island populations approximately 4% of the populations had deformed and shorter tails than usual.

In *B. longicaudatus* most of the populations have lip regions separated from the body by a deep constriction in both sexes. In the type and another population from corn growing on coarse large-grained white sand at Sanford, Florida, the stylets were longer than the tails in 6.7% (n = 15) and 5.9% (n = 136), respectively. In other collections from the Sanford area the following percentages with stylets longer than tails were found: from *Citrus* sp. 17% (n = 57), 10% (n = 10); *Magnolia virginiana* L. 10% (n = 10); *Apium graveolens* L. 9.5% (n = 21); unknown vegetable 4% (n = 25); *Pisum sativum* L. 0% (n = 7); unknown vegetable 0% (n = 21). Other populations of *B. longicaudatus* from widely separate areas were: *Gossypium hirsutum* L., Bullock County, Alabama, 0% (n = 14); *Arachis hypogaea* L., Nichols, S. C., 3.8% (n = 26); *Lolium multiflorum* Lam., Burlington County, N. J., 3.9% (n = 51); *Phaseolus vulgaris* L., West Palm Beach County, Florida, 8.7% (n = 140) (Lip region set off from body by shallow constrictions)*; *Zea mays* L., Tifton, Georgia, 11% (n = 73) and *Zea mays* L., Richardson farm, Holland, Virginia, 14% (n = 56) (tail convex-conoid)*.

*Rau, G. J. 1963. A study of variation in populations of *Belonolaimus longicaudatus* and *B. maritimus*. (In preparation).

Along the beaches in the damp, smooth, fine-gray sand and the damp, smooth, large-grained white sand, populations are present showing a continuing variation in the percentages of stylets as long as or longer than the tail lengths. Such populations may lead to confusion in the identity of *B. maritimus* in those few instances where *B. longicaudatus* show the shallow constriction separating the lip region from the rest of the body in both sexes, or the heavy sclerotized larger paired opposing pieces in the vagina. In addition, other populations are found in the damp, smooth,, fine-gray or white beach sands with ranges of 41% to 59% of the individuals with stylets as long as or longer than the tails, or to a lesser extent populations falling within the ranges of 31% to 69% that are also found in somewhat similar

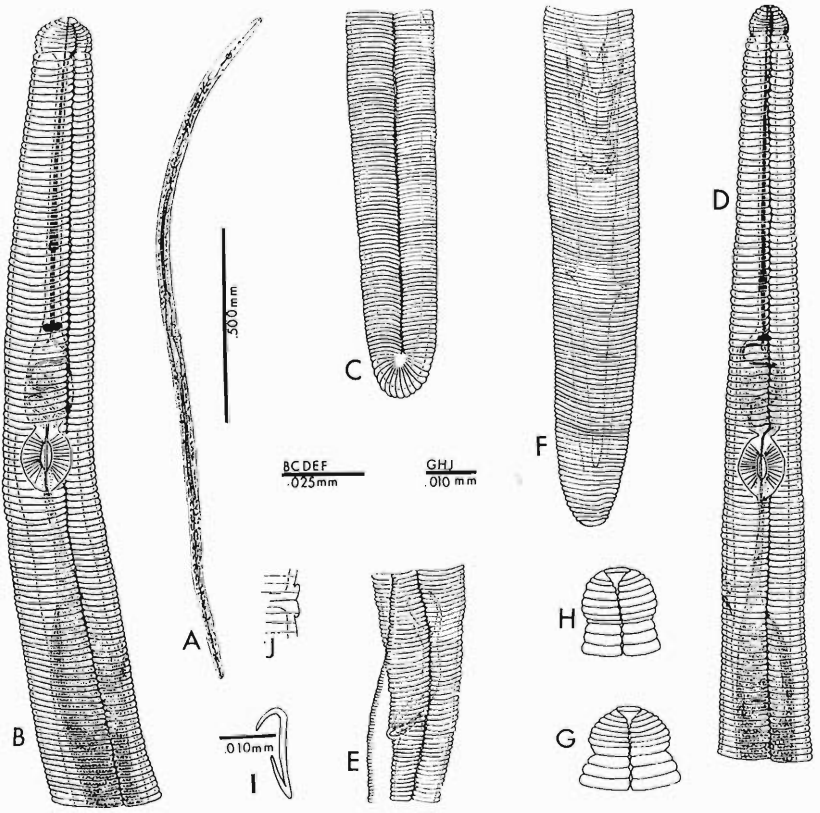

Figure 3. *Belonolaimus nortoni*. A—Female. B—Anterior portion of female body. C—Female tail. D—Anterior portion of male body. E—Spicule and gubernaculum. F—Male tail, ventral view. G—Female lip region. H—Male lip region. I—Gubernaculum. J—Vulva.

beach environments in the Daytona, Florida, Charleston, South Carolina and other seaside locations.

Many examples are found in the literature concerning animals where studies of large numbers of populations and individuals show the presence of continuous variation which may lead to intergradation among closely related species. Under such circumstances it has been found that the changes may represent convergent evolution. Such inferences would suggest that continuous variation may eventually lead to intergradation between *B. longicaudatus* and *B. maritimus,* if it has not already occurred in some instances, when exposed to suitable environmental conditions, which would be difficult to distinguish from the effects of interspecific hybridization.

It appears that *B. maritimus* is more tolerant to salt water or brackish conditions than *B. longicaudatus* since several genera of brackish-water nematodes are generally associated with it in the Ormond Beach area. The genera found associated with *B. maritimus* are *Choanolaimus, Eurystomina, Haliplectus,* an undescribed species of *Longidorella,* together with a few *Hoplolaimus.* On the other hand, mostly plant-parasitic nematode genera *Hoplolaimus, Pratylenchus, Tylenchorhynchus, Longidorus, Criconemoides* and *Meloidogyne* are found with *B. longicaudatus.*

Belonolaimus nortoni n. sp.** (Fig. 3 A-J)

MEASUREMENTS OF FEMALES: Length 1.854 ± 0.123 mm. (1.604-2.124 mm.). a = 58 (51-64); b = 8.0 (6.9-9.3); c = 17 (15-18). V = 50% (49-53%). Stylet = 90 ± 4 microns (78-98 microns).

The length of the body anterior to the vulva is 0.927 ± 0.061 mm. (0.786-1.020 mm.); and length posterior to the vulva is 0.927 ± 0.070 mm. (0.800-1.062 mm.). Tail length is 108 ± 11 microns (84-130 microns). Three and eight-tenths percent of the population have stylets as long as or longer than tails.

Total length, anterior length, posterior length, stylet length, tail length and percentages are the averages for 53 females and a, b and c are averages for 17 females.

MEASUREMENTS OF MALES (averages of 5 specimens): L = 1.6 mm. (1.5-1.7 mm.); a = 59 (54-62); b = 7.2 (6.6-8.2); c = 16 (15-17).

DESCRIPTION: Female annulation 2.2 microns wide anteriorly, 1.5 microns wide in caudal region. Lip region set off from body by a deep constriction, with 7 to 9 annules and a terminal cap. Male lip region also set off from body by a deep constriction, globular in shape, and bearing 7 to 9 annules and a terminal cap. Female stylet with rounded basal knobs 1.4 microns by 4.2 microns. Dorsal gland outlet approximately 2-2.8 microns from base of stylet. Median esophageal bulb elongate, 17 microns by 21 microns. Male stylet 87 microns (84-95 microns) long with weak rounded basal knobs; median esophageal bulb elongate, 15 microns by 18 microns. Female hemizonid two or more annules long, anterior to excretory pore. Excretory pore conspicuous, located 195 microns (170-206 microns) from anterior end. Male hemizonid about two annules long, anterior to inconspicuous excretory pore. Ovaries didelphic, outstretched, anterior ovary 22%, posterior ovary 22% of total body length; with spermathecae containing spermatoza. Vagina without sclerotized pair of opposing pieces; vulva with protruding lips. Testis outstretched. Spicules arcuate, 39 microns (36-41 microns) long measured lat-

**Named in honor of Don C. Norton, who first collected the species.

erally on chord of arc. Gubernaculum 16 microns (14-17 microns) long with anterior flexure 4.2 to 5.6 microns long. Female tail hemispherical; tail length 4.1 (3.4-4.7) times anal body width. Phasmid 78 microns (62-99 microns) from tip of tail. Male phasmid 73 microns (69-77 microns) from tip of tail. Lateral alae in the adults appears as one line extending from the lip region to the terminus of tail in both sexes.

HOLOTYPE: Female collected by D. C. Norton, April 23, 1959.

ALLOTYPE: Male from same collection as holotype.

Both deposited in the U. S. Department of Agriculture Nematode Collection, Beltsville, Maryland. Slide Nos. *T-32t* and *T-33,* respectively.

PARATYPES: Data same as holotype. Also deposited in the U. S. Department of Agriculture Nematode Collection, Beltsville, Maryland and the Nematode Collection, Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABITAT: Corn (*Zea mays*) field.

TYPE LOCALITY: Route 183, 7.8 miles south of Hochheim, DeWitt County, Texas.

DIAGNOSIS: Immediately separated from other species of *Belonolaimus* by the short stylet in both sexes, which reaches a maximum length of 97 microns (mean 83 microns), as compared with a minimum of 100 microns and a mean of 118 microns for *B. longicaudatus;* vulva with protruding lips; vagina without sclerotized pair of opposing pieces; stylet knobs weakly developed.

B. nortoni has the shortest stylet of all the species and populations of *Belonolaimus* thus far examined. Two other populations of sting nematodes received from Texas agree with this species with respect to the absence of the sclerotized pair of opposing pieces in the vagina. A population from Padre Island with the lip region set off from the body by a shallow constriction is close to the *B. longicaudatus* group whereas a population from Smith County over a hundred miles from DeWitt County appears to be similar to *B. longicaudatus* and *B. nortoni.*

SUPPLEMENTARY DATA ON *B. longicaudatus* and *B. gracilis*

The following are measurements of collections of *B. longicaudatus* and *B. gracilis* from the type localities and habitats which have not been reported previously.

B. longicaudatus Rau, 1958

MEASUREMENTS OF FEMALES: Length, 2.509 ± .170 mm. (1.986-3.012 mm.). a = 64 (55-74); b = 9.0 (7.2-12.6); c = 18 (13-21). V = 49% (46-54%). Stylet = 127 ± 4 microns (115-140 microns).

The length of the body anterior to the vulva is 1.227 ± 0.084 mm. (0.973-1.446 mm.); and the length posterior to the vulva is 1.282 ± 0.097 mm. (1.013-1.566 mm.). The length of the stylet is 127 ± 4 microns (115-136 microns); the length of the prorhabdions is 93 ± 4 microns (84-102 microns); and length of meso- and metarhabdions is 34 ± 2 microns (28-39 microns). Tail length is 154 ± 17 microns (115-189 microns). Five and nine-tenths percent of the population with stylets as long as or longer than tails.

Total length, anterior length, posterior length, stylet length, tail length, and percentages are the averages for 136 females and a, b and c are averages of 27 females.

B. gracilis Steiner, 1949

MEASUREMENTS OF FEMALES: Length, 2.014 ± 0.197 mm. (1.410-2.460 mm).

a = 49 (39-63); b = 6.7 (5.1-9.8); c = 23 (16-28). V = 55% (50-57%). Stylet = 151 ± 11 microns (99-175 microns).

Total length of the body anterior to the vulva is 1.059 ± 0.094 mm. (0.714-1.290 mm.); and length posterior to the vulva is 0.955 ± 0.111 mm. (0.636-1.314 mm.). The length of the stylet is 153 ± 10 microns (99-175 microns); the length of the prorhabdions is 113.9 ± 4 microns (98.0-133.0 microns); and length of the meso- and metarhabdions is 39 ± 3 microns (25-43 microns). Tail length 89 ± 14 microns (60-122 microns). One hundred percent of population have stylets as long or longer than tails.

Total length, anterior length, posterior length, stylet length, tail length, and percentages are the averages for 209 females; the measurements of the stylet, together with its parts are average for 155 females and a, b and c are averages for 54 females.

NEOTYPES: Deposited in the United States Department of Agriculture Nematode Collection. Slides Nos. T-38t and T-39t; holotype and allotype, respectively.

KEY TO THE SPECIES OF *Belonolaimus*

1. Stylets shorter than tails. (60-100% of the population) 2
   Stylets as long or longer than tails. (60-100% of the population) 3
2. Female stylet length 90 microns (75.6-96.6 microns) long. Vulva with protruding lips. Male stylet less than 97 microns long ..... *nortoni* n. sp.
   Female stylet length 127.2 microns (116.0-140.0 microns) long. Lips of vulva not protruding. Male stylet more than 100 microns long ..... *longicaudatus* Rau
3. Female lip region not separated from body by construction. Spermathecae apparently weakly developed or absent. Male stylet, stylet knobs, median bulb, and esophagus rudimentary or poorly developed, anterior flexure of gubernaculum 2.9 microns (1.4-4.2 microns) long ..... *euthychilus* n. sp.
   Female lip region separated from body by a definite constriction. Spermathecae generally well developed. Male stylet, stylet knobs, median bulb and esophagus well developed, anterior flexure of gubernaculum 5.6 microns (4.4-7.0) microns long 4
4. Female tail convex-conoid, with tail integument 11.5 microns (8.4-15.4 microns) wide, median bulb ovoid, tail length 1.8-3.6 times anal width. Paired opposing pieces in vagina absent. Male median bulb ovoid. ..... *gracilis* Steiner
   Female tail hemispherical with tail integument 5.9 microns (4.2-7.0 microns) wide, median bulb elongate, tail length 2.4-5.2 times anal width. Paired opposing pieces in vagina large, heavily sclerotized. Male median bulb elongate ..... *maritimus* n. sp.

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Helminth Parasites of Antarctic Vertebrates
Part I. Digenetic Trematodes of Marine Fishes

MITCHELL A. BYRD*

The trematodes of marine fishes of southern seas have received relatively little attention. Leiper and Atkinson (1914, 1915) reported five species collected near Cape Evans (77° 38′ S.) from *Trematomus bernacchii,* of which about 300 specimens were examined. All five trematodes were named by them as new species. The unsatisfactory generic disposition of four of their species is commented upon in this paper. The fifth species, *Allocreadium fowleri,* was based on immature specimens which were insufficient for generic allocation. They would not appear to belong in the Genus *Allocreadium.*

More recently, Szidat (1950) has reported six species from *Eleginops maclovinus* from Tierra del Fuego. Three of these were identified as new species; the other three were identified only to genus. Johnston (1931, 1934, 1934a, 1937) and Nicoll (1915) have reported a few trematodes from Australia. A number of interesting species have been recorded by Crowcroft (1945-1948) and Manter and Crowcroft (1950) from Tasmania.

Young (1938) listed several trematodes which had been reported from New Zealand although many of these were introduced species. MacFarlane (1939, 1945, 1951, 1952) described several species of Digenea from New Zealand fishes and also made some ecological studies. Manter (1954) reported 66 species of digenetic trematodes from 58 species of New Zealand fishes. Thirty-eight new species and six new genera were named by him. Fyfe (1954, 1954a) described an additional new genus and two new species from New Zealand fishes.

The present paper considers six species of digenetic trematodes collected from four species of fishes in the Antarctic during 1959-1960. All collections of hosts were made at the McMurdo United States International Geophysical Year Station. This station is located at 77° 51′ S. latitude and 166° 38′ E. longitude.

Egg measurements are in microns; all other measurements are in millimeters.

PROSOSTOMATA
FAMILY LEPOCREADIIDAE

Lepidapedon antarcticus n. sp. (Figures 1 and 2)

DESCRIPTION (based on 30 specimens; measurements on 10): Body flattened, somewhat elongate, spined cuticle; spines minute more dense on forebody, becoming sparse posterior to acetabulum. Length 1.31 to 2.18; greatest width at acetabulum, 0.42 to 0.58. Body broadly rounded at both ends. Oral sucker 0.20 to 0.26 wide; acetabulum 0.20 to 0.28 wide; sucker ratio 1:96 to 1:1.07, usually 1:1.00 to 1:1.04. Forebody 0.42 to 0.66, approximately one-third of body length.

Pharynx 0.12 to 0.32 long by 0.13 to 0.31 wide; prepharynx very short; esophagus short, 0.03 to 0.10 long; distinctly longer than prepharynx.

*Department of Biology, College of William and Mary, Williamsburg, Virginia. This work was supported in part by Public Health Service Grant E-3354 and National Science Foundation Grant G-9633. Appreciation is extended to Mr. Stanley Wilson who collected hosts and parasites under financial support from Grant G-9633 under the United States Antarctic Research Program. Appreciation is expressed to Dr. Hugh H. DeWitt, Stanford University, for the identification of host species. Contribution Number 122, Virginia Institute of Marine Science.

*A description of this genus is in preparation by Dr. Hugh H. DeWitt, Stanford University.

Intestinal bifurcation immediately pre-acetabular, always closer to acetabulum than to oral sucker. Ceca relatively broad, terminating near posterior end of body.

Ovary rounded, smooth, immediately pre-testicular, in anterior half of hindbody; ovary 0.13 to 0.18 long by 0.13 to 0.19 wide; seminal receptacle rounded, at posterior margin of ovary, slightly overlapping anterior testis in some specimens; uterus coiled between ovary and acetabulum, metraterm to left of cirrus sac. Vitelline follicles extend continuously from posterior end of body to mid-pharyngeal level, often nearly continuous over esophagus, lateral, dorsal, ventral and posterior to ceca, confluent behind posterior testis; eggs large, 109 to 148 by 43 to 71. Testes rounded, smooth, posterior slightly larger than anterior; anterior testis 0.15 to 0.20 long by 0.18 to 0.26 wide; posterior testis 0.19 to 0.26 long by 0.18 to 0.24 wide; post-testicular space 0.30 to 0.52. Cirrus sac divided by a constricted portion into two parts; posterior portion dorsal to acetabulum, containing slightly coiled seminal vesicle surrounded by large gland cells; constricted portion with a bend above anterior margin of acetabulum, slightly overlapping posterior portion of cirrus sac; anterior portion of cirrus sac club-shaped with cirrus, poorly developed pars prostatica, and few gland cells. Common genital pore slightly sinistral.

Excretory vesicle tubular, terminating at rear margin of posterior testis. The name, *antarcticus*, refers to the geographical location from which the species was collected.

HOST: *Trematomus hansoni* Boulenger, type host; in 1 of 6 hosts.

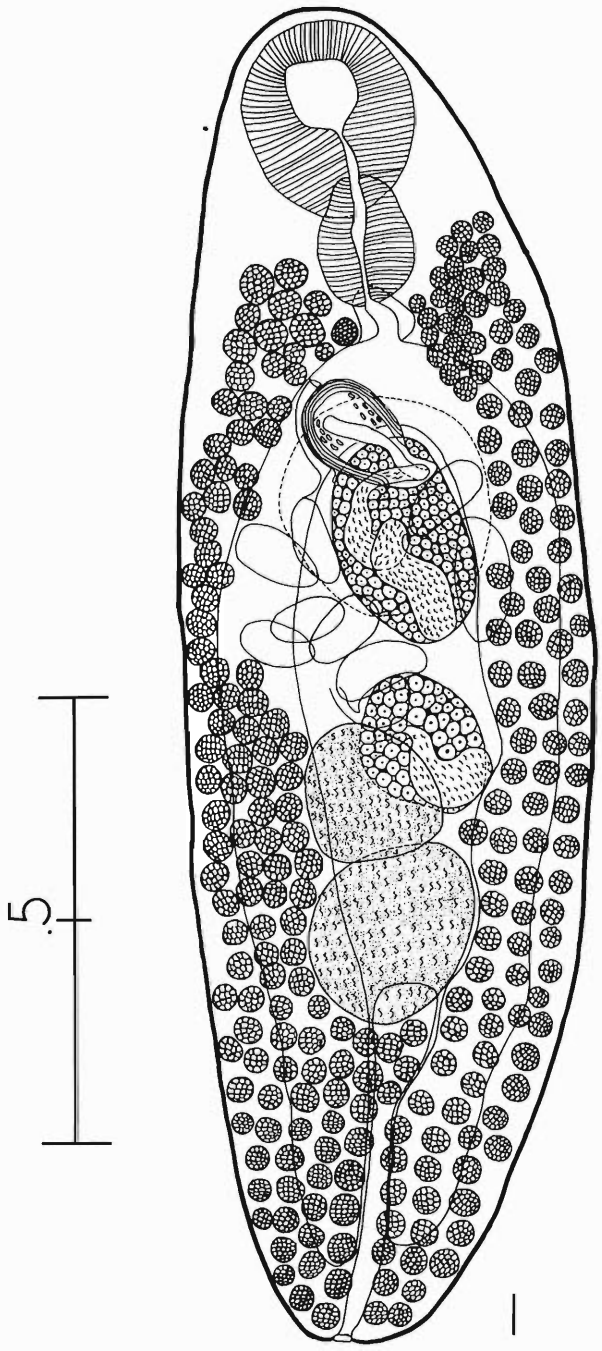
LOCATION: Middle Intestine.

TYPE SPECIMENS (Holotype and Paratype): U. S. National Museum Helminthological Collection Number 59817.

DISCUSSION: Twenty-one species of *Lepidapedon* are recognized: *L. rachion* (Cobbold, 1858) Stafford, 1904; *L. australis* Manter, 1954; *L. calli* Acena, 1947; *L. claratum* Linton, 1940; *L. coelorhynchi* Yamaguti, 1938; *L. congeri* Manter, 1954; *L. elongatum* (Lebour, 1908) Nicoll, 1915; *L. gadi* (Yamaguti, 1934) Yamaguti, 1938; *L. epinepheli* Bravo-Hollis and Manter, 1957; *L. garrardi* (Leiper and Atkinson, 1915) Manter, 1926; *L. genge* Yamaguti, 1938; *L. hancocki* Manter, 1940; *L. lebouri* Manter, 1934; *L. levensini* (Linton, 1907) Manter, 1947; *L. luteum* Yamaguti, 1938; *L. microcotypeum* (Odhner, mss.) Dollfus, 1953; *L. nicolli* Manter, 1934; *L. parepinephili* Sogandares-Bernal, 1959; *L. pugetensis* Acena, 1947; *L. trachinoti* Hanson, 1950; and *L. truncatum* Sogandares-Bernal, 1959.

There are eight species of *Lepidapedon* that possess an excretory vesicle extending to the cecal bifurcation; these are: *L. congeri*, *L. epinephili*, *L. hancocki*, *L. levenseni*, *L. nicolli*, *L. parepinephili*, *L. trachinoti*, and *L. truncatum*. *L. antarcticus* differs from all of these species on the basis of the excretory vesicle which extends only to the rear margin of the posterior testis.

The remaining thirteen species possess an excretory vesicle which does not reach as far forward as the acetabulum. *L. antarcticus* keys to *L. genge* in Hanson's (1950) key. It differs from *L. genge* in possessing vitellaria which extend to the mid-pharyngeal level as compared with vitellaria which terminate at the posterior margin of the acetabulum. *L. antarcticus* further differs from *L. genge* in lacking a well-defined prepharynx, possessing a seminal vesicle which barely extends beyond rear margin of acetabulum, sparse spination, broad ceca, and by its somewhat larger eggs. Of the remaining



All projected scales are in millimeters.

Figure 1. *Lepidapedon antarcticus* from *Trematomus hansoni*. Dorsal view.

species with a short excretory vesicle, *L. luteum* appears to be closely related. *L. antarcticus* differs from *L. luteum* in its smaller body dimensions, shorter prepharynx, much larger eggs, larger and more extensive vitelline follicles, and more anteriorly located seminal vesicle.

Hanson (1950) considered *L. coelorhynchi* and *L. gadi* synonyms of *L. elongatum*. She questioned the validity of *L. calli*, *L. garrardi*, and *L. pugetensis*. Acena (1947) reported *calli* and *pugetensis* from Puget Sound but *pugetensis* from *Sebastodes nebulosus* was incompletely and somewhat inaccurately described. *L. calli* from *Porophrys vetulus* lacks the bipartite seminal vesicle of other species in *Lepidapedon*.

One species, *L. garrardi*, from the Antarctic is very incompletely described. Since the cirrus sac and seminal vesicle were neither described nor figured, its correct genus is uncertain. Hanson (1950) pointed out that the body shape, "delicate" spines, wide ceca, large, rounded testes, and large vitelline follicles suggested *Lepocreadium* rather than *Lepidapedon*. *L. antarcticus* resembles generally the figure of *L. garrardi*. It differs in a number of characters but complete comparison is impossible because of the inadequate description of *L. garradi*. *I. antarcticus* resembles *L. garrardi* in that it possesses broad ceca, large vitelline follicles, and sparse, minute spination. It differs in the size of its eggs which measure 109 to 148 by 43 to 71 as compared with 100 by 30 for *L. garrardi*. The range in egg size for *L. antarcticus* is quite great but specimens agree within narrow limits for all other characters. *L. antarcticus* is somewhat smaller than *L. garrardi* in nearly all dimensions given.

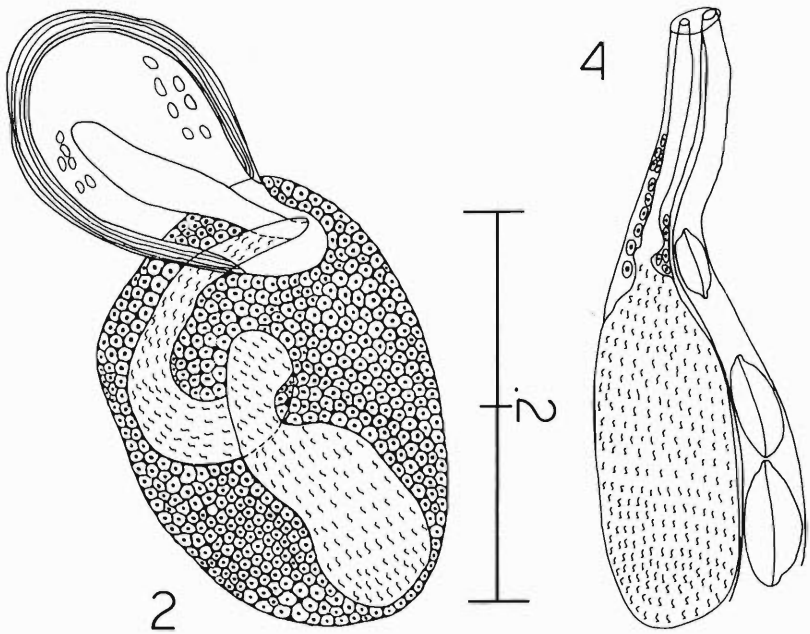


Figure 2. *L. antarcticus*, cirrus sac. Dorsal view.

Figure 4. *P. pennelli*, terminal genital organs. Ventral view.

FAMILY OPECOELIDAE OZAKI, 1925

Plagioporus pennelli (Leiper and Atkinson, 1914) n. comb., redescription (Fig. 3 and 4)

SYNONYM: *Podocotyle pennelli* Leiper and Atkinson, 1914.

DESCRIPTION (Based on 30 specimens, measurements on 10): Length 1.12 to 2.07; greatest width at level of acetabulum, 0.31 to 0.49; body tapering at both ends, more broadly rounded at anterior end than at posterior end. Oral sucker 0.11 to 0.17 in transverse diameter, 0.11 to 0.17 long; acetabulum broader than long, 0.26 to 0.44 in transverse diameter, 0.22 to 0.38 long; sucker ratio 1:2.0 to 1:2.75. Forebody 0.27 to 0.35. Short prepharynx, 0.01 to 0.04; pharynx 0.06 to 0.11 long by 0.06 to 0.10 wide; esophagus usually somewhat shorter than pharynx; bifurcation at anterior margin of acetabulum, usually overlaps acetabulum; intestinal ceca extend to rear margin of posterior testes or sometimes slightly beyond.

Testes smooth, tandem, sometimes slightly oblique; anterior testis 0.20 to 0.22 long by 0.22 to 0.24 wide; posterior testis 0.22 to 0.24 long by 0.22 to 0.23 wide; testes in contact with each other, anterior testis in contact with ovary; anterior testis just posterior to mid-body. Genital pore opens to left, opposite pharynx. Cirrus sac claviform, extending somewhat diagonally backward, dorsal to acetabulum. Cirrus sac extends backward to mid-acetabular level or slightly beyond. Seminal vesicle simple, claviform, in posterior half of cirrus sac; seminal vesicle usually entirely dorsal to acetabulum. Pars prostatica slightly enlarged, surrounded by large gland cells; weakly developed cirrus, surrounded by a few gland cells. Vitelline follicles large, extending from posterior edge of pharynx to posterior extremity of body; interrupted slightly in some specimens opposite acetabulum; dorsal and lateral to ceca; confluent dorsally anterior to acetabulum and above ovary and both testes, usually filling post-testicular space. Ovary post-acetabular, pre-testicular, 0.19 to 0.23 by 0.18 to 0.21. Uterus largely pre-ovarian, extending posteriorly to margin of anterior testis. Eggs 46 to 62 by 24 to 33, usually 55 to 62 by 24 to 26.

Excretory pore terminal; excretory vesicle tubular, extending forward to level of ovary.

HOSTS: *Trematomus bernacchii* Boulenger, in 8 of 9 hosts; *Trematomus hansoni* Boulenger, in 2 of 6 hosts; *Trematomus centronotus* Regan, in 3 of 10 hosts; and in a new species and genus of fish in the Family Zoarcidae*, in 2 of 14 hosts.

LOCATION: Upper and lower intestine.

SPECIMENS DEPOSITED: U. S. National Museum Helminthological Collection Number 59818.

DISCUSSION: Leiper and Atkinson (1914, 1915) listed and later described a new species, *Podocotyle pennelli* from *Trematomus bernacchii* from Antarctic waters. According to their description, the ceca of their specimens end at the level of the posterior limit of the testes; the ovary is pear-shaped to slightly lobate; the vitellaria range from the level of the genital pore to the posterior extremity; there is an armed cirrus present; and the eggs have a distinct knob-like protrusion at one end. These are characters typical of *Plagioporus* and for this reason *Podocotyle pennelli* is transferred to this genus and the new combination becomes *Plagioporus pennelli* (Leiper and Atkinson, 1914). Although the original description of *P. pennelli* is incomplete, the figure is somewhat more detailed. The redescription above is based

on 30 specimens which agree with the description and with Figure 19 by Leiper and Atkinson (1915).

Manter (1954) recognizes two subgenera, *Plagioporus* and *Caudotestis*, in *Plagioporus*. Species in *Caudotestis* have intestinal ceca which do not extend beyond the posterior limit of the testes whereas species in *Plagioporus* have ceca which extend beyond the testes. Leiper and Atkinson's description of *P. pennelli* states that ceca terminate at the end of the posterior testis. Their figure shows ceca which end slightly behind the posterior testis. In my Antarctic specimens, this character is somewhat variable. In some specimens, the ceca end at the rear margin of the posterior testis and in others they end more posteriorly. On the basis of this character, *P. pennelli* should be placed in the Subgenus *Plagioporus*.

Manter (1954) presented a key to the 27 species in the Subgenus *Plagioporus*. Of the species considered in the key, *P. japonicus* Yamaguti, 1938 and *P. isaitschikowi* (Layman, 1930) Price, 1934 seem most closely related to *P. pennelli*. *P. pennelli* differs from *P. japonicus* in possessing somewhat smaller eggs and exhibiting a straight instead of looped seminal vesicle. *P. pennelli* also differs in having a cirrus sac which extends nearly to the posterior margin of the acetabulum instead of one which terminates anterior to the acetabulum. *P. pennelli* differs from *P. isaitschikowi* in its more posterior intestinal bifurcation and continuous vitellaria opposite acetabulum. *P. pennelli* further differs from *P. isaitschikowi* in the extent of the cirrus pouch which extends nearly to the posterior margin of the acetabulum as compared with one which extends anterior to the acetabulum.

FAMILY HEMIURIDAE LÜHE, 1901

Parahemiurus oatesi (Leiper and Atkinson, 1914) Skrjabin and Guschanskaja, 1954 redescription (Fig. 5 and 6)

DESCRIPTION (Based on three specimens): Body small, rounded, with cuticular plications extending from anterior end to slightly beyond end of ovary; body with cecoma (retracted in all three specimens), approximately one-fourth body length; body 1.69 to 1.90 long by 0.34 at acetabulum; body 0.67 wide at widest point; forebody short, 0.21 to 0.32. Oral sucker globular, 0.13 to 0.16 long by 0.16 wide. Acetabulum in anterior one-fourth of body, nearly round, 0.25 to 0.27 long by 0.30 wide; sucker ratio, 1:1.88.

Prepharynx absent; pharynx globular, 0.08 long by 0.08 wide; esophagus very short or absent; ceca end directly behind vitellaria, may extend slightly into retracted cecoma.

Genital pore median, ventral, opening beneath middle of oral sucker. Testes rounded, slightly diagonal; anterior testis 0.15 long by 0.18 wide; posterior testis 0.16 long by 0.18 wide. Seminal vesicle undivided, post-acetabular, with thick muscular walls, extending somewhat diagonally in body. Pars prostatica relatively long, post-acetabular, somewhat S-shaped, reflected above antero-dorsal margin of seminal vesicle with numerous, large gland cells. At rear margin of acetabulum, just anterior to pars prostatica, male duct unites with uterus to form a long ductus hermaphroditicus enclosed in a somewhat muscular sac; terminal portion of hermaphroditic duct eversible and functions as a copulatory organ.

Ovary ovoid, median, 0.14 long by 0.23 wide, immediately post-testicular. Seminal receptacle [was] not observed. Uterine loops pass across body from ovary posterior to cecoma; uterus then loops forward in several coils in ventral portion of body, passing forward to unit with male duct to form

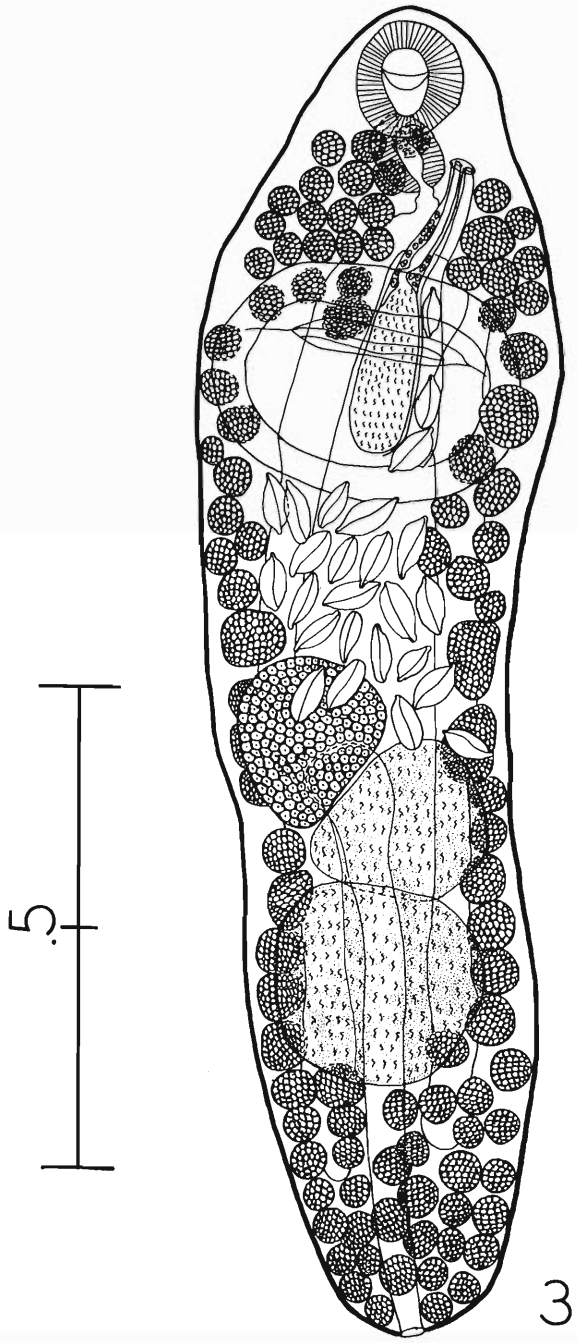


Figure 3. *Plagioporus pennelli* from *Trematomus hansoni*. Ventral view.

ductus hermaphroditicus just dorsal to rear margin of acetabulum. Vitellaria consist of eight well-defined, deeply cleft lobes, apparently forming two glands immediately behind ovary. Eggs 19.2 to 24 by 9.6 to 12.

Excretory vesicle tubular, bifurcating into two excretory arms which unite behind pharynx.

HOSTS: *Trematomus bernacchii* Boulenger, in 1 of 9 hosts; *T. hansoni* Boulenger, in 1 of 6 hosts; *T. centronotus* Regan, in 1 of 10 hosts.

LOCATION: Stomach.

SPECIMEN DEPOSITED: U. S. National Museum Helminthological Collection Number 59822.

DISCUSSION: Yamaguti (1958) lists 14 species under the Genus *Parahemiurus*. These are: *P. anchoviae* Vaz and Pereira, 1930; *P. atherinae* Yamaguti, 1938; *P. australis* Woolcock, 1935; *P. clupeae* Yamaguti, 1953; *P. dogieli* Skrjabin and Guschanskaja, 1954; *P. ecuadori* Manter, 1940; *P. harengulae* Yamaguti, 1938; *P. lovettiae* Crowcroft, 1947; *P. merus* (Linton, 1910) Woolcock, 1935; P. oatesi (Leiper and Atkinson, 1914) Skrjabin and Guschanskaja, 1954; *P. platichthyi* Lloyd, 1938; *P. sardiniae* Yamaguti, 1934; and *P. seriolae* Yamaguti, 1934.

Manter (1940 considered *P. parahemiurus, P. platichthyi, P. atherinae*, and *P. harengulae* synonyms of *P. merus*. Manter (1934) described a species, *Hemiurus* sp., which was characterized by an undivided seminal vesicle. His specimen was described as having a thin-walled seminal vesicle in contrast to the typical thick, muscular-walled vesicle of *Parahemiurus*. Skrjabin and Guschanskaja (1954) named Manter's specimen, *P. dogieli*, apparently on the basis of the undivided seminal vesicle. These same authors transferred *Hemiurus oatesi* Leiper and Atkinson, 1914, to *Parahemiurus*. Although the original description of *P. oatesi* was incomplete and apparently inaccurate in some cases, it belongs in *Parahemiurus* on the basis of its thick-walled, undivided seminal vesicle. With the exception of egg size, my specimens of *Parahemiurus* agree with the description and figure of *P. oatesi*. In the description of this species, the authors state "the eggs are very small as compared with those in the succeeding *Hemiuridae*. The uterus (ut) is filled with eggs, 0.05 × 0.03 mm., and occupies most of the interstices between the posterior lobule of the yolk-glands and the ventral sucker." The next species of *Hemiuridae* described in their paper is *Aponurus bowersi* in which the indicated egg size (.04 mm. by .02 mm) is even smaller than that given for *P. oatesi*. Because of this inconsistency, and because the range of egg size (.015 to .034 mm. by .008 to .014 mm.) for other species of *Parahemiurus* is much lower, the indicated egg size for *P. oatesi* most likely is an error. My Antarctic specimens of *Parahemiurus* have an egg size of 19.2 to 24 by 9.6 to 12, and are assigned to the species, *P. oatesi*.

P. oatesi differs from all other species in the genus except *P. australis* and *P. lovettiae* on the basis of deeply lobed vitellaria. *P. oatesi, P. australis,* and *P. lovettiae* are closely related and differ only slightly in a few characters. *P. oatesi* differs from *P. australis* on the basis of more deeply lobed vitellaria, somewhat smaller body measurements, less extensive cuticular plications, and slightly larger eggs. It differs from *P. lovettiae* on the basis of larger body size, larger internal organs, less extensive cuticular plications, and somewhat larger eggs although there is some overlap in measurements.

Genolinea leiperi n. sp. (Figs. 7, 8, and 9)

DESCRIPTION (based on 30 specimens, with measurements on 10): Body

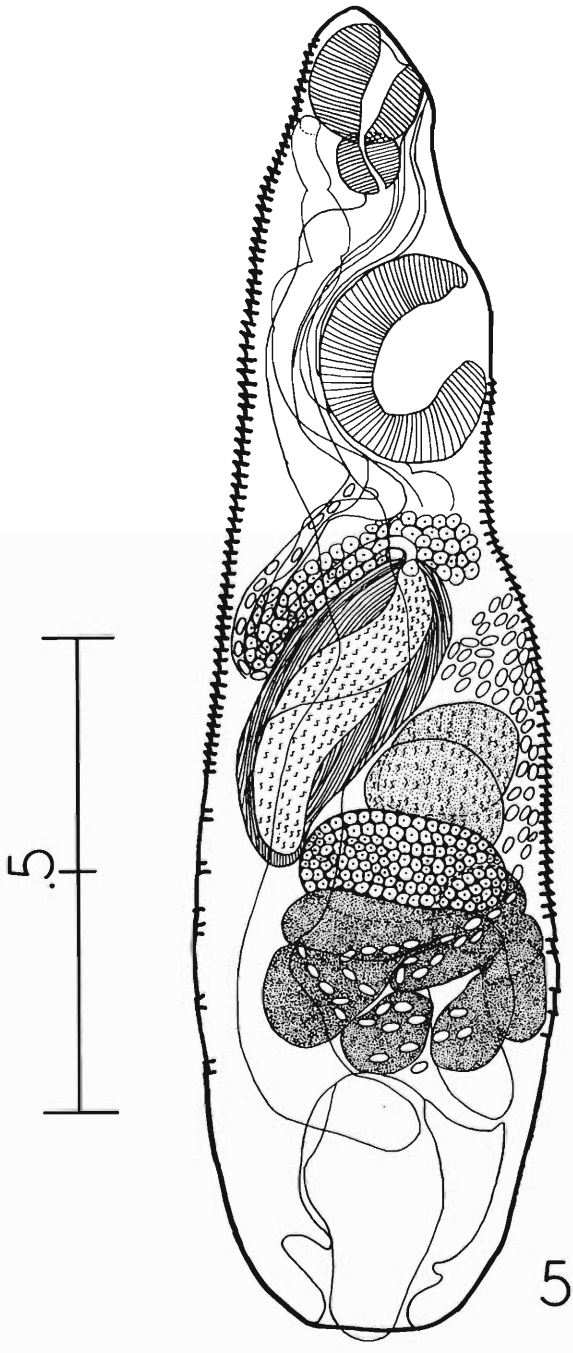


Figure 5. *Parahemiurus oatesi* from *Trematomus bernacchii*. Lateral view.

elongate, muscular, not flattened; cuticle slightly striated; body 1.18 to 1.94 long by .34 to .46 wide at acetabulum. Forebody .28 to .44 or approximately one-fourth of body length. Oral sucker nearly round, subterminal, .11 to .17 long by .12 to .18 wide. Acetabulum nearly round, .20 to .30 by .23 to .32 wide. Sucker ratio 1:1.60 to 1:1.91.

Pharynx .06 to .10 long by .10 to .12 wide; esophagus very short; ceca broad, undulating, ending near posterior end of body.

Genital pore median or slightly sub-median, at posterior margin of pharynx. Testes rounded, usually tandem, sometimes slightly diagonal; anterior testis .15 to .19 long by .14 to .20 wide; posterior testis usually in contact with anterior testis, .13 to .19 long by .20 to .26 wide. Sinus sac with weakly muscular wall, .09 to .15 long by .06 to .08 wide; sinus sac ovoid, containing a distensible hermaphroditic duct with thick-walled basal portion; sinus sac containing numerous small gland cells. Pars prostatica well developed, a narrow curved tube surrounded by a mass of gland cells which

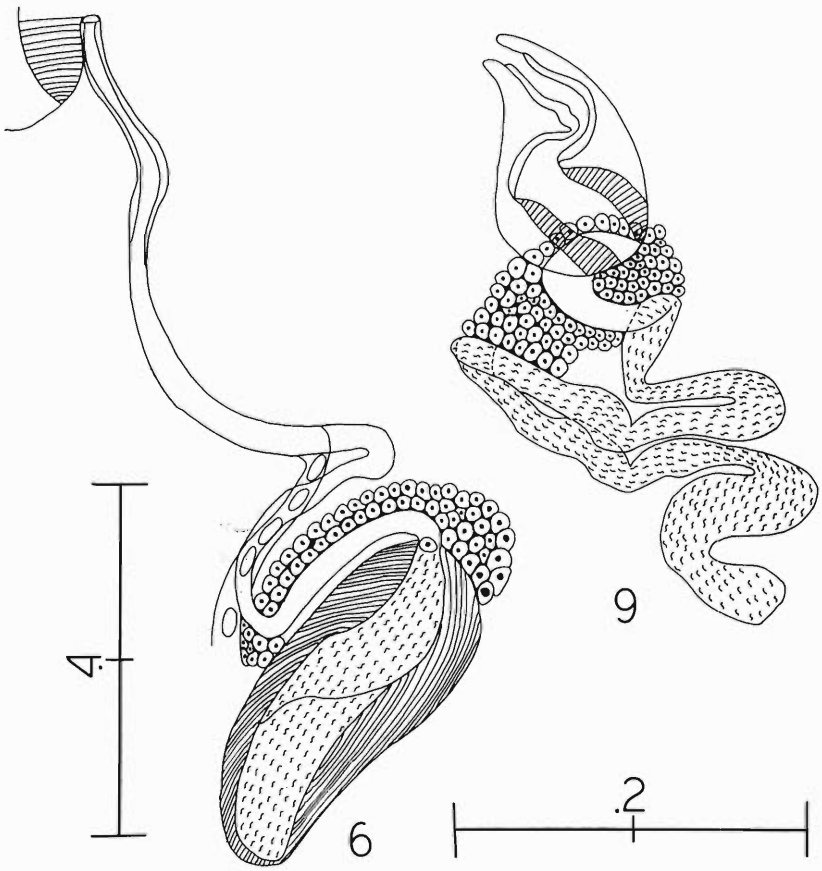


Figure 6. *P. oatesi*, terminal genital organs. Lateral view.

Figure 9. *G. leiperi*, terminal male genital organs. Lateral view.

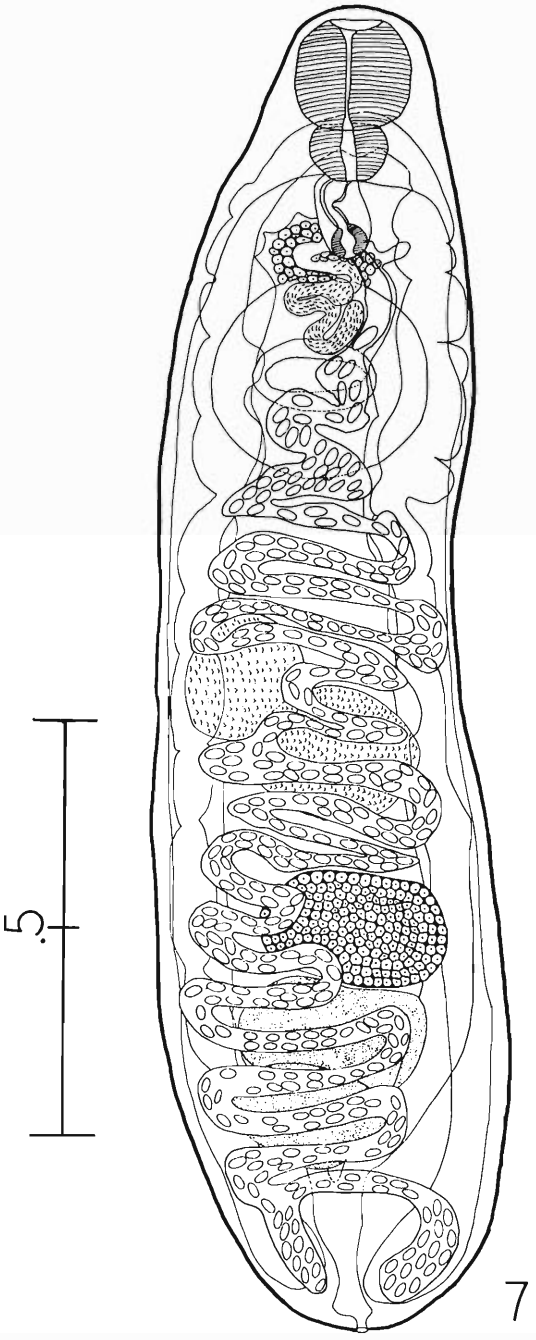


Figure 7. *Genolinea leiperi* from *Trematomus bernacchii*. Ventral view.

occupy a space nearly as large as sinus sac; gland cell mass immediately anterior to acetabulum, sometimes overlapping it slightly. Seminal vesicle external, tubular, with several dilations and lateral coils, extending from prostate cell mass to mid-acetabular level.

Ovary rounded to slightly ovoid, .10 to .19 long by .17 to .23 wide, immediately post-testicular. Seminal receptacle not observed. Uterus with coils extending beyond posterior vitellarium, nearly to end of body, then coiling forward to enter base of sinus sac. Vitellaria consist of two compact lobes, usually tandem, often oblique or lateral to each other, immediately post-ovarian; both vitellaria slightly wider than long; anterior vitellarium .10 to .14 long by .11 to .26 wide; posterior vitellarium .09 to .15 long by .12 to .20 wide; post-vitelline space short. Eggs 31 to 39 long by 12 to 17 wide.

Excretory pore slightly subterminal; crura of excretory vesicle with slight convolutions, uniting dorsal to posterior margin of oral sucker.

HOSTS: *Trematomus bernacchii* Boulenger, type host, in 5 of 9 hosts; *Trematomus centronotus* (in 4 of 10 hosts).

LOCATION: Stomach.

HOLOTYPE AND PARATYPE (Two specimens): U. S. National Museum Helminthological Collection Number 59819.

DISCUSSION: Leiper and Atkinson (1915) described and named a species from the Antarctic as *Aponurus bowersi*. Their specimens cannot belong in the Genus *Aponurus* because the vitellaria consist of two compact, nearly tandem, lobes rather than the seven characteristic of *Aponurus*. The authors failed to describe the seminal vesicle or any of the terminal genital ducts except a "cirrus," hence the generic disposition of their specimens is uncertain. Their figures indicate that their specimens could be either *Derogenes* or *Genolinea*. Skrjabin and Guschanskaja (1955) transferred *Aponurus bowersi* to *Genolinea*, based on the figure and description in the original paper. The anterior position of the acetabulum and the usually tandem position of the vitellaria would indicate *Genolinea*. The egg size given for *A. bowersi* is 40 by 20 and body size is given as 1. Upper egg size of my specimens of *G. leiperi* is just slightly below the minimal egg measurements of *A. bowersi*. My antarctic specimens of *G. leiperi* are very similar to the published figure of *A. bowersi*. Since the terminal genital ducts and seminal vesicle were not described for this species, the transfer to *Genolinea* would appear to be unjustified. At the present time, the correct allocation of *A. bowersi* remains questionable.

Yamaguti's (1953) synopsis of the digenetic trematodes lists seven species of *Genolinea*, two of which originally were assigned to other genera. Yamaguti considered *Parasterrhurus* Manter, 1934 a synonym of *Genolinea* and the type and apparently only species of *Parasterrhurus*, *P. anurus* Manter, 1934, became *Genolinea anura* (Manter, 1934). Since *Brachyphallus anurus* Layman, 1930 previously had been transferred to *Genolinea* by Yamaguti (1934), this specific name was preoccupied by Layman's species. Yamaguti (1953) therefore proposed the new combination *Genolinea argentinae* for Manters' specimens.

Manter (1954) described a new species, *Genolinea dactylopagri*, from New Zealand waters and also presented a key to the six species which he recognized at the time. He did not include *G. argentinae* and reduced *G. robusta* Lloyd, 1938 to synonomy with *G. laticauda* Manter, 1925. Manter (1955) noted that the genus consisted of seven species, thereby implying his acceptance of the synonomy of *Parasterrhurus* with *Genolinea*.

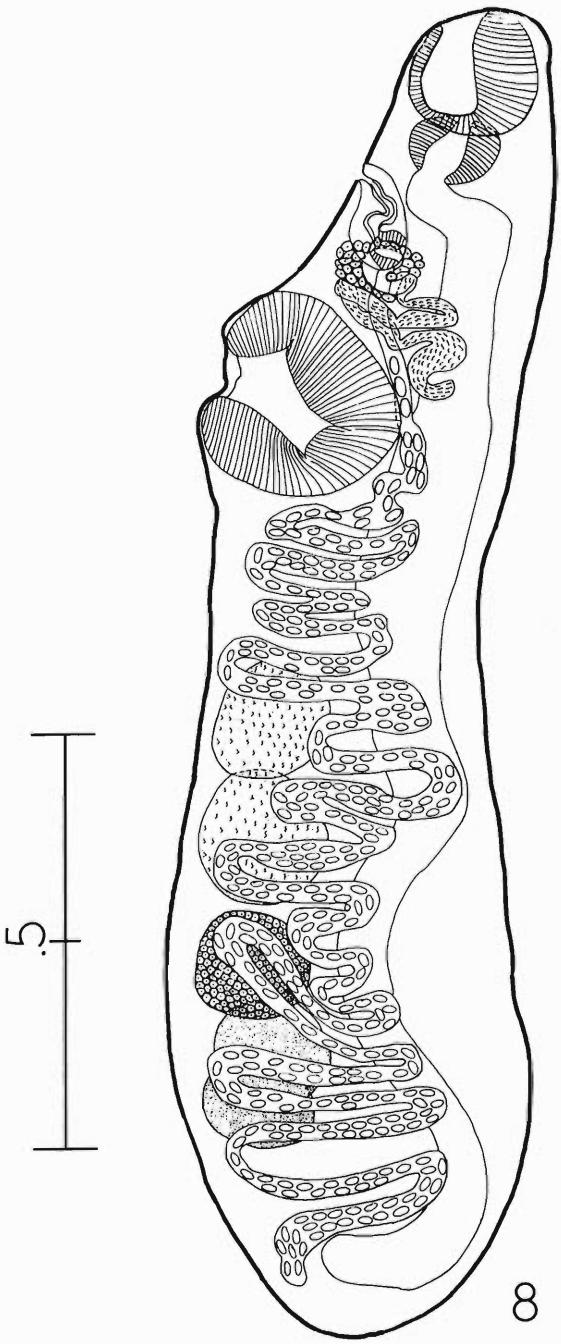


Figure 8. *G. leiperi* from *Trematomus bernacchii*. Lateral view.

Margolis and Adams (1956) described *G. oncorhynchi* from the salmon, *Oncorhynchus gorbuscha* in British Columbia. Montgomery (1957) reported another species, *G. tanyopa from Medialuna californiensis* (Steindachner) and *Hypsypops rubicunda* (Girard) at La Jolla, California. Manter and Pritchard (1960) described *G. ampladena* from *Acanthurus sandvicensis* (Streets). These same authors (Manter and Pritchard, 1960a) described *Genolinea lobata* from the same host.

Skrjabin and Gushanskaja (1955) named Linton's (1940) *Genarches* sp., *Genolinea lintoni*. These authors are unjustified in making their generic disposition of Linton's specimens of *Genarches* sp. I have examined Linton's specimens and found them to be in poor condition. They should not be in *Genarches* as they do not possess united ceca. The seminal vesicle and terminal genital ducts were not seen in these specimens but the transverse testes and vitellaria and distinct preoral lip indicate *Derogenes* rather than *Genolinea*.

G. leiperi is most like *G. laticauda*. It differs from that species by the absence of sphincter muscles of the acetabulum. It also differs in the more posterior position of the seminal vesicle and prostatic complex and in its larger egg size.

Gonocerca lobata n. sp. (Figs. 10 and 11)

DESCRIPTION (based on six specimens, complete measurements on 1; two specimens immature; three large specimens in poor condition).

Body large, rounded, smooth, short pre-oral lip, .05; cuticular striations evident anteriorly; both ends broadly rounded, tail appendage lacking. Length 3.70 (5.50 and 5.70 in two largest specimens); greatest width immediately pre-acetabular, 1.40 (2.3 and 2.4 in two largest specimens). Oral sucker .47 long by .68 wide; acetabulum large, nearly round, .87 long by .85 wide; acetabulum distinctly pre-equatorial; sucker ratio 1:1.25. Forebody 1.24, approximately one third of body length.

Pharynx .26 long by .19 wide, slightly overlapped by oral sucker; prepharynx absent; esophagus short, .029 long. Intestinal bifurcation well anterior to acetabulum, closer to oral sucker than to acetabulum. Ceca swing anteriorly to level of posterior margin of oral sucker; broadened when directed posteriorly, extending to posterior tip of body.

Ovary rounded, smooth, post-acetabular, separated from acetabulum by two loops of uterus; ovary lies in mid-line between vitelline glands, pretesticular, nearly touching anterior-most testis. Vitellaria compact, deeply and symmetrically four-lobed (in six specimens), lateral to ovary and anterior to testes. Eggs 71 to 86 long by 33 to 39 wide. Muscular metraterm enters genital pore to right of sinus sac. Uterus transversely coiled between ovary and acetabulum; major portion of uterus transversely coiled above acetabulum and forward to level of pharynx. Testes rounded, slightly diagonal, post-ovarian; anterior testis .65 long by .59 wide; posterior testis .78 long by .63 wide; post-testicular space .20. Seminal vesicle transversely placed in body between acetabulum and pharynx; seminal vesicle not enclosed in cirrus sac, closer to pharynx than to acetabulum; seminal vesicle with folded constriction at posterior end, tapering towards anterior end; anterior end sharply reflected where it enters pars prostatica; pars prostatica well developed, surrounded by a number of loose prostate cells; common genital pore medial, ventral to pharynx and immediately behind oral sucker; pars prostatica and prostate gland cells slightly overlapping pharynx.

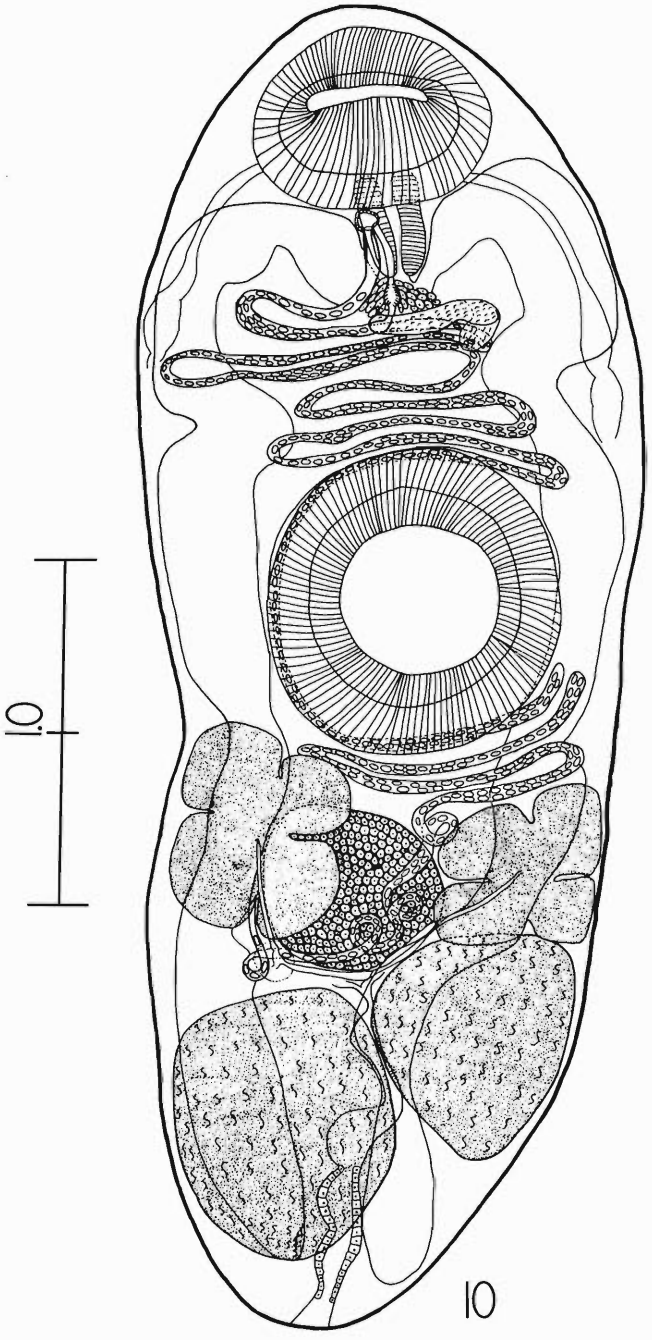


Figure 10. *Gonocerca lobata* from *Trematomus bernacchii*. Ventral view.

Excretory pore terminal, opening into a bladder lined with columnar epithelium; bladder extends along right side of body, ventral to testes and bifurcates at anterior margin of testes; two excretory arms extend anteriorly beneath intestinal ceca; excretory arms constricted at level halfway between oral sucker and acetabulum, uniting dorsal to oral sucker.

The name *lobata* is for the distinctive appearance of the vitellaria.

HOST: *Trematomus bernacchii* Boulenger, type host, in 2 of 9 specimens; *T. hansoni*, in 1 of 6 hosts.

LOCATION: Lower Intestine.

TYPE SPECIMEN: Holotype, U. S. National Museum Helminthological Collection Number 59821.

Gonocerca trematomi n. sp. (Figs. 12 and 13)

DESCRIPTION (based on a single specimen): Body elongate, rounded; forebody flexed ventrally, posterior end broadly rounded; tail appendage lacking; short pre-oral lip. Length 3.8, forebody tapered somewhat anteriorly. Oral sucker .34 long by .35 deep; acetabulum large, post-equatorial, .67 long by 45 deep. Forebody tapered somewhat anteriorly. Oral sucker .34 long by .35 deep; acetabulum large, post-equatorial, .67 long by .45 deep. Forebody 2.0, approximately one-half of body length.

Pharynx rounded, .15 long by .15 deep, slightly overlapped by oral sucker; pre-pharynx absent; intestinal bifurcation well anterior to acetabulum, closer to oral sucker than to acetabulum; ceca extend beyond testis to posterior tip of body.

Ovary rounded, smooth, immediately post-acetabular, anterior margin of ovary in contact with posterior margin of acetabulum; ovary lies in midline between vitelline glands, pre-testicular except for posterior margin which slightly overlaps anterior testis foremargin; ovary .30 long by .44 deep. Vitellaria compact, rounded, smooth; left vitelline gland somewhat more posterior than right, extending back opposite forward portion of anterior testis. Testes large, in tandem, margins overlapping slightly; anterior testis .67 long by .63 deep; posterior testis .68 long by .65 deep; testes extend to posterior end of hindbody; post-testicular space .09. Uterus extends forward from ovary, transversely coiled in body above acetabulum and forward nearly to level of pharynx; muscular metraterm enters genital pore to right of sinus sac. Eggs 45 to 52 long by 24 to 26.4 wide. Seminal vesicle not enclosed in cirrus sac, closer to phrynx than to acetabulum, club-shaped, tapering anteriorly to enter pars prostatica; pars prostatica well developed, surrounded by a mass of loose prostate gland cells; genital pore medial, ventral to pharynx at posterior margin of oral sucker; pars prostatica and prostate gland cells lying partially beneath pharynx.

Excretory pore slightly subterminal, opening into a tubular bladder; excretory arms were not traced throughout their length but apparently unite above the pharynx. The specific name, *trematomi*, refers to the host genus.

HOSTS: *Trematomus bernacchii* Boulenger, type host, in 1 of 9 specimens.

LOCATION: Branchial Chamber.

TYPE SPECIMEN: Holotype, U. S. National Museum Helminthological Collection Number 59820.

DISCUSSION: The type of the genus, *G. phycidis*, was described from *Urophycis chuss* by Manter (1925) from the coast of Maine and later collected (Manter, 1934, 1947) from depths of 139 to 300 fathoms at Tortugas, Florida where it infected *Urophycis regius*, *Merluccius* sp., and *Coleorhynchus*

carminatus. It was found to be rather common in New Zealand by Manter (1954), and was recorded there from *Coleorhynchus australis* Richardson, *Macruronus novae-zelandiae* (Hector) *Merluccius gayi* (Guichenot), *Parapercis colias* (Forster), and *Scorpaena cruenta* Richardson.

In addition to the two new species from the Antarctic described in this paper, three other species occur in the Genus *Gonocerca;* these are: *G. kobayashii* (Layman, 1930) Manter, 1934; *G. crassa Manter,* 1934; and *G. macroformis* Wolfgang and Myers, 1954. *G. kobayashii* was reported from the stomach of *Myxocephalus raninus* from Peter the Great Bay. The species is characterized by its lobed vitellaria. *G. crassa* was reported from 13 different hosts from deep-water fishes at Tortugas, Florida and later was reported from *Coleorhynchus* sp. from Japan by Yamaguti (1934). Rees (1953) has since reported it from *Molva byrkelange* from 160 fathoms from Iceland.

G. macroformis was described from the ovary of two other bottom-dwelling forms, the witch and plaice flounders. The occurrence of this species in the ovary is somewhat unusual in that other members of the genus occur in the branchial cavity or upper digestive tract of their hosts. The species exhibits a number of peculiarities, including unusually constructed ceca lined with several cell types, and its peculiar location in the host.

G. lobata is similar to *G. kobayashii* in the possession of lobed vitellaria. No other members of the genus possess lobed vitellaria. It differs from *G. kobayashii* in having a generally larger body size, larger eggs, smaller sucker ratio, symmetrical lobation of vitelline glands, and location of the acetabulum anterior to mid-body.

Gonocerca trematomi lacks the lobed vitellaria characteristic of *G. lobata* and *G. kobayashii*. In addition, it differs from *G. phycidis* in larger, more robust body, wider eggs, much longer forebody, more globular seminal vesicle, and smaller sucker ratio. *G. trematomi* may be distinguished from *G. crassa* on the basis of its more tandem testes, wider eggs, more anterior genital opening, smaller pre-oral lobe, and uterine coils extending laterally to overlap

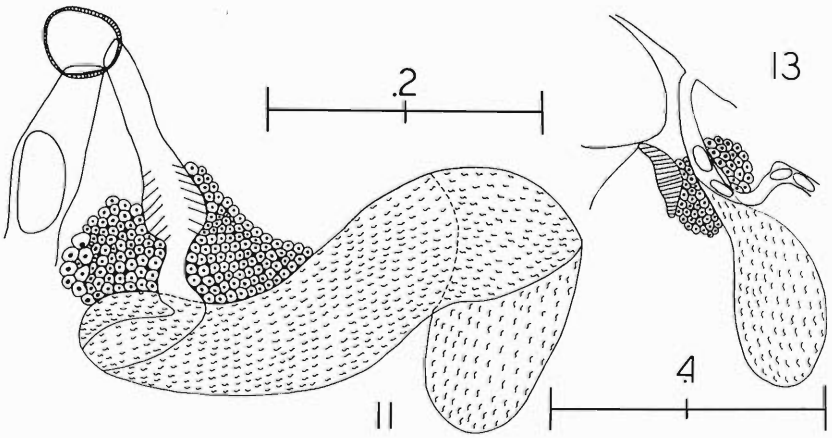


Figure 11. *G. lobata,* terminal genital organs. Ventral view.

Figure 13. *G. trematomi,* terminal genital organs. Lateral view.

intestinal ceca. *G. trematomi* possesses more tandem testes; more laterally extended uterine coils; thinner, more uniform cecal linings; and much smaller body size than *G. macroformis*.

Wolfgang and Myers (1954) pointed out the structural peculiarities and unusual location within the host of *G. macroformis*, and commented upon its similarities to the gorgoderids which undergo visceral migration in the definitive host. They concluded that it was a true and not an aberrant species on the basis of its occurrence in associated species of bottom dwellers. *G. lobata* was collected only from the extreme lower intestine of the host. The occurrence of both *G. macroformis* and *G. lobata* in somewhat unusual habitats would seem to indicate that this genus of Derogetine hemiurids may be normal inhabitants of the entire digestive tract and associated organs.

Manter (1934) has commented upon the distribution of *G. phycidis* in shallow waters of Maine and in cold waters at depths of 150 to 300 fathoms at Tortugas, Florida. Collection of the genus from Iceland, Japan, New Zealand, and Antarctica further confirms the distinct cold water affinities of the group.

SUMMARY

Described are four new species: *Lepidapedon antarcticus, Genolinea leiperi, Gonocerca lobata,* and *Gonocerca trematomi.*

The following new combination is proposed: *Plagioporus pennelli* (Leiper and Atkinson, 1914) for *Podocotyle pennelli.*

Redescriptions are given of *Plagioporus pennelli* (Leiper and Atkinson, 1914) and *Parahemiurus oatesi* (Leiper and Atkinson, 1914) Skrjabin and Guschanskaja, 1954.

New host records are reported for *Parahemiurus oatesi* and *Plagioporus pennelli.*

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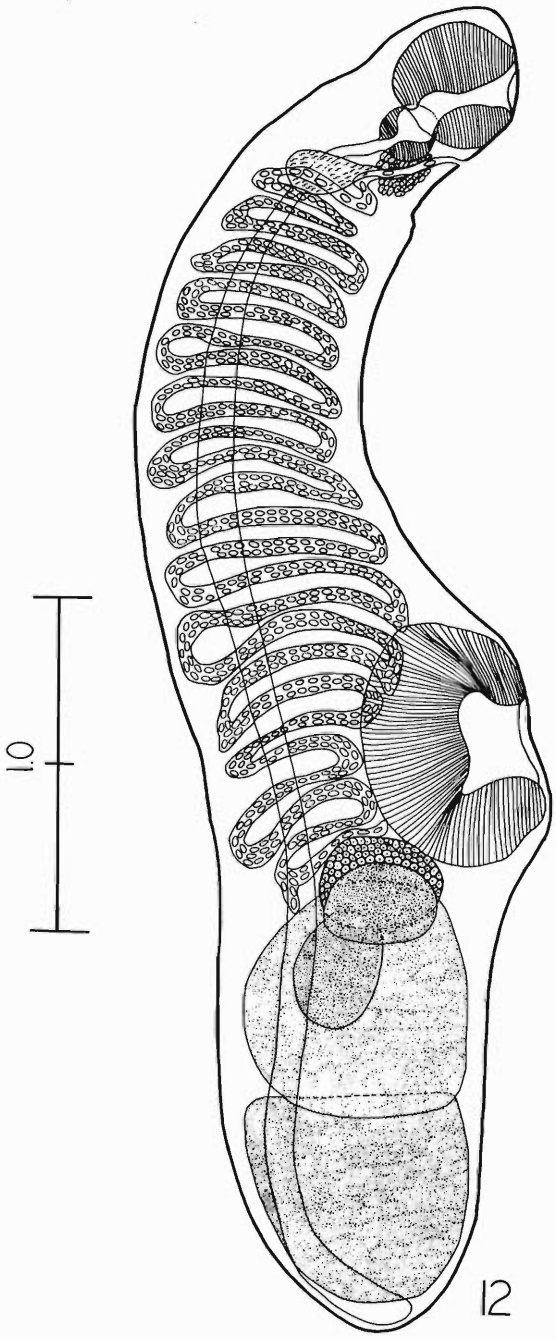

Figure. 12. *G. trematomi* from *Trematomus bernacchii*. Lateral view.

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Redescriptions of Some Species of *Caballerocotyla* Price (Monogenea; Capsalidae)*

EMMETT W. PRICE

In a review of the monogenean subfamily Capsalinae Johnston, 1929, the writer (Price, 1960) proposed the genus *Caballerocotyla* for those species in which the pharynx was constricted, the central heptagon of the opisthohaptor open (keyhole-shaped), and the testes confined to the interintestinal field. Included in this genus was a species which Winter (1955) described as *Capsala caballeroi* from the gills of a "bonito" taken in the Pacific Ocean near Acapulco, Mexico. The study of the description of this form suggested that there had been some misinterpretations of the structure of the opisthohaptor and of the terminal portions of the genital systems.

Recently, in identifying some specimens of *Caballerocotyla*, it seemed desirable to examine the original specimen of Winter's *C. caballeroi*. This specimen was made available on loan through the kindness of Senorita Margarita Bravo Hollis, to whom appreciation is here expressed. An examination of the specimen confirmed the writer's earlier suspicions and it seems desirable to present a brief redescription of the species.

In addition to the species referred to above, the writer has available to him specimens of *Tristoma magronum* Ishii and *T. katsuwonum* Ishii, both assigned by Price (loc. cit.) to the genus *Caballerocotyla*. The specimens were made available through the generosity of the late Prof. Nobutaro Ishii. These species were originally described in Japanese by Ishii (1936) and later in English by Ishii and Sawada (1938). Except for a few oversights and inaccuracies, the existing descriptions are about as complete as could be expected from the specimens available. In view of the relative inaccessibility of the original paper, redescriptions of these species are included herein.

Caballerocotyla caballeroi (Winter, 1955) Price, 1960 (Fig. 1, a-b)

SYNONYM: *Capsala caballeroi* Winter, 1955.

DESCRIPTION: Body ellipsoidal, 5.6 mm in overall length and 3.1 mm in maximum width; cuticle apparently without papillae and dorsal marginal spines. Prohaptoral suckers ellipsoidal, concave ventrally, about 0.5 by 0.65 mm. Opisthohaptor oval (apparently due to distortion), rotated about 80° so that anterior and posterior margins appear lateral, about 1.5 mm long by 1.1 mm wide, surrounded by delicate festooned marginal membrane which is readily observed only at anterior and posterior margins of haptor; central heptagon "open"—keyhole-shaped—with customary 7 rays radiating from it; anchors apparently absent; marginal hooklets present (only 6 of the 14 observed), about 0.018 mm long. Eyes present, 2 pairs, dorsal and anterior to level of cephalic end of pharynx; remainder of nervous system not observable. Oral aperture median, opening into constricted pharynx, about 0.55 mm long by 0.68 mm wide; remainder of digestive tract apparently as in other capsalids. Genital apertures lateral, at left body margin and slightly distal to left prohaptoral sucker. Cirrus pouch slender, about 0.7 mm long,

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its base lying immediately posterior to left distal margin of pharynx. Testes 29 or 30, widely scattered in interintestinal field, some partially obscured by vitelline follicles. Ovary somewhat globular, about 0.6 mm wide, median and immediately pretesticular. Oviduct short, extending to left and entering base of pestle-shaped ootype; ootype about 0.9 mm long by 0.15 mm wide, its base lying in median field immediately anterior to vitelline reservoir. Seminal receptacle globular, to left of vitelline reservoir; vagina short, opening at level of base of ootype and immediately ventral to left intestinal branch—not near genital aperture as shown by Winter. Vitellaria extensive, occupying greater part of body proper and extending into cephalic lobe. No eggs present.

HOST: *Sarda orientalis* (Temminck and Schlegel).

LOCATION: Gills.

DISTRIBUTION: Mexico (Pacific Ocean off Acapulco, Guerrero).

SPECIMEN: Coll. Helm. Inst. Biol. Univ. Nac. Autón. Mexico, 212-12 (holotype).

The writer's observations differ from those of Winter's mainly in the position and structure of the opisthohaptor and in the nature of the female genital system. Winter's description and figure of *Capsala caballeroi* indicate that the opisthohaptor is elongate laterally, the central heptagon irregularly hexagonal, only six haptoral rays, no marginal hooklets observed, and the marginal membrane present only at the lateral extremes of the haptor. An examination of the holotype suggests that the specimen had been subjected to pressure before fixation in view of the displacement posteriad of the opisthohaptor, its oval shape, and the apparent absence of a complete marginal membrane. As a matter of fact, what Winter considered as the lateral sides of the structure in question are actually the anterior and posterior margins, the haptor being rotated approximately 80°. The heptagon is of the open type and has the customary seven rays radiating from it. The marginal membrane is identifiable as such only at the anterior and posterior margins; however, careful search shows that it extends around the haptor in the usual manner except that due to pressure it had been embedded in the substance of the organ. No anchors could be observed, but marginal hooklets are present, 6 of the possible 14 having been found.

As regards the female genital system, Winter showed that the oviduct followed a sigmoid course anteriorly to the right of the median line, turning sharply to the left near the base of the pharynx and entered a slender ootype or uterus which was closely applied to the cirrus pouch. Actually the ootype-uterus complex is of the conventional type of flukes of this group; it was difficult to see because of excessive flattening in the region. However, by the use of the highest magnification and proper adjustment of light its outline could be followed, showing that it is pestle-shaped with its base lying in the median field immediately anterior to the vitelline reservoir. The oviduct leads directly, more or less transversely, into the base of the ootype. No structure such as indicated as the ootype by Winter could be found. Furthermore, Winter apparently mistook the uterine pore for the vaginal aperture, since the latter is clearly located at the level of the vitelline reservoir and in the field of the left intestinal branch.

Caballerocotyla caballeroi (Winter) is most closely related to *C. pelamydis* (Taschenberg) from a closely related host, *Sarda sarda* (Bl.), the former lacking the minute marginal papillae and haptoral anchors which are described as present (Palombi, 1949) in the latter species.

Caballerocotyla magronum (Ishii, 1936) Price, 1950 (Fig. 2, a-d)

SYNONYMS: *Tristoma magronum* Ishii, 1936; *Capsala magrona* (Ishii, 1936) Price, 1939.

DESCRIPTION: Body oval, about 7 mm long by 5.5 mm wide. Cuticle smooth except for band of unicuspid spines arranged in 3 irregular rows on lateral margins of dorsum; spines pointed, about 0.015 mm long. Prohaptors cup-like, about 0.9 mm in diameter; opisthohaptor subterminal, about 1.6 mm in diameter, with central heptagon open and with customary 7 rays or ridges radiating from it; anchors present, about 0.3 mm long, simple, slightly

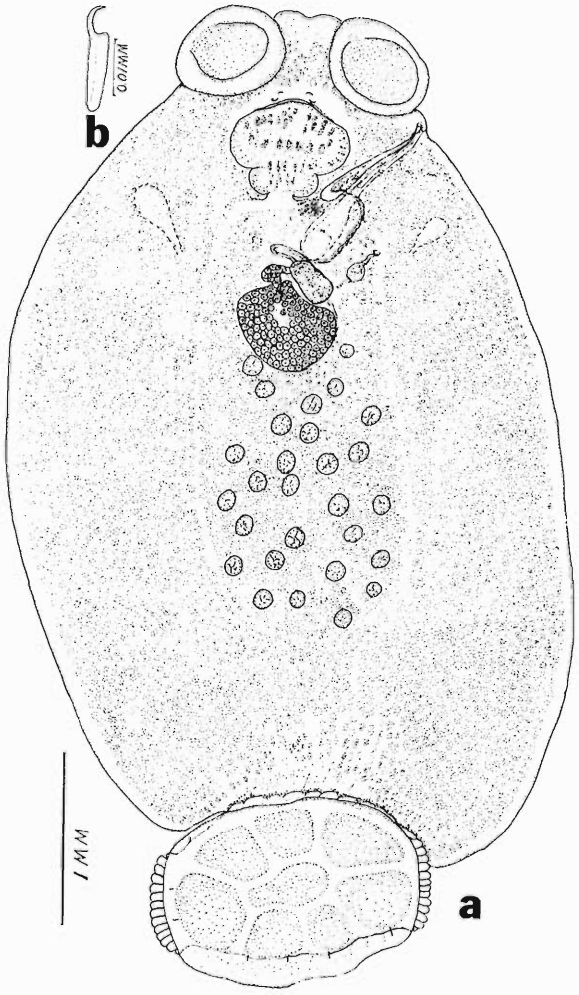

Figure 1. *Caballerocotyla caballeroi.* a, complete worm, ventral view; b, marginal opisthohaptoral hooklet.

curved; marginal hooklets present; marginal membrane delicate; ventral surface between rays of haptor provided with scattered, relatively large pulvinate papillae. Oral aperture median, about 0.9 mm from anterior end of body. Pharynx constricted, about 1.3 mm long by 1.2 mm wide, with anterior portion of cavity provided with strong papillae; remainder of digestive tract apparently as in other capsalids. Eyes present, 4 in number, dorsal and immediately anterior to cephalic margin of pharynx; remainder of nervous system not observed. Genital apertures not observed, apparently situated some distance posterior to left prohaptoral sucker margin and about an equal distance from body margin (Ishii and Sawada stated that the "genital pore opens behind left anterior sucker," but the exact point behind the sucker is not given). Testes numerous, confined within limits of intestinal tract. Ovary transversely oval, about 0.5 mm long by 0.8 mm wide, median and immediately pretesticular. Ootype pestle-shaped, relatively short. Seminal receptacle prominent, to left of vitelline reservoir; vaginal aperture not located. Vitelline reservoir oval, to left and adjacent to anterior margin of ovary. Vitelline follicles abundant, occupying greater part of body and extending into cephalic lobe. Egg not present.

HOST: *Thunnus orientalis.*

LOCATION: Gills.

DISTRIBUTION: Japan.

SPECIMEN: U. S. National Museum Helm. Coll. No. 37748 (holotype).

The original descriptions of this species are about as complete as possible from the material available, except for presence of dorsal marginal spines, ventral opisthohaptoral papillae, and distribution of vitellaria. Price (1939) called attention to the oversight as regards spines and papillae. With respect to vitelline distribution, follicles of these glands are found to fill the cephalic lobe, which is apparently consistent for the genus but not noted by the original author.

Caballerocotyla katsuwoni (Ishii, 1936) Price, 1960 (Fig. 2, e-f)

SYNONYMS: *Tristoma katsuwonum* Ishii, 1936; *Capsala katsuwona* (Ishii, 1936) Price, 1939.

DESCRIPTION: Body oval, about 3.9 mm in overall length by 2.1 mm in maximum breadth, without distinctly demarcated cephalic lobe. Cuticle apparently without papillae or spines. Prohaptors slit-like, about 0.25 mm long, imbedded in anterior margin of cephalic lobe and not cup-like as in other species. Opisthohaptor about 0.5 mm in diameter, stalked; ventral ray pattern apparently similar to that of other species; anchors about 0.13 mm long, almost straight, tips slightly incurved; ventral papillae absent; marginal hooklets present, about 0.018 mm long. Oral aperture median; pharynx constricted, 0.6 mm long by 0.6 mm wide in anterior portion; anterior portion of pharyngeal cavity provided with strong papillae; remainder of digestive tract not observed. Eyes present, 2 pairs, located dorsally and in front of pharynx; remainder of nervous system not observable. Genital apertures marginal, sinistral, at level of widest portion of pharynx. Cirrus pouch about 0.3 mm long; testes relatively numerous, confined to interintestinal field. Ovary globular, about 0.3 mm wide, median, pretesticular. Ootype pestle-shaped, its base lying in median field about midway between base of

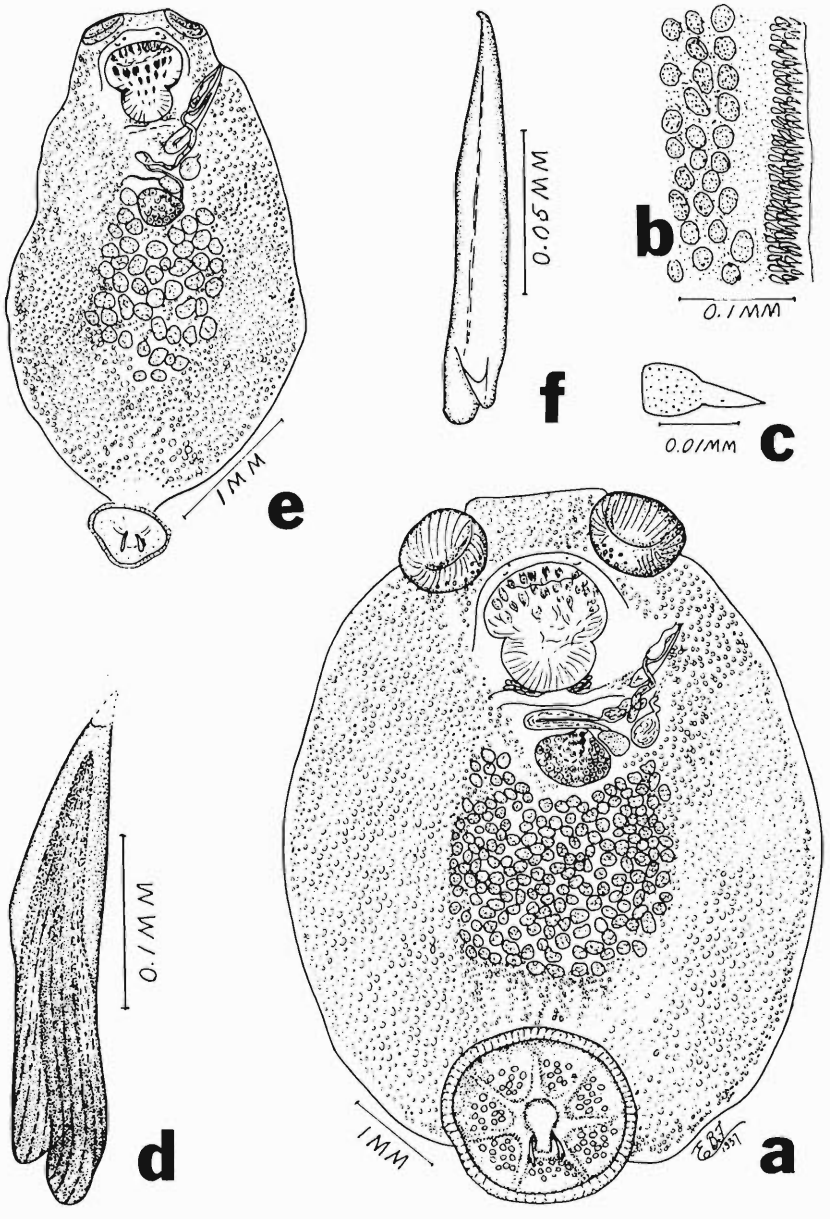

Figure 2. a-d, *Caballerocotyla magronum*. a, complete worm, ventral view; b, dorsal marginal spines showing distribution; c, individual dorsal marginal spine; d, opisthohaptoral anchor. e-f, *C. katsuwoni*. e, complete worm, ventral view; f, opisthohaptoral anchor.

pharynx and vitelline reservoir. Seminal receptacle prominent, to left and slightly anterior to vitelline reservoir; vaginal aperture not located. Vitelline follicles abundant, occupying greater part of body and extending into cephalic lobe. Eggs not present.

HOST: *Katsuwonus vagans.*

LOCATION: Gills.

DISTRIBUTION: Japan.

SPECIMEN: U. S. National Museum Helm. Coll. No. 37749 (holotype).

The specimen upon which this species is based is not in the best condition; the cuticle is missing in many areas and there is evidence of erosion, indicating that the worm had been dead for some time before fixation. Aside from the relatively small size of the opisthohaptor, the lack of a well defined cephalic lobe and the slit-like prohaptors are distinctive.

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Two New Species of Coccidia, *Eimeria crassa* and *E. pulchella* (Sporozoa, Eimeriidae) from the Canada Goose, *Branta canadensis* (L.)

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During an investigation into coccidiosis of Canada geese, feces were collected from a group of these birds that had been kept in captivity for about 2 years at the Patuxent National Wildlife Refuge. The feces were mixed with 2.5 percent potassium dichromate and held for a few days to promote sporulation of any oocysts that might be present. An aqueous suspension prepared from this material was injected into the esophagus of a young Canada goose that had been raised outdoors at the Beltsville Station. Within one week after the injection, two different kinds of oocysts appeared in the feces of this goose. The oocysts were unlike any than had been reported from ducks and geese and are here described as new species.

Eimeria crassa n. sp. (Fig. 1)

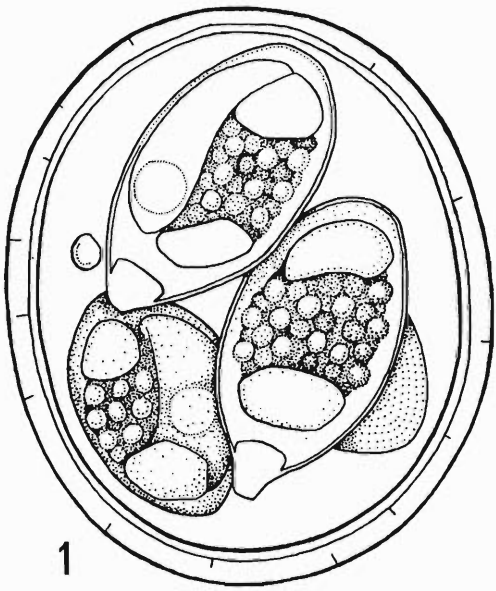
Oocysts 19.2 to 24.3 by 24.0 to 28.3, average 21.2 by 25.8 microns; dimensions based on a total of 51 measured oocysts. Shape broadly elliptical to ovoid. Shape index (breadth divided by length) 0.70 to 0.90, average 0.81. No micropyle. Wall thick, composed of 2 layers; outer layer pale yellow, lightly sculptured, friable, about 0.9 microns thick, slightly thinner at one end; inner layer smooth, colorless, about 0.4 microns thick. Cytoplasm of unsporulated oocyst coarsely granular. Sporulated oocyst with 1 large and 1 to 3 small granules among sporocysts. No oocystic residuum. Sporocysts (16 measured) 7.5 to 9.6 by 12.8 to 16.0, average 8.2 by 14.1 microns; rounded at one end and broadly pointed at other; large Stieda body; coarsely granular sporocystic residuum.

The absence of a micropyle differentiates the oocyst of *E. crassa* from all species of *Eimeria* described from ducks and geese except *E. parvula* Kotlán, 1933, and *E. farri* Hanson, Levine and Ivens (1957). The oocyst of *E. parvula* is much smaller (10 to 14 by 10 to 15 microns), spherical to subspherical in shape, and has a smooth, colorless wall. *Eimeria crassa* differs from *E. farri* in having a lightly sculptured double-layered wall rather than a wall composed of a single smooth layer and also in having an almond-shaped sporocyst with a large Stieda body rather than an elongate ovoid sporocyst with a small Stieda body.

The oocysts of *E. crassa* were recovered from the feces of *Branta canadensis* in large numbers on the 5th and in diminishing numbers on the 6th and 7th days after experimental inoculation.

Eimeria pulchella n. sp. (Figs. 2-3)

Oocysts 12.1 to 18.2 by 20.1 to 27.6, average 14.8 by 24.3 microns; dimensions based on a total of 57 measured oocysts. Shape index 0.52 to 0.72, average 0.60. Shape ovoid, somewhat broader at one end than at other. Very small micropyle visible on some but not all oocysts. Wall composed of 2 layers; outer layer colorless to pale yellow, smooth, about 0.6 microns thick; inner layer colorless, smooth, about 0.3 microns thick. Cytoplasm of unsporulated oocyst finely granular. Sporulated oocyst with a cluster of small



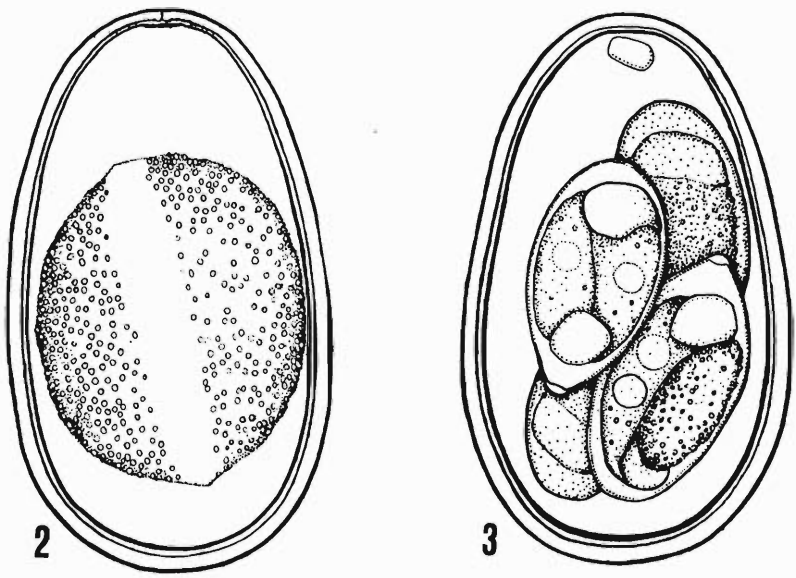


Fig. 1. *Eimeria crassa* n. sp.
Fig. 2. *E. pulchella* n. sp. Oocyst in 1st stage of sporulation.
Fig. 3. *E. pulchella* n. sp. Sporulated oocyst.

flattened granules or with one large flattened granule at narrow end of oocyst and occasionally with 1 or 2 small granules among sporocysts. No oocystic residuum. Sporocysts average 6.0 by 11.9 microns (dimensions based on 12 measured sporocysts), rounded at one end and bluntly pointed at other end, with a small Stieda body. Sporozoites closely applied to one another and to finely granular sporocystic residuum. A large ellipsoidal refractile body at rounded end of sporozoite and a smaller spherical refractile body just anterior to nucleus. A number of small granules irregularly distributed through cytoplasm of sporozoite.

Except for *E. parvula*, *E. farri* and *E. crassa* n. sp., the oocysts of *E. pulchella* differ from all other species of *Eimeria* described from ducks and geese in that the micropyle is very small or sometimes imperceptible. Of the 3 species in which no micropyle has been described, *E. parvula* is relatively small and is almost round; *E. farri* is ellipsoidal to slightly ovoidal, the wall is composed of a single layer, the sporocysts are elongate and ovoid, with the sporozoites located at opposite ends of the sporocysts; *E. crassa* is broadly ellipsoidal to ovoid, with a lightly sculptured thick outer wall, with a large Stieda body on the sporocyst, and a coarse sporocystic residuum.

This species was recovered from feces of a captive Canada goose on the 5th, 6th, and 7th days after experimental inoculation.

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Trichodorus allius, a New Species of Stubby-Root Nematode from Oregon (Nemata: Dorylaimoidea)*

HAROLD J. JENSEN

Periodic soil sampling since 1955 indicates the stubby-root nematode *Trichodorus allius* n. sp. is a common soil inhabitant in root-zones of declining onions. Large populations of stubby-root nematodes in onion plantings usually correlate with patches of severely diseased plants in the fields. The symptoms, stunting and top yellowing, are more conspicuous in damp, cool weather before onions begin rapid growth and are less noticeable as the growing season progresses. Such onions are characterized also by inferior root systems consisting of a few short remnants which have lost their normal white color, turned yellowish, and become marked with dark-brown tips and numerous localized lesions. Earlier noticeable differences are less apparent at harvest. Growers, however, estimate that 10-12% of the crop is lost annually because of the smaller size of affected onions.

Hoff and Mai (1962) recently described symptoms and demonstrated pathogenicity of another stubby-root nematode, *T. christiei* Allen 1957, affecting onion plantings in New York. Their description of the disease was very similar to the onion disease described by Jensen (1961) and by Jensen and Konicek (1962) in relation to an unidentified stubby-root nematode taken

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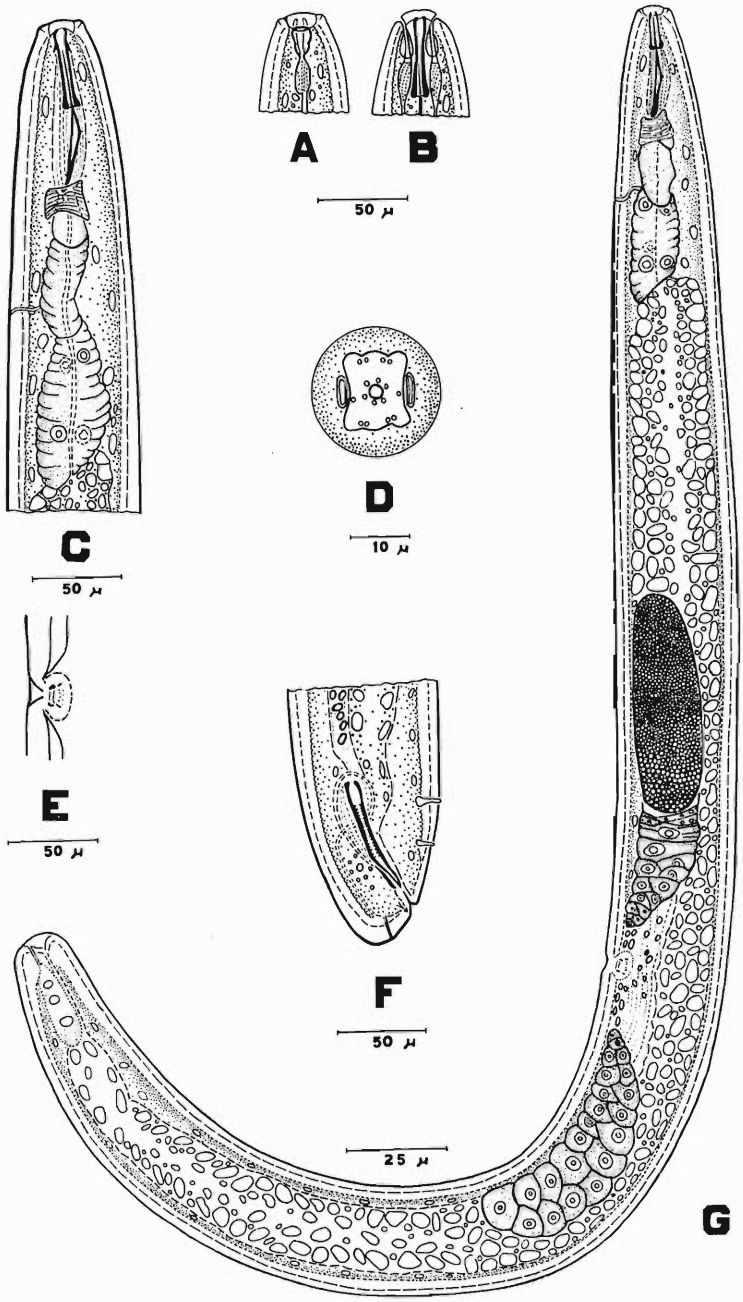

Fig. 1. *Trichodorus allius:* A, anterior end of female showing amphid in lateral view; B, anterior end of female showing amphids in ventral view; C, esophageal region of female; D, face view of female; E, vulva region showing arrangement of sclerotized pieces; F, male tail; G, adult female.

from onion plantings in Oregon. Later investigations have shown that the Oregon stubby-root nematode is the new species herein described.

Trichodorus allius, n. sp.

FEMALE (10): 0.64-0.78 mm.; a = 15-18; b = 5-6.4; c = subterminal; V = $^{24-11}$ 51-56$^{10-21}$. Onchiostyle = 37-48 microns.

MALE (1): 0.68 mm.; a = 16.5; b = 6.2; c = 65.5; T = 61. Onchiostyle = 42 microns. Spicules = 30.9 microns. Gubernaculum = 12 microns.

FEMALE (Holotype): 0.74 mm.; a = 16.5; b = 6.4; c = subterminal; V = $^{14.6}$52^{14}. Onchiostyle = 37.5 microns.

Body cylindroid with slight taper towards blunt anterior and posterior ends. Thickened cuticle typical of the genus with inner surface frequently marked by transverse striae at anterior and posterior extremities. Truncate lip region set-off by amphid apertures. Stomal rhabdians conspicuous, extending about one-third onchiostyle length. Onchiostyle typical with tripartite region. Esophagus strongly developed, frequently folded twice to appear in three sections. Muscular bulb-like basal portion contains five esophageal-gland nuclei and overlaps intestine. Well developed nerve ring encircling anterior portion of esophagus usually near base of onchiostyle. Excretory pore opens opposite anterior margin of basal esophageal bulb; canal makes right angle turns or passes through cuticle in zig-zag path before becoming obscure in body. Vulva near middle of body. Vagina surrounded by two distinct reniform sclerotized pieces and two arched parallel bands; additional internal series of cutinized pieces frequently observed. Didelphic, ovaries reflexed about three-fourths their length. Spermatheca not observed. Eggs approximately three times longer than wide and about twice as wide as adjacent body width. Rectum about one and one-half times adjacent body width. Anus and caudal pores subterminal.

MALE (Allotype) Resembles female in general body shape. Spicules only slightly curved, bearing transverse striated markings. Gubernaculum faintly sigmoid with slight keel-like enlargement near distal end. Caudal alae absent. Two supplementary papillae located within range of spicules. Paired post-anal papillae and subterminal caudal pores present.

HOLOTYPE: Female collected July 7, 1961 by H. J. Jensen, Slide Number *Trichodorus* 6, Oregon State University Nematode Collection, Corvallis.

ALLOTYPE: Male collected July 7, 1961 by H. J. Jensen, Slide Number *Trichodorus* 6a, Oregon State University Nematode Collection, Corvallis.

PARATYPES: 12 females same data as holotype and allotype.

TYPE HOST: Soil from root zone of onion, *Allium cepa* L. Yellow Globe Danvers (Oregon Selection).

TYPE LOCALITY: Labish Center, Oregon.

DIAGNOSIS: Females of *Trichodorus allius* can be distinguished by the anterior position of nerve ring and by sclerotized pieces surrounding the vagina. Males are characterized by slightly curved, striated spicules and two supplements located within range of the spicules. Males rare, only two found in numerous collections.

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A Second Report of the Occurrence of *Ostertagia lyrata* in Cattle in California

MARY TERESA MULLEE*

Since the publication of the first report of the occurrence of *Ostertagia lyrata* in two naturally infected cattle in California (Mullee, M. T., 1962. J. Parasitol. 48: 86), fifty-six cattle from another area of California have been found to have been parasitized by this nematode on three separate occasions.

The infected animals were purchased from the Orland area, Glenn County, California for various anthelmintic trials at the University of California. Following treatment of some, all were sacrificed in order to determine the number and species of the gastro-intestinal nematodes. Male *O. lyrata* occurred on an average as 10.5% of the abomasal trichostrongyles with a range from 5 to 25% of the worm population in the fifty-six treated and untreated cattle infected with this species. The abomasal nematode which occurred in the largest number was *O. ostertagi*. *Haemonchus* sp. and *Trichostrongylus axei* were present in varying numbers. Females of *Osteragia* spp. were not speciated.

It is felt that the occurrence of *O. lyrata* is more widespread in California than first reported.

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Thanks are expressed to the veterinary students who assisted in the projects.

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