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PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

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The feeding of some hollow-stylet nematodes.[1] M. B. LINFORD, Pineapple Experiment Station, University of Hawaii.

In a preliminary report, Linford and Oliveira, 1937, described briefly the flow of saliva during the predacious feeding of 2 species of *Aphelenchoides* Fischer, 1894, and recorded the habit of preying on other nematodes in 3 genera of dorylaims. This paper describes techniques employed in those observations and reports details omitted from the earlier note to achieve brevity. It also considers the feeding habits of 3 fungus-sucking species, including *Ditylenchus intermedius* (de Man, 1880) Filipjev, 1936, and briefly reports observations on the feeding of *Heterodera marioni* (Cornu, 1879) Goodey, 1932. The feeding of this root-knot nematode is discussed more fully in a separate paper (Linford, 1937).

METHODS

Nematodes have been observed chiefly in Petri dishes of hard agar inverted on the stage of the microscope and viewed through the glass. Specimens for study are located with a wide-field microscope, but details are observed at 600 diameters with the aid of a 40 × achromatic water-immersion objective with free-working distance of 1.9 mm. Adequate illumination requires a powerful lamp with neutral tint filters and a condenser system which focuses well above the stage.

Of several agar formulas employed 2 have been used most extensively: 3 per cent agar in tap water, and 3 per cent agar in a corn-meal decoction prepared by soaking 40 grams of corn-meal in a liter of water at 60°C. for 1 hour, straining and restoring to volume. The plain agar, when inoculated with a mixed soil flora and fauna, supports ample growth to favor various free-living nematodes and still retains transparency for microscopic study. The corn-meal agar is preferred when nematode populations are initially low and, of course, when nematodes are to be observed feeding on fungi. Richer media favor more rapid multiplication of nematodes which feed upon fungi, but the above formula favors a sparse mycelial growth suitable for observation. The agar content of both these media favors absorption of excess water and limits development of bacteria and protozoa.

For recognition of the predacious habit, suspected nematodes have sometimes been transferred to agar in which other nematodes are already abundant. This was done especially with the dorylaims after the initial observations, and has proved particularly useful with these nematodes which often but not always fail to multiply in agar. For prey, *H. marioni* larvae hatched in place have often been used, although the tendency of some dorylaims to feed in egg masses where they are not readily observed is a disadvantage.

Species of predacious *Aphelenchoides* have been found in dishes to which were added chance mixtures of nematodes from soil or roots. Given a sufficient population of prey they multiply until they are detected readily. The mixed population of nematodes is washed from a sample, concentrated in the usual

[1]Published with the approval of the director as Technical Paper No. 100 of the Pineapple Experiment Station, University of Hawaii.

way and transferred to a small area of the agar in as little water as possible. A period of exposure of the agar or covering with a porous clay Petri-dish cover hastens reduction of the surface film of water, permitting the nematodes to move freely over and through the substratum. Cultures so obtained may be retained for study over a period of weeks if tightly covered to prevent excessive drying.

From cultures prepared in this way, fungus-sucking species frequently may be isolated by picking with a needle to established cultures of suitable fungi.

THE FEEDING OF PREDACIOUS DORYLAIMS

Members of the genera, *Dorylaimus* Dujardin, 1845, *Discolaimus* Cobb, 1913, and *Actinolaimus* Cobb, 1913, in attacking nematodes orient the head at right angles to prey, bringing their lips into firm contact, before protruding the stylet in an attempt to penetrate. Large discolaims appear to grip their prey with their lips. If the first attempt is unsuccessful there follow repeated thrusts of the stylet. Once penetration is accomplished the stylet is held far protruded into the prey while the esophagus begins a rhythmic sucking process which quickly disorganizes the structure of the prey. The various organs are seen to break down, drift towards the stylet and enter it. Lateral expansion and contraction of the esophagus involve such changes in length that a forward and backward motion of the anterior end of the intestine is conspicuous even at low magnification. This interferes seriously with observation of the esophageal glands during feeding, and no flow from them has been seen.

Periods of continuous sucking are relatively long, and during alternating intervals the predator rests with its stylet still protruded. The first period of sucking disorganizes the prey so that there is no appreciable struggling, and feeding periods are continued until the body wall is left almost empty and often collapsed.

Too limited data are at hand to estimate the relative importance of nematodes in the diet of any of the observed members of these 3 dorylaim genera. The writer has seen various species of *Dorylaimus* sucking nematode eggs, rotifers and large infusoria, and earlier workers have recorded from direct observation or indirect evidence, their feeding on oligochete worms, mite eggs, and nematode eggs.

THE FEEDING OF PREDACIOUS APHELENCHOIDES

Aphelenchoides tenuicaudatus (de Man, 1895) Goodey, 1933, and an unidentified species of this genus mentioned in the earlier report as predacious, are so similar in habit of feeding that one description suffices. These nematodes are particularly favorable for observation because of their relatively small diameter, transparent bodies, very slight striation, and their habit of lying motionless except for pulsation of the esophageal bulb during prolonged periods of feeding. A third species recognized more recently to be predacious is less favorable because of more prominent striation.

These 3 species prey successfully on various free-living nematodes and such root parasites as *H. marioni* and *Pratylenchus pratensis* (de Man, 1881) Filipjev, 1936, even their larvae killing adults of species much larger than themselves. In addition to attacking live nematodes, all 3 species will feed upon nematodes killed by others. As many as 4 individuals have been seen feeding simultaneously on one prey, and prey left by one nematode may later be fed upon by another even after as long as 20 hours. Only one of these species, *tenuicaudatus*, has been seen feeding upon nematode eggs, and none has been seen attempting to penetrate with its stylet members of its own species or fungal hyphae even though many contacts have been observed. Each of these predators appears to recognize its prey only through stimuli obtained while its head is in direct contact with the body, and shows no ability to follow an escaping nematode.

After so orienting itself that its lips make firm contact with its prey, a predacious *Aphelenchoides* protrudes its slender stylet in an attempt to penetrate and, if not immediately successful, may thrust repeatedly unless its prey escapes. Once the stylet penetrates, it is held protruded one-fourth to one-third its length even for periods of an hour or longer, until the predator is ready to leave the kill. Withdrawal of the stylet from the prey is sometimes difficult, particularly after short periods of feeding, the predator pulling back or laterally for several seconds and often bending the somewhat flexible stylet. In such cases the stylet may remain protruded for several seconds after removal from the prey before sliding back to its normal resting position.

The feeding of these small predators is of particular interest for it exemplifies partial digestion of food before ingestion under the influence of a secretion from the dorsal esophageal gland which is injected into the prey through the stylet. This secretion is regarded as saliva. The dorsal gland of one of these nematodes which has not fed recently appears closely granular because of its being filled with small, somewhat refractive globules. These globules suspended in a clear fluid phase permit one to follow movement of the saliva and, during feeding, they are seen to flow from this gland until, after prolonged feeding, the gland is optically almost empty.

During each period of pulsation of the esophageal bulb and continuing briefly after each period, the salivary emulsion flows anteriorly from the gland through a slender and otherwise inconspicuous duct lying adjacent to and dorsad of the intestine. This duct enters the bulb, then widens and continues anteriorly dorsad of the cuticular plates between the sub-dorsal segments of the bulb, to a point just anterior of the plates. The anterior region of the bulb is alveolated, and into its cavities the duct empties. Here saliva accumulates prior to its injection into the prey. While this reservoir is filling with saliva and while the bulb is not pulsating there occurs an irregular twitching of this anterior part, and after the alveoli are full such twitching may be associated with limited return flow of saliva through the duct towards the gland.

From this reservoir in the esophageal bulb the saliva is ejected forward through the lumen of esophagus and stylet during periods when food is not being ingested. The globules are drawn out to elongated form during passage, round up again as they escape from the stylet tip, but are soon lost from sight as they drift away into the prey.

Ingestion of food occurs during periods of vigorous and rapid pulsation of the esophageal bulb alternating with periods when the bulb is at rest. Lengths of such periods of pulsation and rest vary widely but have approximated 20 seconds and 2 minutes, respectively, in some individuals. These periods of pulsation are interrupted momentarily at varied intervals by very sudden rushes of saliva forward into the prey from the reservoir in the bulb. The most conspicuous and apparently most copious injections of saliva occur, however, just at the end of each period of pulsation. When a predator attacks a large, firm bodied nematode, such as an adult *Aphelenchus avenae* Bastian, 1865, injection of saliva appears to be the dominant process during the first 10 minutes or longer, with little food entering the intestine. Later, however, salivary injection becomes progressively less copious and food is ingested more freely.

The inward flow of food through stylet and esophagus is not as readily seen as the outward flow of saliva even when the drift of globules towards the stylet tip and the flow into the intestine make it obvious that food is entering. The food approaches the tip of the stylet as globules larger than those of the saliva and these must be drawn out to very elongated form to pass the lumen. Such elongated homogeneous masses, moving rapidly under the suction of the bulb, are inconspicuous by comparison with the less elongated and well spaced masses of saliva which apparently move forward at lower velocity. Passage of food through the esophagus is most readily seen after the prey is almost empty so that smaller masses of food enter the stylet well separated by colorless fluid.

Two apparent results of the salivary injections are paralysis of the prey and the beginning of digestion of its organs *in situ*. Paralysis was suggested by a conspicuous absence of struggling of the prey which, unlike those attacked by the dorylaims, are disorganized only slowly. Definite evidence was provided by the observation reported in the prior note and now repeated several times that a nematode penetrated by the stylet of one of these small predators loses its powers of locomotion even if the stylet is withdrawn almost immediately after penetration. Such paralysis is very slow, however, in affecting the stylet and esophagus which may continue to twitch for as long as an hour, in extreme cases, while the prey is being continuously fed upon.

A digestive action of the injected saliva was suggested by the fact that during prolonged feeding the prey becomes progressively disorganized even though the mechanical force, by itself, usually is insufficient to collapse the empty body wall. The organs break down to a coarse emulsion which flows towards the stylet as a series of globules, leaving the denuded stylet, esophageal tube, cuticular plates of the bulb, excretory duct and lining of the intestine as the only solid remains within the cuticle. The narrow orifice of the stylet would readily be clogged by solid matter. Ejection of saliva from the stylet tip appears, indeed, to aid mechanically in crowding back masses of food still too large or rigid to pass through the stylet with ease.

More direct evidence of digestion is provided by the observation of nematodes fed upon briefly and then abandoned. One *tenuicaudatus* was seen to feed 3 minutes upon an *avenae* larva and then leave it before any disorganization was apparent. Digestion continued until by the following morning, the cuticle enclosed merely a globular suspension. Another *tenuicaudatus* fed an hour midway on the body of an *avenae* female, with copious injection of saliva. It then moved away, its salivary gland apparently empty, leaving its prey with stylet and esophagus still twitching and with only local disturbance of its tissues near the point of penetration. The following morning, digestion of this prey was far advanced throughout its body length, even the muscular bulb being reduced to an aggregation of globules. These observations demonstrate that the secretion of the dorsal gland of these predacious *Aphelenchoides* is a digestive fluid which aids in reducing the bodies of prey to a consistency ready to enter the narrow lumen of the stylet.

An incidental point of interest is that mature but unlaid eggs of *Aphelenchus avenae* will hatch within the body of a nematode sucked almost empty by such predators, and that the larvae may live for at least 24 hours within the mother's cuticular wall.

THE FEEDING OF NEMATODES ON FUNGI

Since Christie and Arndt, 1936, described the feeding of *Aphelenchus avenae* and *Aphelenchoides parietinus* (Bastian, 1865) Steiner, 1932, on fungal hyphae, Christie and Crossman, 1936, and Steiner, 1936, have reported the similar feeding of *Aphelenchoides fragariae* (Ritzema Bos, 1891) Christie, 1932, and *A. limberi* Steiner, 1936, respectively. The writer and J. M. Oliveira, while studying the influence of decomposing organic matter in soil upon populations of various nematodes, detected an increase in numbers of *Ditylenchus intermedius*. Upon testing, this nematode was found to suck hyphae and to multiply in cultures of various fungi.

With respect to feeding habits, as well as morphology, these species fall into two classes. *Avenae* and *parietinus* feed as described by Christie and Arndt except that while feeding the stylet is held distinctly protruded, its tip often reaching the opposite wall of a narrow hyphal cell. As the nematode moves away its stylet is promptly drawn back to its resting position. Both species are active and their periods of feeding are of short duration making close observation

difficult but, thus far, no flow of saliva either within the duct or into the fungus has been detected.

Intermedius presents a striking contrast. When not feeding it is moderately active, moving freely through agar. Upon contact of its head with mycelium it protrudes its stylet in the usual way with a series of quick thrusts. Once the hypha is penetrated, however, unlike *avenae* and *parietinus* which feed at once, this nematode comes to rest not disturbed even by pulsation of the esophageal bulb, and remains at rest for periods often exceeding 1 hour and sometimes 2. Then there follows a relatively slow pulsation of the bulb lasting only a few seconds, after which the nematode promptly withdraws its stylet and moves away.

Since observing saliva flow in predacious *Aphelenchoides*, this slow feeding of *intermedius* has been followed in detail with the result that saliva has been seen to flow from the dorsal esophageal gland, through the long duct, to near the base of the stylet. This gland is more conspicuous in the live specimen than are the 2 subventral glands, and its content, while finer than in predacious *Aphelenchoides*, is still sufficiently granular to be followed in a favorable specimen. After a hypha is penetrated there is a slow forward flow through the dorsal side of the esophageal bulb and anteriorly along the slender duct adjacent to the lumen of the esophagus, up towards the dorsal connection of the duct with the lumen of the esophagus near the stylet. As this flow continues the duct expands laterally, becoming more granular and much more conspicuous. Then a clear space, resembling a vacuole, sometimes appears in the anterior end of the duct, enlarges and lengthens until it may extend half or more of the length of the duct posteriorly towards the bulb. Gradually, again, this space is occupied by granular matter and the duct becomes narrower. Later, the esophageal bulb pumps rhythmically for a few seconds and the nematode moves away.

No flow of saliva through the stylet into the hypha has been detected, and yet these observations compose a strong circumstantial case for digestion of food before injestion. In this nematode, the stylet is so slender that observation of substances flowing through its lumen would be difficult. Moreover, it has thus far been seen feeding only on hyphae of such small diameter that observation of their cytological constitution is not satisfactory with the techniques here employed. But movement of saliva within the duct towards the stylet occurs at a time when the esophageal bulb is at rest and when nothing can be seen entering the intestine. It thus seems most probable that the secretion is injected slowly into the hyphal cell and given time to start digestion before ingestion of food begins.

THE FEEDING OF HETERODERA MARIONI

After these observations were completed, the writer turned his attention to the root-knot nematode. This nematode, contrary to earlier views, punctures the giant cells surrounding its head with its extremely slender stylet tip, feeding in turn in all the cells within reach of its remarkably mobile head. Pulsation of its esophageal bulb occurs only with the stylet protruded. Swollen females removed undamaged from galls have been observed feeding in nutrient solution, and under these conditions the extrusion of saliva from the stylet tip has been observed. For details of techniques and observations, see Linford, 1937.

DISCUSSION

In a recent survey of plant diseases caused by nematodes, Goodey, 1935, summarized evidences for the flow of pathogenic secretions from the mouth but found no records of observation of such secretions and refrained from referring to esophageal glands as salivary glands in the absence of adequate evidence. It now appears, however, that the dorsal gland, in esophaguses of the *Aphelenchus* and *Ditylenchus* types, is definitely salivary in function. Its duct opens into the

lumen of the esophagus anteriorly from the valvular mechanism of the bulb, making possible the flow of its secretion out through the mouth. The 2 subventral glands, however, emptying behind the valve, cannot well be salivary.

Goodey also called attention to the absence, at that time, of evidence of use of the stylet as a puncturing organ and pointed out that some of the most destructive parasites have very delicate stylets. In view of the strong digestive action of saliva here demonstrated, it now appears likely that destructiveness may be found more closely related to volume and activity of saliva injected into tissues than to ability of the parasite to destroy tissue by mechanical means. The varied pathological states induced by different parasites may be directly related to composition of saliva, for obviously the secretion which stimulates development of giant cells around the head of the root-knot nematode is less actively proteolytic than the saliva of predacious *Aphelenchoides*. The troublesome problem of several distinct pathological states in strawberries attributed to infestations of *Aphelenchoides fragariae* may plausibly be a result of distinct strains of this nematode species, secreting salivas of different properties.

Among the 7 genera of hollow stylet nematodes which the writer has seen feeding, including species of 3 dorylaim genera with odontostylets, as well as 3 predacious *Aphelenchoides*, 3 fungus-sucking species, and 1 obligate plant parasite with buccal stylets, all use the stylet in puncturing and all hold it protruded far into the food organism during the period of ingesting food. Even swollen females of *H. marioni* which have long been fixed in position within the gall, when dissected out and examined in nutrient solution, exhibit pulsation of the bulb only when the stylet is protruded. On this basis it appears safe to regard this as the usual feeding habit of nematodes equipped with such stylets until exceptions are actually observed.

Penetration of a plant cell or of animal prey by a stylet is accomplished only when the nematode and its food object are held in some medium which offers sufficient resistance that the force required to puncture can be applied. In water, where nematodes are most commonly observed, the predators discussed here cannot feed and in soil, unless spread very thinly, they cannot be observed. The use of agar media has been indispensable in this work and probably can be adapted to studies on the feeding habits of various other nematodes.

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Notes on the feeding of *Ditylenchus dipsaci* (Nematoda: Tylenchidae).[1]

M. B. LINFORD, Pineapple Experiment Station, University of Hawaii.

Since completing two recent papers on the feeding habits of several nematodes with buccal stylets and with odontostylets (Linford, 1937 a & b), the

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writer has made a few incidental observations on *Ditylenchus dipsaci* (Kühn, 1858) Filipjev, 1936, which indicate that it, like the species observed more adequately, uses its stylet for puncturing and feeds with its stylet protruded.

Godfrey (1931) reported *dipsaci* in *Hypochaeris radicata* L. at Olinda, Maui, Territory of Hawaii, on the slopes of Haleakala. For these studies the writer collected it in this host at Olinda and also at various higher points to above 6,000 feet, all in pasture land.

When thick sections of fresh leaf galls were mounted in water for observation the uninjured nematodes quickly worked out of the tissue. Sections mounted between thin layers of plain 0.5 per cent agar, previously cooled on both slide and cover glass, were more favorable, for with a 40× water immersion objective it was possible to see adequate details of favorably situated specimens, and nematodes remained longer in the tissues, sometimes returning to work about persistently in sections after having left them. Some such sections, exposed to light, remained fresh during 40 hours with mesophyll cells apparently unaltered. Lack of sufficient infested material and the observation of feeding with another technique led the writer to abandon this method without observing actual feeding. Persistently, however, *dipsaci* (large larvae and an adult male were observed) were seen pressing their heads against mesophyll cells and thrusting their stylets in a series of quick jabs as if attempting to penetrate the wall. No actual penetration was seen, and likewise no pulsation of the esophageal bulb accompanied such thrusting.

Several observations of feeding on fungal hyphae were obtained from Petri dishes of water agar on which pieces of leaf galls had been placed. The fungi, which were not identified, were chance contaminants associated with the galls. Nematodes emerging from the galls remained chiefly within a few millimeters of the leaf tissue even after this was far decomposed.

Each *dipsaci* observed to feed was first seen moving about slowly, jerkily thrusting its stylet slightly forward at frequent intervals. (*Ditylenchus intermedius* (de Man, 1880) Filipjev, 1936, similarly jerks its stylet irregularly as it moves through agar prior to feeding.) Upon contact with mycelium it pressed its head firmly against a cell and thrust its stylet vigorously and repeatedly until it either penetrated the cell or moved away. When penetration was accomplished the stylet was thrust far forward into the cell and pulsation of the esophageal bulb began at once. This, in each instance, was irregular and halting in comparison with nematode species formerly observed, and extended from less than 1 minute to over 5 minutes in different instances. No flow of saliva was observed, but too few observations were made for significance to be attached to this, particularly since this probably represents only incidental feeding.

Meager as these notes are, they demonstrate that, contrary to views formerly expressed (Goodey, 1935, p. 19), *Ditylenchus dipsaci* feeds by puncturing plant cells with its stylet. They also demonstrate that this plant parasite is able to feed upon fungi, but they have been too limited in scope to determine the extent to which such feeding may favor the long survival of this parasite in soils devoid of higher plants.

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The nematode *Ditylenchus dipsaci* (Tylenchidae) in tulip leaves. GRACE SHERMAN COBB, U. S. Bureau of Plant Industry.

During some recent nematode examinations at Babylon, Long Island, N. Y., in cooperation with the U. S. Bureau of Entomology and Plant Quarantine, 3 tulip leaves (variety "Le Notre") were found infested with the bulb or stem nematode, *Ditylenchus dipsaci* (Kühn, 1858) Filipjev, 1936. These findings are of particular interest because this nematode has never before been reported from tulips growing in this country. The only previous record of dipsaci in tulip seen in this country was in a bulb from Holland intercepted at New York in 1925. This identification was made by Dr. G. Steiner of the Division of Nematology.

The fact that the present infestation was in the leaves only, and not in the bulbs, is also significant and may be explained by the history of the planting which is as follows: The bulbs came from Holland in 1935 and were very small when planted in the experimental plot at Babylon along with nema-infested narcissus bulbs. In the fall of 1936 the tulips were dug and the plot again planted with narcissus bulbs, some of which were nema-infested. The infested leaves in question came from volunteer tulips which appeared in 1937, having been missed during the 1936 digging. No especial symptoms were noticed, and only 3 out of 16 leaves examined contained *D. dipsaci*. Eggs, various larval stages and adults were seen in large numbers in these 3, however.

Although tulip has been known as a host of *D. dipsaci* since 1906 (Ritzema Bos, 1906, Tijdschr. Plantenziekten., 12: 183) the attacks are extremely rare as only single infestations have been reported from Holland, Ireland and England.

Opuscula miscellanea nematologica, VI. G. STEINER, U. S. Bureau of Plant Industry.

(1) THE STATUS OF THE NEMATODE APHELENCHOIDES COFFEAE (ZIMMERMAN, 1898), N. COMB.

Zimmerman (1898, Meded. S'Lands Plantentuin 27 (1): 44) described this species under the name *Aphelenchus coffeae* from dying roots of coffee plants in Java. Micoletzky (1922, Arch. Naturg. Abt. A, 87. J. (9): 590) made it a synonym of *Aphelenchoides parietinus* (Bastian, 1865) Steiner, 1932. Goodey (1928, J. Helminth. 6: 135), Rahm (1929, Arch. Inst. Biol. Defesa Agr. e Animal 2: 68, 77, 78) and Bally and Reydon (1931, Arch. Koffiecultuur 5. j. (2): 100) followed Micoletzky. Recently Dr. Fawcett of the Instituto Biologico of São Paulo, Brazil, submitted 2 agar cultures with numerous *Aphelenchoides* which appear to belong to the species originally described by Zimmerman. A study of this material convinced us of the good standing of Zimmermann's form which herewith is reestablished and redescribed as *Aphelenchoides coffeae* (Zimmermann), n. comb. The inoculum of Dr. Fawcett's culture originated from diseased citrus fruits.

Aphelenchoides coffeae (Zimmermann), n. comb. (fig. 18)

Description.—Closely resembles *Aphelenchoides parietinus*. Tail terminus of female somewhat variable (fig. 18, D & E) but usually with shape shown in figure 18, D. Cuticular annules on neck region about 1μ wide. Lateral fields 3.5 to 4μ or about 1/5 as wide as body diameter, seemingly with 4 longitudinal striae. Apparently these 4 striae are produced by 3 flat longitudinal thickenings as shown in figure 18, G, the striae being the borders of these ribbon-like thickenings, which posteriorly extend to the tail end. (*A. parietinus* has lateral fields only 2μ wide or 1/10 of the body diameter and only 2 of these longitudinal ribbon-like thickenings.) Head button-shaped, with the same kind of basal knobs (fig. 18, C), which are thickenings of the stylet wall rather than set-off spherical structures. Esophagus typically aphelenchoid. Esophageal glands very slender,

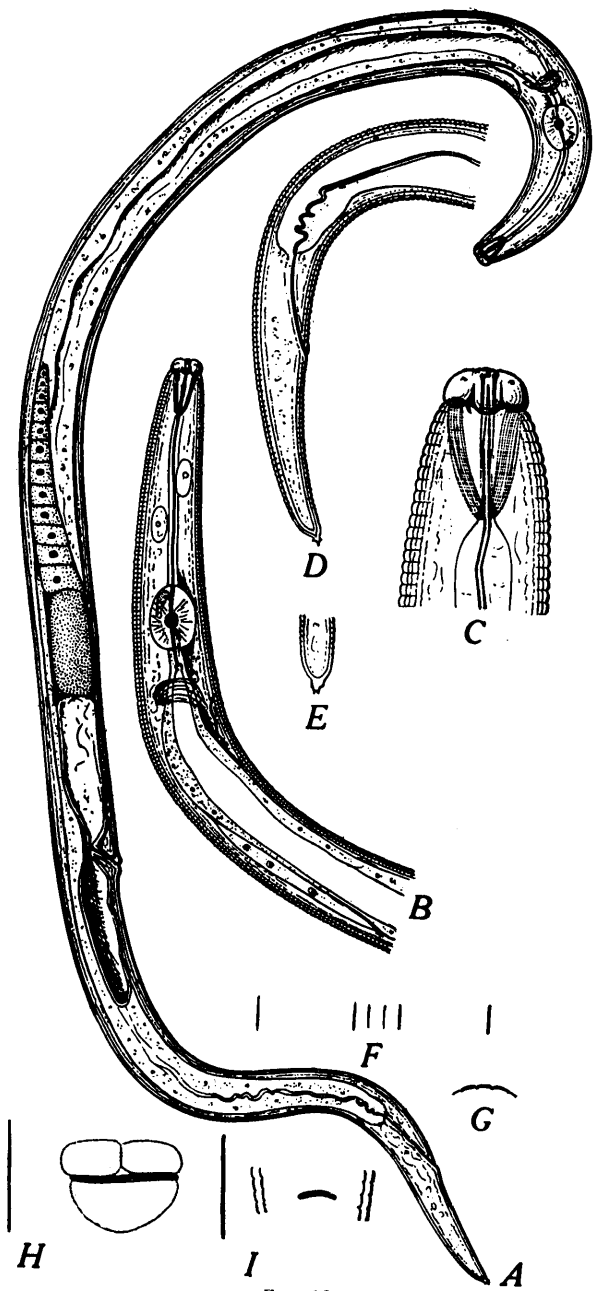


FIG. 18

Aphelenchoides coffeae (Zimmermann, 1898), n. comb. A—Female; ×340. B—Anterior end of body showing end of esophageal canal; ×530. C—Head end showing cuticular apophysis serving as attachment for protrudor muscles of stylet; ×1400. D—Tail end showing prerectal, transparent portion of intestine; ×530. E—Variation of tail end; ×690. F—Arrangement of lateral longitudinal markings in relation to body width; ×690. G—Thickenings on lateral area as appearing in cross section (sketch). H—Face view of vulvar opening; ×530. I—Face view of anal opening; ×530.

situated on the dorsal side of the intestine, well behind the nerve ring (fig. 18, B). Prerectal portion of intestine (fig. 18, D) often differentiated from the finely granulated preceding part by a glossy transparent appearance. Length of rectum about twice anal body width. Female sexual apparatus remarkable for its shortness; ovary never reflexed, consisting of only 8 to 12 oocytes in single series. Postvulvar uterine sac extending only ¼ to ⅓ distance from vulva to anus. Deposited eggs 56 to 58μ by 17 to 19μ. Males absent. Propagation probably by protandric hermaphroditism.

It is questionable whether Bally & Reydon dealt with the present species, or *A. parietinus*, or still some other form. Their figure of the anterior end (loc. cit., p. 101) shows the nerve ring anterior to the esophageal bulb (metacorpus), which position, if not erroneously drawn, would disassociate it from the present form as would also the ovary which they figure as reflexed and extending far forward. Similarly the female sketched by them (loc. cit., p. 101, fig. 30, A) exhibits a folded oviduct never seen in the present form. On the other hand their statement of the absence of males and their measurements could well apply to *A. coffeae*. Or did they deal with 2 different species?

Rahm (loc. cit., p. 77) also synonymizes *A. coffeae* of Zimmermann with *A. parietinus*. He states that he observed females only, but it is impossible to decide if he had Zimmermann's species or not. Fr. Noack (1898, Ztschr. Pflanzenkrank. 8:137-142) mentions a nematode, *Aphelenchus coffeae*, as the cause of a disease of coffee in Brazil called "Pfahlwurzelfäule des Kaffees." This is a nomen nudum, published October 29, 1898. It is believed that this publication is antedated by that of Zimmermann therefore the name proposed by him is of good standing.

Measurements.—♀ : total length = 0.695 to 0.88 mm; a = 24 to 36, β = 9.3 to 11.3; γ = 13.1 to 19.4; v = 62 to 70%.

Diagnosis.—With the characters of *A. parietinus*, but syngonic (probably protandric hermaphroditism); lateral fields about twice as wide as in *A. parietinus* (3.5 to 4μ as against 2μ in *A. parietinus*); female apparatus, particularly ovary, much shorter, never reflexed, with very small number of oocytes (8 to 12 as against 25 or more in *A. parietinus*).

Type locality.—Java.

Type host.—Roots of coffee plant.

(2) THE OCCURRENCE OF THE BUD AND LEAF NEMATODE, APHELENCHOIDES FRAGARIAE (RITZEMA BOS, 1891) CHRISTIE, 1932 ON THE PEONY AND ORIENTAL POPPY IN THE U. S. A.

The peony was reported as a host plant of the bud and leaf nematode by Goffart (1932, Blumen u. Pflanzenbau 6. J. (10):154). Specimens of peony, varieties La Lorraine and Alsace Lorraine, were found affected in the Rhine Province of Germany. The diseased plants were said to have been imported from Holland and the parasite was referred to the fern and begonia nematode (*Aphelenchoides olesistus*) here considered a physiological race of *A. fragariae*.

Our observations refer to the peony, variety Shinso-jibiki; the plant was submitted from Ashland, Va. but had been bought from an importer in 1935 and probably was also of Holland origin. The parasites were found mainly in the flower buds, which were dwarfed and undeveloped. The leaves were also affected, exhibiting a mottled appearance, although discolored brown spots had not yet developed at this early stage. The nematodes clearly belong to the begonia or fern strain of *A. fragariae*.

Measurements.—5 ♀ ♀ : total length = 0.470 to 0.877 mm; a = 33 to 50; β = 9.9 to 11.8; γ = 14.8 to 20.4; v = 67 to 72%. ♂ : total length = 0.55 mm; a = 39; β = 9.8; γ = 17.7.

An oriental poppy, growing adjacent to this peony, exhibited some failing flower buds of dwarfed and black appearance which also were attacked by this same nematode. However, in these buds a large number of *Panagrolaimus subelongatus* (Cobb, 1914) Thorne, 1937 was also seen. Other peonies or oriental poppies in the planting had normal flowers and were not found infested. Possibly the disease had transferred from the peony to the oriental poppy. Leaves of the latter were apparently not attacked.

Measurements (specimens from poppy).—6 ♀ ♀ : total length = 0.56 to 0.63 mm; a = 47 to 51; β = 9.3 to 11.9; γ = 17 to 19; v = 70 to 73%. 6 ♂ ♂ : total length = 0.42 to 0.66 mm; a = 34 to 49; β = 7.7 to 9.8; γ = 15 to 19.

(3) REMARKS ON EUCEPHALOBUS TERES THORNE, 1937

This form, described by Thorne, (1937, Proc. Helminth. Soc. Wash. 4 (1): 10-11) was observed by us on a narcissus bulb (*Narcissus pseudonarcissus*) grown in Ashland, Va. It was found in small, round or irregular brown pustules on the surface of the bulb; the contents of the pustules were also of brownish color. Although it was quite numerous in each pustule, its role as a disease agent is not known; it is supposed to be associated with a fungoid or bacterioid agent.

The present material permits a more complete description of this species, the male of which hitherto was not known.

Description.—Cuticular annules 2μ wide, very plain; lateral fields about 1/6 as wide as corresponding body diameter, having 3 longitudinal striae, the center one often indistinct. Female tail somewhat variable in acuteness and length; tail form shown in figure 19, D considered an accidental variation. Lip region very characteristic through the reduced lateral lips which are amalgamated with the ventrosubmedial one. Cephalic papillae probably 10, (2 submedial, 1 lateral); amphids at base of head. Buccal cavity typically cephaloboid, with cheilo-, pro-, meso-, meta- and telorhabdions present; dorsal metarhabdion often with distinct small toothlet. Corpus of esophagus long, slender, pro-and meta-corpus not differentiated, about 3 1/3 times as long as isthmus (corpus 94μ and isthmus 28μ).

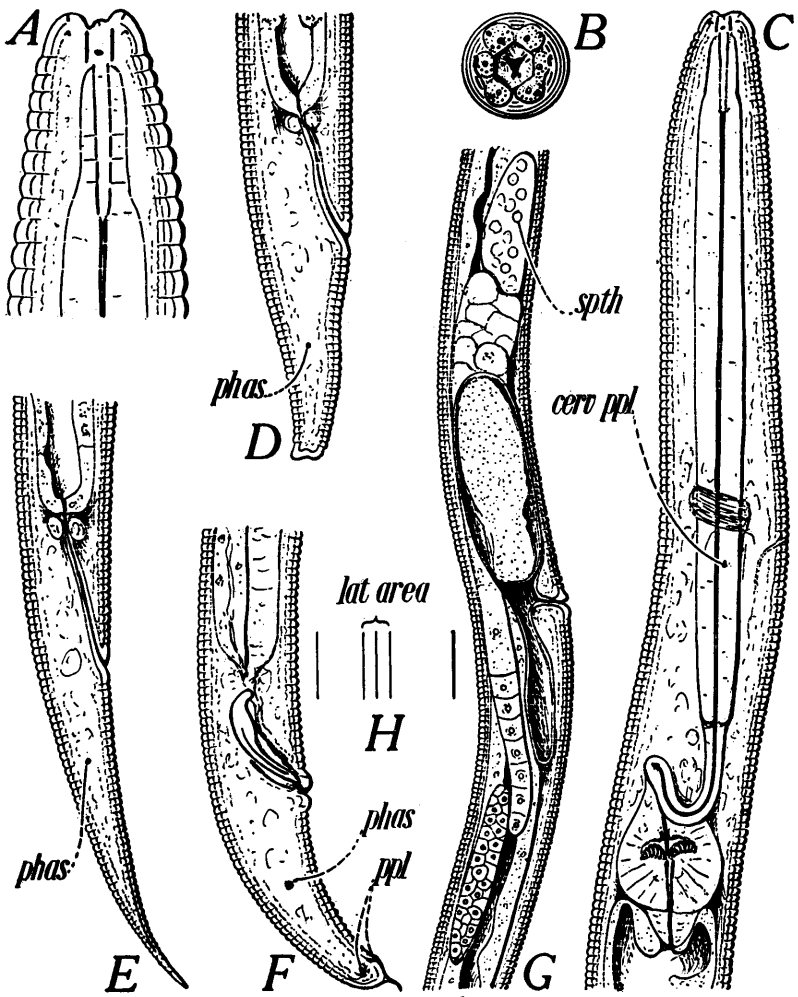


FIG. 19

Eucephalobus teres Thorne, 1937

A—Head end; ×2100. B—Front view of head; ×2100. C—Anterior end of body; *cerv ppl*, cervical papilla; ×800. D—Abnormal, truncate tail end of female; *phas*, phasmid; ×800. E—Normal tail end of female; *phas*, phasmid, ×800. F—Tail of male; *phas*, phasmid; *ppl*, copulatory papillae; ×800. G—Female sexual apparatus; *spth*, spermatheca; ×520. H—Lateral area in relation to body width; ×800.

Terminal bulb slightly pear-shaped with apparently complete valvular apparatus. Intestinal cells probably uninucleate. Length of rectum about 1½ times anal body diameter. Nerve ring encircling posterior portion of corpus, often seen with difficulty; cervical papilla slightly behind nerve ring. Female sexual apparatus as in figure 19, G; ovary with S-shaped flexure just posterior to caudal end of postvulvar uterine sac; terminal portion of ovary with pluri seriate oocytes; spermatheca at flexure of oviduct, almost twice as long as corresponding body diameter; uterus with postvulvar sac, about 1½ body diameters long; eggs 60μ by 21μ. Male probably with non-reflexed testis. Spicula and gubernaculum as in figure 19, F; male tail with mucronate terminus and a pair of papillae on each side just in front of it; phasmids in position corresponding to that of female (fig. 19, D & E).

Measurements.—♀: total length = 0.61 to 0.66 mm; a = 26 to 28; β = 3.6 to 4.1; γ = 9.5 to 10, v = 59 to 63%. ♂: total length = 0.64 to 0.67 mm; a = 24 to 29; β= 4.3 to 5.5; γ = 15 to 16.

A method of separating infective larvae of *Haemonchus contortus* (Trichostrongylidae) from free-living nematodes. D. A. SHORB.

While studying the longevity of the infective larvae of *Haemonchus contortus* under natural conditions, free-living nematodes were frequently encountered in soil on which sheep manure containing eggs of *H. contortus* had been placed. These free-living nematodes occurred in such large numbers that an accurate count of *H. contortus* larvae was very difficult, if not impossible. In order to overcome this difficulty mixed suspensions of infective larvae of *H. contortus* and free-living nematodes recovered from soil by the Baermann isolation technique, were treated by adding to the suspension of larvae concentrated hydrochloric acid so that the final dilutions varied from 1:2 to 1:300.

The results of this procedure are summarized in table 1.

TABLE 1.—*Effect of different dilutions of HCl on infective larvae of Haemonchus contortus and on free-living nematodes*

Proportion of HCl to H_2O	*Immediate reaction*		*Reaction after exposure for 30 minutes*		*Reaction after exposure for 24 hours*	
	Infective larvae of H. contortus	*Free-living nematodes*	*Infective larvae of H. contortus*	*Free-living nematodes*	*Infective larvae of H. contortus*	*Free-living nematodes*
1:2	alive	dead	dead	dead	dead	dead
2:7	alive	dead	dead	dead	dead	dead
1:6	alive	dead	alive	dead	dead	dead
1:10	alive	dead	alive	dead	dead	dead
1:15	alive	dead	alive	dead	dead	dead
1:20	alive	dead	alive	dead	dead	dead
1:30	alive	dead	alive	dead	alive	dead
1:60	alive	dead	alive	dead	alive	dead
1:300	alive	alive	alive	dead	alive	dead

Infective larvae of *Nippostrongylus muris, Cooperia curticei* and of some horse strongyles when similarly treated were resistant to the action of hydrochloric acid in concentrations not lethal to *H. contortus*. In all concentrations except the lowest all free-living nematodes died almost instantly, while the infective larvae lived for a few seconds even in the highest concentrations of acid used. All free-living nematodes were dead at the end of one-half hour's exposure in the most dilute solution used, but the infective larvae lived for that length of time in dilutions of 1:6 and for 24 hours in dilutions of 1:30. In practice concentrated hydrochloric acid is added to the water containing the larvae to be counted at the rate of ⅓ cc of acid to 10 cc of water, making a dilution of 1:30. In this dilution all free-living nematodes are killed almost instantly, while the infective larvae remain alive for at least 24 hours.

Observations on the length of dormancy of certain plant-infesting nematodes. C. W. McBeth, U. S. Bureau of Plant Industry (Salt Lake City, Utah).

Dormancy experiments with nematodes infesting certain plants were reported by Corder (1933, J. Parasitol. 20 (2):104). These samples were examined again in April, 1934, by Corder, and November, 1936, by the writer. The results are shown in the following table.

Sample number 10 was reported as all dead in 1934 but in 1936 a total of 3 nemas was found, 2 of them living. This discrepancy is undoubtedly due to the small number of nemas in the sample.

Due to the small amount of material left in sample 14 there will not be another examination until 1938; the last examination was made in 1933 by Corder, 100 per cent found living after 11 years.

The maximum dormancy period for *Ditylenchus dipsaci* in alfalfa appears to be 3 to 5 years; all were dead after 3 years in alfalfa buds, sample 18, and after 5 years in alfalfa seed, sample 11. Teasel and oats appear to be the most preferable dormancy hosts for *D. dipsaci;* 50 per cent living after 9 years in teasel, sample 6, and 100 per cent living after 8 years in oats, sample 7.

TABLE 1.—*Results of examination of dormancy samples,* 1934 *and* 1936

*Sample** No.	*Species*	*Host*	*No. Years Dormant* 1934	1936	*Per cent of worms alive* 1934	1936
3	*Ditylenchus dipsaci*	Teasel leaves	8	10	0	0
4	*Ditylenchus dipsaci*	Garlic	8	10	0	0
5	*Ditylenchus dipsaci*	Long-leaf plantain	7	9	0	0
6	*Ditylenchus dipsaci*	Teasel	7	9	100	50
7	*Ditylenchus dipsaci*	Oats	6	8	100	100
8	*Ditylenchus dipsaci*	*Hypochaeris*	5	7	0	0
10	*Ditylenchus dipsaci*	*Hypochaeris*	5	7	0	33
11	*Ditylenchus dipsaci*	Alfalfa Seeds	5	7	2	0
14	*Anguina tritici*	Wheat	not examined			
17	*Tylenchus balsamophilus*	*Balsamorhiza sagittata*	9	11	0	0
18	*Ditylenchus dipsaci*	Alfalfa Buds	..	3	..	0

*Nos. 1, 2, 9, 12, 13, 15, 16 as listed by Corder discarded. See Corder (1933, loc. cit.) for locality and date of collection.

Experiments to determine the nematocidal qualities of beta naphthol, colloidal arsenate of lead and colloidal sulphur. C. W. McBeth, U. S. Bureau of Plant Industry (Salt Lake City, Utah).

A supply of soil heavily infested with sugar beet nematode, *Heterodera schachtii* Schmidt, and free-living species was collected. Glass beakers with loose fitting lids, used as containers for the experiments, were placed in a room at a fairly even temperature of about 70° F. The moisture content was kept fairly constant by adding water occasionally. Small portions of soil were examined from time to time and the results recorded in the following table.

It can be readily seen that beta naphthol is the superior as a nematocide, but even that is useless from an economic standpoint, the cost being many times the value of the land. As can be seen by the table, a 10 per cent concentration of colloidal sulphur is not effective. Due to the high cost of treating at this concentration the experiment was not carried farther.

The cost of treating one acre foot of soil, 5,548,650 lbs. in field used, would be as follows: Beta naphthol $14,152; colloidal arsenate of lead, $703,681; colloidal sulphur $703,681.

TABLE 1.—*Nematocidal experiments with beta naphthol, colloidal arsenate of lead and colloidal sulphur*

Amount of soil treated	Moisture content	Application % by weight	Time	Beta naphthol		Collodial sulphur		Collodial arsenate of lead	
				Eggs & larvae in cysts	Free-living	Eggs & larvae in cysts	Free-living	Eggs & larvae in cysts	Free-living
100 gr.	19%	10%	4 hrs.	living	dead				
100 gr.	19%	10%	25 hrs.	dead	dead				
500 gr.	19%	10%	4 days			living	living	living	dead
500 gr.	19%	10%	7 days			living	living	living	dead
500 gr.	19%	10%	11 days			living	living	dead	dead
500 gr.	19%	10%	15 days			living	living	dead	dead
100 gr.	19%	5%	25 hrs.	dead	dead				
100 gr.	19%	5%	10 days					living	living
200 gr.	19%	.5%	3 days	dead	dead				
1,000 gr.	18%	.4%	4 days	dead	dead				
1,000 gr.	18%	.3%	4 days	dead	dead				
1,000 gr.	18%	.2%	4 days	living	living				
1,000 gr.	18%	.2%	8 days	living	living				
1,000 gr.	18%	.2%	12 days	living	living				
1,000 gr.	18%	.2%	15 days	living	living				
1,000 gr.	18%	.1%	3 days	living	living				
1,000 gr.	18%	.1%	12 days	living	living				

A new genus and ten new species of marine nematodes from North Carolina. B. G. CHITWOOD.

The species described in this paper were collected by the writer during the summer of 1934, while stationed at the U. S. Bureau of Fisheries Laboratory, Beaufort, N. C. These species include representatives of the families Oncholaimidae, Microlaimidae, Enoplidae and Comesomatidae.

ONCHOLAIMIDAE

Oncholaimoides, new genus

Diagnosis.—Oncholaiminae: Oral opening surrounded by 6 lips bearing an internal circle of 6 papillae and an external circle of 10 setae posterior to lips; amphids with elliptical to ovoid openings, moderate in size; stoma wide, containing 1 large and 2 small teeth. Cuticle transversely striated, bearing longitudinal ridges broken by striae. Male with 2 short straight spicules. Female with 2 ovaries; demanian system apparently absent.

Type species.—*Oncholaimoides rugosum*, new species.

Oncholaimoides rugosum, new species (fig. 20, A & B)

Description.—Cuticle very coarsely striated; longitudinal ridges pronounced (fig. 20, B).

Male 1.48 mm long; a, 30 to 32; β, 6.1; γ, 12.5 to 14.4.

Female 1.25 mm long; a, 27; β, 5.6; γ, 13.5; vulva 53% of body length from anterior extremity.

Habitat.—Marine (below low-tide mark and at a depth of 15 feet).

FIG. 20

A & B—*Oncholaimoides rugosum*, n. sp.; C & D—*O. striatum*, n. sp.; E & F—*Viscosia paralinstowi*, n. sp.; G-I—*V. brachylaimoides*, n. sp.; J & K—*Oxystomina alpha*, n. sp.; L-P—*Microlaimus dimorphus*, n. sp.

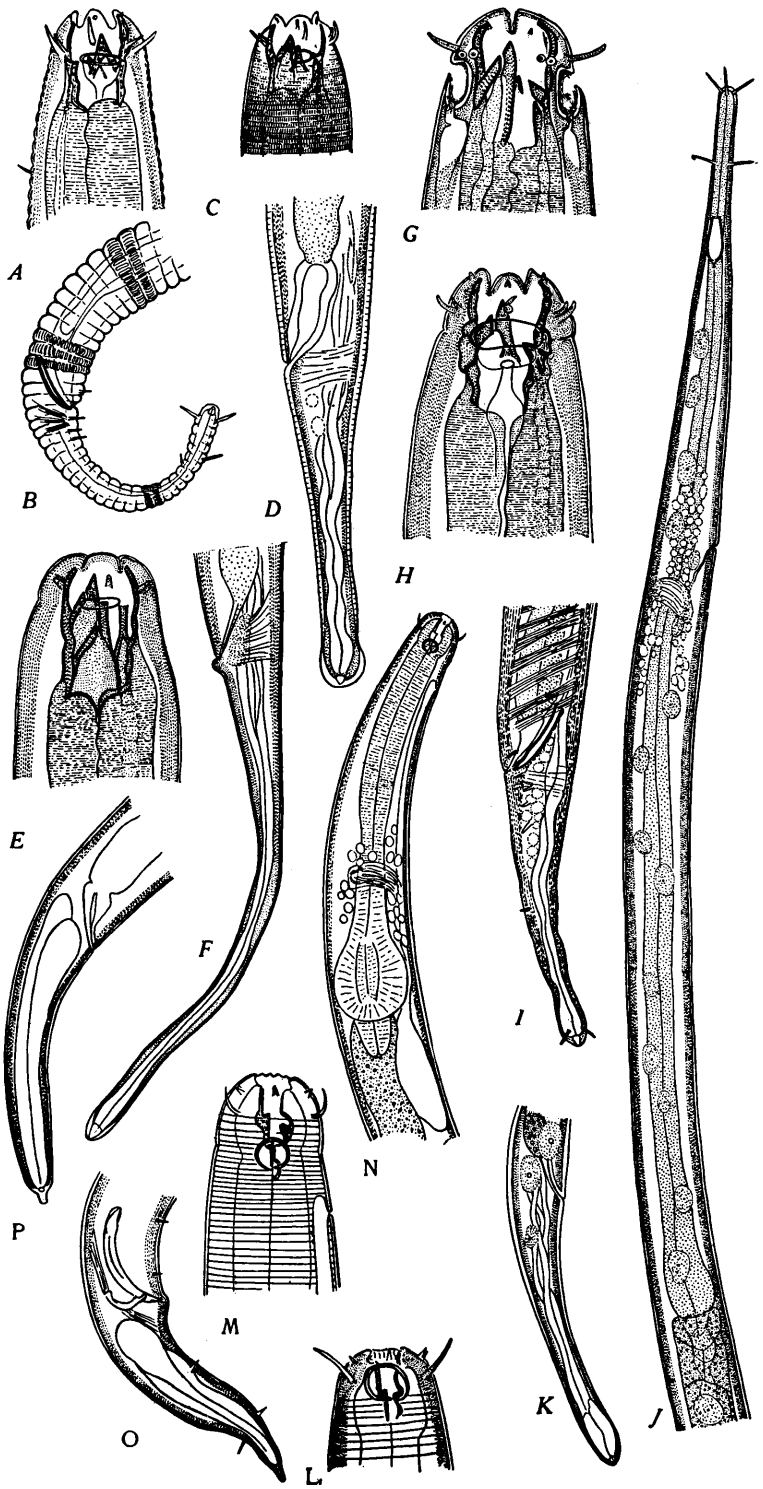


Fig. 20

Locality.—Beaufort and Shackleford's Banks, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 27976 (cotypes).

Oncholaimoides striatum, new species (fig. 20, C & D)

Description.—Cuticle finely striated; longitudinal ridges minute (fig. 20, C).

Male unknown.

Female 2.1 to 2.7 mm long; a, 29 to 37; β, 6 to 6.5; γ, 18 to 23; vulva 52 to 57% of body length from anterior extremity.

Habitat.—Marine (below low-tide mark).

Locality.—Beaufort, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 27975 (cotypes).

The representatives of the *Oncholaimoides* are rather typical oncholaims having the teeth and general form of other representatives of the subfamily Oncholaiminae. This genus differs from all other genera, however, in the cuticular marking which consists of longitudinal ridges broken by transverse striae.

Viscosia paralinstowi, new species (fig. 20, E & F)

Description.—Lips inconspicuous; cephalic setae extremely short; amphids inconspicuous; stoma elongated (1/15 as long as esophagus); large subventral tooth reaching nearly to anterior end of stoma; dorsal and small subventral teeth reaching beyond mid-region of stoma; small teeth truncate terminally (fig. 20, E).

Male unknown.

Female 2.9 mm long; a, 83; β, 7.45; γ, 13; vulva 49% of length of body from anterior extremity; tail 8 times as long as diameter of body in region of anus.

Habitat.—Marine (below low-tide mark).

Locality.—Beaufort, North Carolina.

Specimen.—U. S. N. M. Helm. Coll. No. 27977 (type).

Viscosia paralinstowi is similar to *V. linstowi* (de Man, 1904) in that the small teeth are of the truncate form, but differs from that species in being over twice as large, and in being relatively much more slender (a in *V. linstowi* is 35, while in *V. paralinstowi* it is 83). Other somewhat similar species of *Viscosia*, such as *V. glabra* (Bastian) and *V. pseudoglabra* Kreis, have sharp rather than truncate teeth.

Viscosia brachylaimoides, new species (fig. 20, G-I)

Description.—Lips conspicuous; cephalic setae up to 1/5 as long as head diameter; amphids 1/2 to 1/2.5 as long as head diameter. Cephalic groove distinct; stoma short and wide (1/13 as long as esophagus); left subventral tooth large but not reaching to anterior end of stoma; right subventral and dorsal tooth very small, not quite reaching to mid-region of stoma. Tail in both sexes about 3 times as long as body diameter in region of anus and terminating in a characteristic cylindrical swelling (fig. 20, I).

Male 1.7 to 2.54 mm long; a, 26.5 to 39; β, 6.17 to 7.4; γ, 14.2 to 25.

Female 1.82 to 2.5 mm long; a, 22 to 29; β, 5.7 to 6.1; γ, 18 to 21; vulva 42 to 47% of body length from anterior extremity.

Habitat.—Marine (below low-tide mark and depth of 15 feet).

Locality.—Beaufort, N. C., and Shackleford's Banks, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 27978 (cotypes).

Viscosia brachylaimoides appears to be most closely related to *V. viscosia* (Bastian) and *V. brachylaima* (Filipjev) but differs from both species in the shortness of the left subventral tooth (reaching further anteriad in *V. viscosia* and *V. brachylaima*) and in the characteristic form of the tail.

MICROLAIMIDAE

Microlaimus dentatus, new species (fig. 21, A-C)

Description.—Amphids circular, opposite, or anterior to, mid-region of stoma, from 1/6 to more than 1/2 as wide as cephalic diameter, variable, larger and more posterior in males and larvae. Cephalic setae 1/6 as long as cephalic diameter. Stomatal region more or less distinctly set off from remainder of esophagus; stomatal walls and teeth heavily cuticularized. Excretory pore posterior to nerve ring.

Male 926 to 953μ long; a, 25 to 30; β, 6.3 to 6.4; γ, 6.3 to 6.6.

Female 908μ to 1.03 mm long; a, 22 to 26; β, 6.1 to 7.7; γ, 5 to 6.6; vulva dividing body in proportions of 38:62 to 42:48.

Habitat.—Marine (dredging at depth of 30 feet).

Locality.—Bogue Sound, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 27220 (cotypes).

Microlaimus dimorphus, new species (fig. 20, L-P)

Description.—Amphids in form of a broken circle from 1/4 to 1/2 as wide as cephalic diameter, either anterior or posterior to middle of stomatal region. Stomatal region set off from remainder of esophagus and heavily cuticularized but less so than in *M. dentatus*. Excretory pore 2 cephalic diameters from anterior extremity.

Male 800μ long; a, 21; β, 6.5; γ, 9.9.

Female 890 to 900μ long; a, 16 to 19; β, 5.6 to 6; γ, 8.8 to 10.6; vulva dividing body in proportions 49:51 to 52:48.

Habitat.—Marine (below low-tide mark).

Locality.—Beaufort, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 26471 (cotype).

Both *Microlaimus dentatus* and *M. dimorphus* appear to be more closely related to *Microlaimus robustidens* Stekhoven and de Coninck than to other species of the genus in the following respects: The stomatal region is more or less distinctly set off from the remainder of the esophagus and the stomatal lining and teeth are heavily cuticularized. *M. dentatus* differs from *M. robustidens* in that the amphids are always anterior to the base of the stomatal region and the cephalic setae anterior to the level of the teeth, while in *M. robustidens* the amphids are posterior to the base of the stomatal region and the setae are opposite the level of the teeth. *M. dimorphus* differs from *M. robustidens* in that the former is a plump species (a, 16 to 21) whereas the latter is slender (a, 43).

ENOPLIDAE

Oxystomina alpha, new species (fig. 20, J & K)

Description.—Cephalic and subcephalic setae longer than width of head; amphids longer than corresponding body diameter (fig. 20, J).

Male unknown.

Female 2.03 to 2.04 mm long; a, 70 to 76; β, 4.2 to 4.6; γ, 18 to 20.7; vulva dividing body in proportions of 30:70; egg 142μ long by 20μ wide.

Habitat.—Marine (below low-tide mark).

Locality.—Beaufort, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 26472 (cotypes).

Oxystomina alpha differs from all other representatives of this genus in that the cephalic and subcephalic setae are longer than the cephalic diameter; in other species these structures are less than 1/2 as long as the cephalic diameter.

COMESOMATIDAE

Laimella quadrisetosa, new species (fig. 21, D & E)

Description.—Cuticle minutely punctate. Cephalic sensory organs consisting of 6 papillae of internal circle and 10 setae of external circle (dd. and vv. long,

ld., el., and lv. short); 4 submedian subcephalic setae present. Stoma cylindroid, armed anteriorly with 3 teeth. Esophagus clavate, glandular; nerve ring and excretory pore 2/3 length of esophagus from anterior extremity.

Male 1.44 to 1.48 mm long; a, 31 to 40; β, 8.2 to 8.9; γ, 9 to 11; 30 or more papilloid supplementary organs present; spicules narrow, jointed; gubernaculum parallel to spicules.

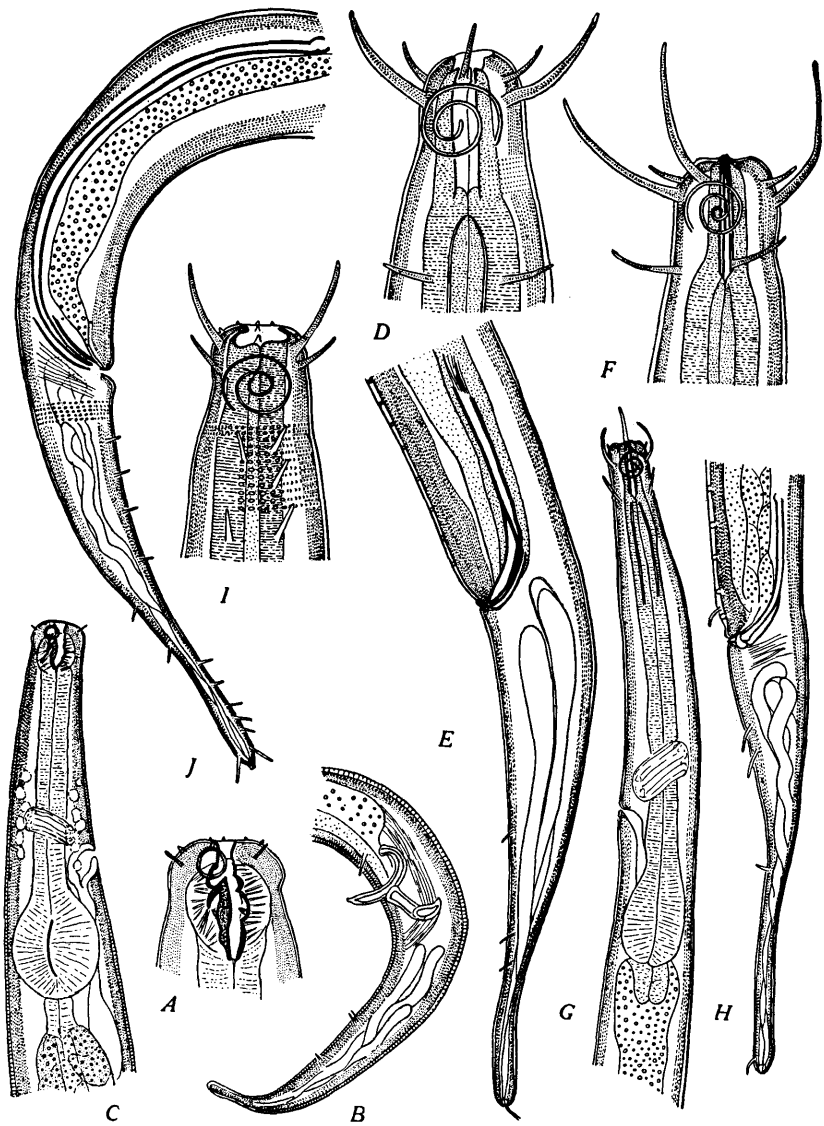


FIG. 21

A-C—*Microlaimus dentatus*, n. sp. D & E—*Laimella quadrisetosa*, n. sp. F-H—*L. hexasetosa*, n. sp. I & J—*Comesoma minimum*, n. sp.

Female 1.19 to 1.62 mm long; a, 25 to 36.5; β, 6.6 to 8.9; γ, 8.6 to 12; vulva dividing body in proportions 44:56 to 49:51; ovaries extending to within 1/3.5 to 1/5 and 1/3 to 1/4 of body length, respectively, from anterior and posterior extremities.

Habitat.—Beach (below low-tide mark).

Locality.—Beaufort, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 26473 (cotype).

Laimella hexasetosa, new species (fig. 21, F-H)

Description.—Similar to *L. quadrisetosa*, except for 6 long (dd., el., and vv.) and 4 short (ld. and lv.) cephalic setae.

Male 2.22 mm long; a, 50; β, 10; γ, 13.3; 40 or more supplementary organs present.

Female 2.07 mm long; a, 37; β, 11; γ, ?; vulva dividing body in proportions 42:58; ovaries extending to within 1/3.6 and 1/2.75 length of body, respectively, from anterior and posterior extremities.

Habitat.—Sand flats.

Locality.—Beaufort, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 27997 (cotypes).

While *Laimella* is generally considered a synonym of *Comesoma*, careful study of the original description (Contrib. Sci. Nematology (9), p. 261) indicates that in all probability *L. longicauda* Cobb, 1920, has a cylindroid stoma containing 3 teeth at the anterior end. The genus as interpreted on the basis of the present species is characterized by having a cylindroid stoma provided with 3 teeth; 10 cephalic setae; spicules filiform; gubernaculum parallel to spicules; cuticle finely punctate, punctations not modified laterally. In form of spicules and gubernaculum this genus is undoubtedly close to *Comesoma* while in stomatal character it resembles *Dorylaimopsis* and *Mesonchium* (Syn. *Pepsonema*).

Key to the species of Laimella

1. Four short and 6 long cephalic setae ..... *L. hexasetosa*, n. sp.
   Six short and 4 long cephalic setae 2
2. Tail elongate, filiform (γ, 3.3) ..... *L. longicauda* Cobb, 1920
   Tail not elongate, attenuated (γ, 8 to 14) 3
3. Esophagus relatively long (β, 6.5 to 9) ..... *L. quadrisetosa*, n. sp.
   Esophagus relatively short (β, 11.5)
   L. dubia (Filipjev, 1918), n. comb. (=*Comesoma dubia* Filipjev, 1918).

Comesoma minimum, new species (fig. 21, I & J)

Description.—Cephalic setae 4 (ld. and lv.); subcephalic setae 4; cervical setae in 4 sublateral rows of 3 to 4 setae each.

Male 1.37 to 1.52 mm long; a, 23 to 24; β, 7.7 to 8.2; γ, 8.2 to 9; spicules long, setaceous; short papilloid supplementary organs present.

Female 1.34 mm long; a, 18; β, 7.2; γ, 9; vulva dividing body in proportions of 48:52; ovaries extending within 1/5 and 1/6 of body length respectively, from anterior and posterior extremities; anterior ovary reflexed at tip, posterior ovary outstretched.

Habitat.—Marine (below low-tide mark).

Locality.—Beaufort, North Carolina.

Specimens.—U. S. N. M. Helm. Coll. No. 27219 (cotype).

Comesoma minimum appears to be most closely related to *Comesoma vulgaris* Bastian, 1865, and to *C. stenocephalum* Filipjev, 1918, but differs from those species in the presence of only 4 subcephalic setae.

A preliminary note on "rhabditin" sphaero-crystalloids. LEON JACOBS, U. S. Bureau of Plant Industry and B. G. CHITWOOD, U. S. Bureau of Animal Industry.

The cell inclusions of nematodes are in general of 3 kinds: Glycogen as an amorphous deposit, or in solution; fatty substances, in droplets; and sphaero-crystalloids (birefringents). The last, found in the intestinal cells, are of at least 2 types: One highly insoluble, exemplified by those in *Strongylus* and *Ascaris;* the other relatively soluble, as in *Rhabditis.* The latter are at present being investigated by the authors in an effort to determine their significance in the physiology of the worms.

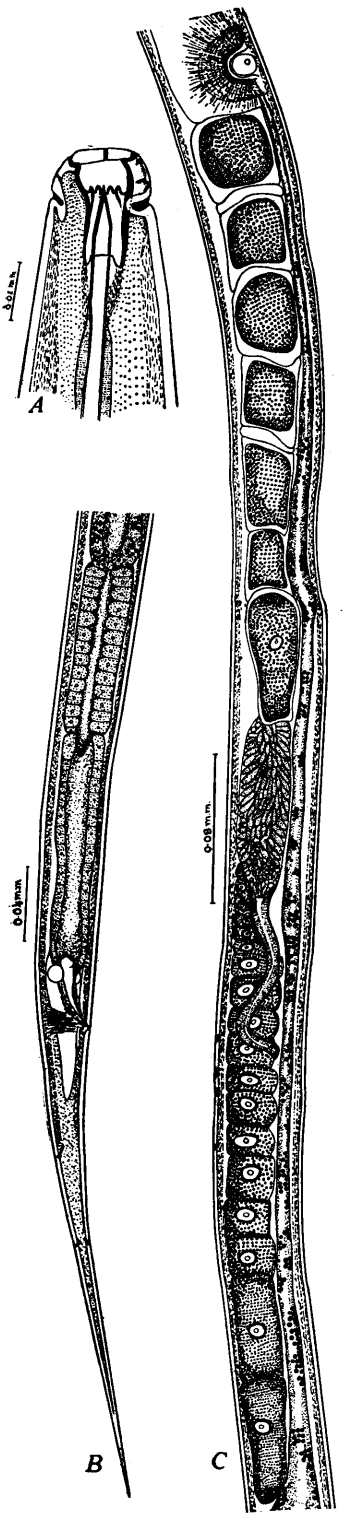
Maupas (1900, Arch. Zool. Expt. et Gen., ser. 3, v. 8) first recorded the occurrence of birefringent "granules" in the intestinal cells of most of the species of *Rhabditis* he studied (loc. cit., p. 479), and considered them products of regression (p. 480). He also noted (p. 508) their absence in the "dauer" larvae of these forms. Cobb (1914, J. Parasitol., 1:40-41) redescribed them in *R. monhystera* Bütschli, stated that they were slowly soluble in water, rapidly so in acids and alkalies, and insoluble in alcohol, glycerin, xyol, and oils. He also stated that each appears as a maltese cross when viewed through crossed Nichol prisms. On the basis of these observations and a positive microscopic Fehling's solution test, he regarded the birefringents as carbohydrate in nature and gave them the name "rhabditin." He also stated that they would not stain in iodin-potassium-iodide solution, and that they did not disappear when the animal was starved. In this connection, Maupas (loc. cit., p. 507) noted a diminution in the number of "granules" in "poorly-nourished" specimens.

The present writers have been able to confirm the observations of these authors to this extent: Rhabditin "granules" are birefringent spheres, 1 to 4μ in diameter, slowly soluble in water, 5 per cent formalin, and dilute acetic acid, rapidly soluble in commercial formalin, 50 per cent acetic acid, dilute and concentrated hydrochloric, sulphuric, and nitric acids, and sodium and ammonium hydroxides. They are insoluble in alcohol, glycerin and xyol. They are never present in the "dauer" larvae although present in all other stages, even in the egg, and they do not disappear when attempts are made to starve the animals. Attempts to stain them with iodin-potassium-iodide and various other carbohydrate stains have proved unsuccessful. Since large quantities of glycogen are known to occur in these nematodes, and since it is impossible to isolate the sphaero-crystalloids from the rest of the worm, and a Fehling's solution test in the presence of glycogen is without significance, the writers deemed it of no use to repeat Cobb's Fehling's solution test on mashed specimens.

To add to this information, the writers have performed a test which seems to confirm Cobb's view of the carbohydrate nature of rhabditin. Specimens of *Rhabditis strongyloides* and *R. ocypodis* were cut with an eye knife in such a way that the intestine was forced outside the body wall by the animal's movements.

These specimens were then examined through crossed Nichol prisms, in mounts of saliva, water, and saliva inactivated by heating. The birefringency of the crystalloids disappeared twice as rapidly in the saliva test as in the controls with water and inactivated saliva. This test was repeated 8 times, and in most cases the birefringency disappeared in the saliva test in about a half-hour, while it was still evident in the 2 controls after an hour under the same conditions. In 2 of the tests, disappearance was totally effected in the saliva mount in an hour, while birefringency could still be observed in the 2 controls after 2 hours under the same conditions, the relative time for test and controls therefore remaining the same. This is the only indication pointing to their carbohydrate composition.

Since the presence of a crystalloid carbohydrate substance can logically only be explained as a reserve food supply, this at once appears inconsistent with the presence of these crystalloids in starved specimens. Neither Cobb nor the present writers have noted any change concerning rhabditin in specimens they attempted to starve, but Maupas, as noted above, stated that they diminished in number in "poorly-nourished" specimens. This may mean that the attempts of Cobb and the present writers to starve the nematodes have been unsuccessful (*Rhabditis* species are known to take bacteria into their alimentary tract and to eliminate them without their capsules); or further experiments may reveal these sphaero-crystalloids to be of a different nature.



A new species of fresh-water nematode, *Actinolaimus chitwoodi* (Dorylaimidae). V. N. MOORTHY, Fellow of the Rockefeller Foundation from Mysore State Department of Health, Bangalore, India.

While collecting specimens of *Cyclops* from step-wells and fresh-water ponds, in connection with certain investigations on dracontiasis, some of the fresh-water nematodes present in them were also collected. The specimen described is from this collection.

Actinolaimus chitwoodi, n. sp. (fig. 22)

Description.—Cuticle 1.8μ thick, smooth. Stomatal wall "chitinized" throughout; narrow denticulate ridge present. Stylet 5.9 times as long as wide; aperture 2/5 length of stylet; guiding teeth anteriorly directed, bluntly conoid. Esophagus with an enlargement, not well pronounced, slightly anterior to the midhalf of its length.

Female 3.4 mm long; a, 56.6; β, 5.0; γ, 13.7; vulva 40%. Tail attenuated, 257μ long. Esophago-intestinal valve 18μ long. Prerectum 214μ long, consisting of 2 distinct parts, of which the posterior part comprises 3/5 of total length. Rectum 40μ. Vulva transverse, rounded; uteri containing 4 to 5 eggs; eggs up to 44μ long by 32μ wide; uteri each terminated by a seminal receptacle (fig. 22, C) containing many sperms packed together giving the appearance of a pattern; oviduct elongate, tubular, connecting uteri and ovaries.

Habitat.—Fresh-water pond.

Locality.—Chitaldrug District, Mysore State, India.

Specimen.—U. S. N. M. Helm. Coll. No. 26488.

This species appears to be most closely related to *Actinolaimus omer-cooperi* Filipjev, 1931, but differs from it in the guiding teeth being less acute and the eggs being smaller in size (maximum length of egg in *A. chitwoodi* 44μ while in *A. omer-cooperi* the minimum length is 57μ).

Acknowledgment is made to the International Health Division of the Rockefeller Foundation for having granted the fellowship which made this work possible.

FIG. 22
Actinolaimus chitwoodi, n. sp. A—Head, median view. B—Tail, lateral view. C—Posterior uterus and ovary.

Infestation of suckling pigs with helminth parasites under conditions of constant exposure to infection. L. A. SPINDLER, U. S. Bureau of Animal Industry.

Although it is known that suckling pigs kept under insanitary conditions become infested with parasitic worms, it is not definitely known how early in life such infestations are acquired. To obtain information on this point, 2 litters of pigs, farrowed and kept in a permanent hog lot at Beltsville, Md., were killed at various times and examined for worm infestations.

The pasture lot in which the pigs were farrowed had for 2 years been frequented by hogs infested with one or more of the worm parasites common in swine in the vicinity of Beltsville, Md. At the time the pigs were farrowed the soil of the lot was found extensively contaminated with embryonated ascarid eggs, *Ascaris suis,* and infective larvae of nodular worms, *Oesophagostomum* spp., kidney worms, *Stephanurus dentatus,* and intestinal threadworms, *Strongyloides ransomi.*

The sow that gave birth to litter 1 was infested with nodular worms, kidney worms, threadworms and spirurid stomach worms, *Ascarops strongylina,* or *Physocephalus sexalatus;* the sow that gave birth to litter 2 was infested with nodular worms, kidney worms and threadworms.

Litter 1 was farrowed June 14, 1933; individual pigs, selected at random, were killed and examined for worms post mortem at the age of 3, 7, 10, 17, 32, 54, and 70 days, respectively. Litter 2 was farrowed June 15, 1933, and pigs selected at random were killed and examined for worms at the age of 2, 8, 17, 19, 23, 26, 64, and 70 days, respectively. Examinations for parasites were made as described below.

The small intestine was flushed out by means of hot water under pressure and its contents sedimented and examined for ascarids and threadworms. The contents of the stomach, colon and cecum were washed through fine screens containing 16 meshes to the inch, and the material adhering to the screens was examined. The walls of the stomach, colon and cecum were examined for adhering parasites and for lesions caused by parasites. The liver and lungs were finely ground and placed in flasks containing physiological saline and glass beads. The flasks were then placed in an incubator having a temperature of 37° C. and at intervals of 15 to 20 minutes each flask was vigorously shaken for approximately 1 minute. At the end of 4 hours the salt solution from the flasks was centrifuged and examined for larval ascarids and kidney worms.

The post-mortem findings, summarized in the accompanying table, show that the pigs of both litters became infested with ascarids, threadworms, kidney worms and nodular worms during the first 3 weeks of life. Spirurid stomach worms were found in only one pig of the entire series; this pig was 70 days old.

During the period covered by these observations it was noted that the sow which farrowed litter 1 apparently did not produce sufficient milk for her pigs. The young animals appeared to be in poor physical condition and soon began nosing about over the ground apparently in search of food. On the other hand, pigs of litter 2 appeared to be well fed and in good physical condition, and these host animals did not begin to forage extensively until they were from 2 to 3 weeks old. The post-mortem findings given in the table show that pigs of litter 1 became infested with ascarids and with nodular worms noticeably earlier than the pigs of litter 2.

In this connection it may be noted that kidney worms and threadworms, the larvae of which are capable of penetrating the skin of the host animal, were found infesting pigs of both litters at about the same age. The early infestation of pigs from litter 1 with ascarids and nodular worms support the writer's statement (1933, North Amer. Vet., 14 (11): 37-44) that inadequate feed for growing pigs is a factor of considerable importance in the spread of nodular worms in swine; in the light of the data presented in this paper inadequate feed is also responsible to some extent for ascarid infestations early in the life of pigs.

The findings reported in this paper show that in addition to the parasite control measures that have been recommended in the past, the selection of sows which provide adequate nourishment for their young, and the supplying of sup-

plementary feed for young animals are important parasite-control measures. These findings further emphasize the need of maintaining sanitary surroundings for young pigs, as recommended by the U. S. Bureau of Animal Industry for the control of parasites in swine.

TABLE 1.—*Results of post-mortem examination of suckling pigs farrowed and kept under insanitary conditions.*

Litter No. and age of pigs (days)	*Parasites found* — *Designation*	*Stage of development or lesions observed*	*Location*
Litter No. 1			
3	*Ascaris suis*	larvae	Liver and lungs
	Stephanurus dentatus	larvae	Liver
10	*Ascaris suis*	larvae	Lungs and s. intestine
	Oesophagostomum sp.	nodules	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
17	*Ascaris suis*	larvae	S. intestine
	Oesophagostomum sp.	nodules	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
32	*Ascaris suis*	larvae	S. intestine
	Oesophagostomum sp.	nodules	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
54	*Ascaris suis*	immature	S. intestine
	Oesophagostomum sp.	nodules	Cecum and colon
	Oesophagostomum dentatum	adults	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
70	*Ascaris suis*	adults	S. intestine
	Ascarops strongylina	adults	Stomach
	Oesophagostomum dentatum	adults	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
Litter No. 2			
2	None	———	———
8	*Strongyloides ransomi*	immature	S. intestine
	Stephanurus dentatus	larvae	Liver
17	*Ascaris suis*	larvae	Liver and lungs
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
19	*Ascaris suis*	larvae	Lungs
	Oesophagostomum sp.	nodules	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
23	*Ascaris suis*	larvae	Lungs and s. intestine
	Oesophagostomum sp.	nodules	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
26	*Ascaris suis*	larvae	S. intestine
	Oesophagostomum sp.	nodules	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
64	*Oesophagostomum dentatum*	adults	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver
70	*Ascaris suis*	adults	S. intestine
	Oesophagostomum dentatum	adults	Cecum and colon
	Strongyloides ransomi	adults	S. intestine
	Stephanurus dentatus	larvae	Liver

A new nematode, *Habronema clarki*, n. sp. (Spiruridae), from *Hydrochoerus isthmius* Goldman. A. O. FOSTER, Gorgas Memorial Laboratory, Panama, and B. G. CHITWOOD, U. S. Bureau of Animal Industry.

Several nematodes of the genus *Habronema* were collected from the stomach of an isthmian capybara in Darien Province, Panama. A review of the species placed in this genus indicates that at present only 3 species belong to the genus *Habronema*, s. s., these being *H. muscae*, *H. zebrae*, and *H. microstoma*, all from equines. The present species appears to be most closely related to *H. microstoma*, but differs from the latter sufficiently for the characterization of a new species. The name *Habronema clarki* is proposed in honor of Dr. Herbert C. Clark, Director of the Gorgas Memorial Laboratory.

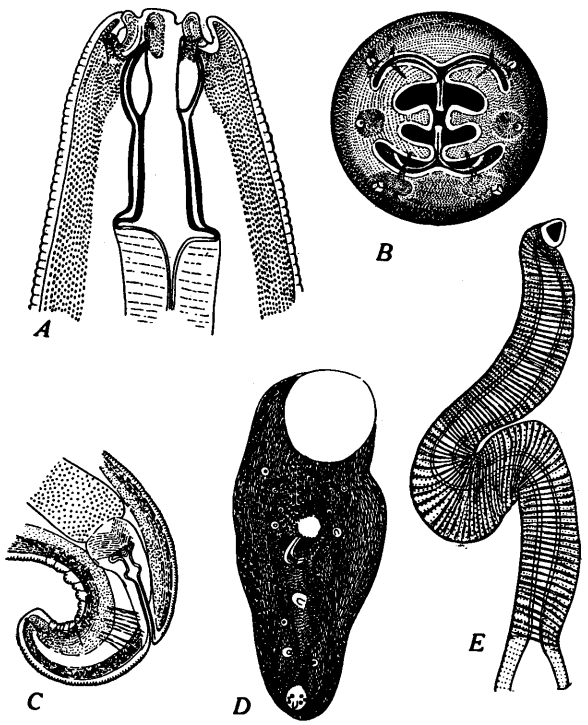


FIG. 23

Habronema clarki, n. sp.

A—Head, lateral view. B—Head, enface view. C—Tail of female. D—Tail of male. E—Vagina.

Habronema clarki, n. sp.

Description—Pseudolabia and cephalic papillae (fig. 23, B) as in *H. muscae* and *H. microstoma*. Stoma 69 to 85μ deep by 18 to 23μ wide. Median cuticular ridges sharp, not denticulate (fig. 23, A and B). Left cervical ala extending from level of nerve ring posterior to base of esophagus. Cervical papillae anterior to nerve ring. Esophagus 2 to 2.6 mm long; anterior muscular part approximately 1/8 of total length of esophagus.

Male 12 mm long by 200μ wide; left spicule 787μ long; right spicule 340μ long; gubernaculum present; genital papillae consisting of 4 pairs of large preanal and 2 pairs of large postanal papillae, and a group of small subterminal papillae (fig. 23, B).

Female 15.75 to 17 mm long by 230 to 320μ wide. Anus 220 to 234μ from posterior extremity. Vulva dividing body in proportions of 1:4 to 1:5; vulva ventral to the lateral left line; vagina at first cylindrical then forming a loop at which point the muscular wall is thickened (fig. 23, E); uteri parallel. Eggs 38μ by 14μ.

Host.—*Hydrochoerus isthmius* Goldman, the isthmian capybara or "poncho."

Location.—Stomach, in mucosa.

Locality.—Darien Province, Panama.

Specimens.—U. S. N. M. Helm. Coll. No. 31362 (types) and No. 31383 (paratypes).

Habronema clarki may be differentiated from the other species of the genus by the following key:

Key to species of Habronema

1. Long spicule 1.8 to 2.5 mm 2
   Long spicule 0.76 to 0.80 mm 3
2. Stoma with median dentate processes ..... *H. zebrae* Theiler, 1924
   Stoma without median dentate process ..... *H. muscae* (Carter, 1861)
3. Vaginal thickening close to vulvar orifice ..... *H. microstoma* (Schneider, 1866)
   Vaginal thickening some distance from vulvar orifice ..... *H. clarki*, new species

A note on the location of the nematode *Cooperia curticei* (Trichostrongylidae) in sheep. JOHN S. ANDREWS, U. S. Bureau of Animal Industry.

During the course of an investigation to determine the effect upon lambs of pure infestations of *Cooperia curticei*, an opportunity was afforded to determine the distribution of this nematode in the intestinal tract of its host. When the infested lambs, 5 in number, were examined post mortem, the small intestine was cut into 10-foot lengths, each section opened lengthwise and washed out thoroughly. The washings obtained in this manner were examined carefully and the worms counted. The following table shows the number and distribution of *C. curticei* in each of the lambs examined.

TABLE 1.—*Location of specimens of C. curticei in 5 infested lambs*

Lamb No.	*No. of worms at indicated distances (in feet) from the abomasum*				
	1-10	10-20	20-30	30-40	More than 40
102	6,159	17,697	1,152	6	0
61	2,715	5,009	60	0	12
63	2,851	3,759	257	7	0
88	749	6,055	321	61	17
65	161	294	0	0	0

These observations show that the majority of the parasites are located within the first 20 feet of the small intestine, although a few do occur even beyond 30 feet from the abomasum. In collecting this parasite it would be necessary to examine the first 30 feet of the small intestine in order to get practically all of the worms present.

Two new species of the nematode genus *Nematodirus* (Trichostrongylidae) from rabbits. GERARD DIKMANS, U. S. Bureau of Animal Industry.

The genus *Nematodirus* was created by Ransom (1907) with *Nematodirus filicollis* (Rudolphi, 1802) as type species.

Price (1927, Proc. U. S. Natl. Mus. 71:1-4) listed 14 species as members of this genus. Of these, only 4 have been reported from rodents, namely: *Nematodirus leporis* Chandler, 1924, from *Oryctolagus cuniculus; Nematodirus neotoma* Hall, 1916, from *Neotoma* spp. from Colorado; *Nematodirus spathiger* reported by Seurat from *Ctenodactylus gundi* from Tunis, North Africa; and *Nematodirus mugosaricus* Schultz, 1926, from *Citellus mugosaricus*. More recently Boughton (1932, Canad. J. Research 7: 524-547) has reported another species, *N. triangularis*, from the snow shoe rabbit, *Lepus virginianus*. In the present paper 2 new species of *Nematodirus* from rabbits are described. While rabbits are not regarded by mammologists as members of the Rodentia, they may be regarded as rodents for practical purposes.

Nematodirus neomexicanus, n. sp.

Description.—Male 13 to 15 mm long by 175μ wide just anterior to the bursa. Esophagus 480 to 490μ long. Cervical inflation 120 to 125μ long by 45 to 55μ wide. Edges of bursa rounded; rays arranged in the typical *Nematodirus*

pattern. Ventral rays parallel and close together; externolateral about midway between ventrolateral and mediolateral; mediolateral and posterolateral run close together in a slightly dorsal direction except at the tips, where the posterolateral turns ventrally; posterolateral slightly longer than mediolateral; dorsal rays similar to those of other members of the genus. Spicules 900μ long, thin, filiform, ending in straight sharp points.

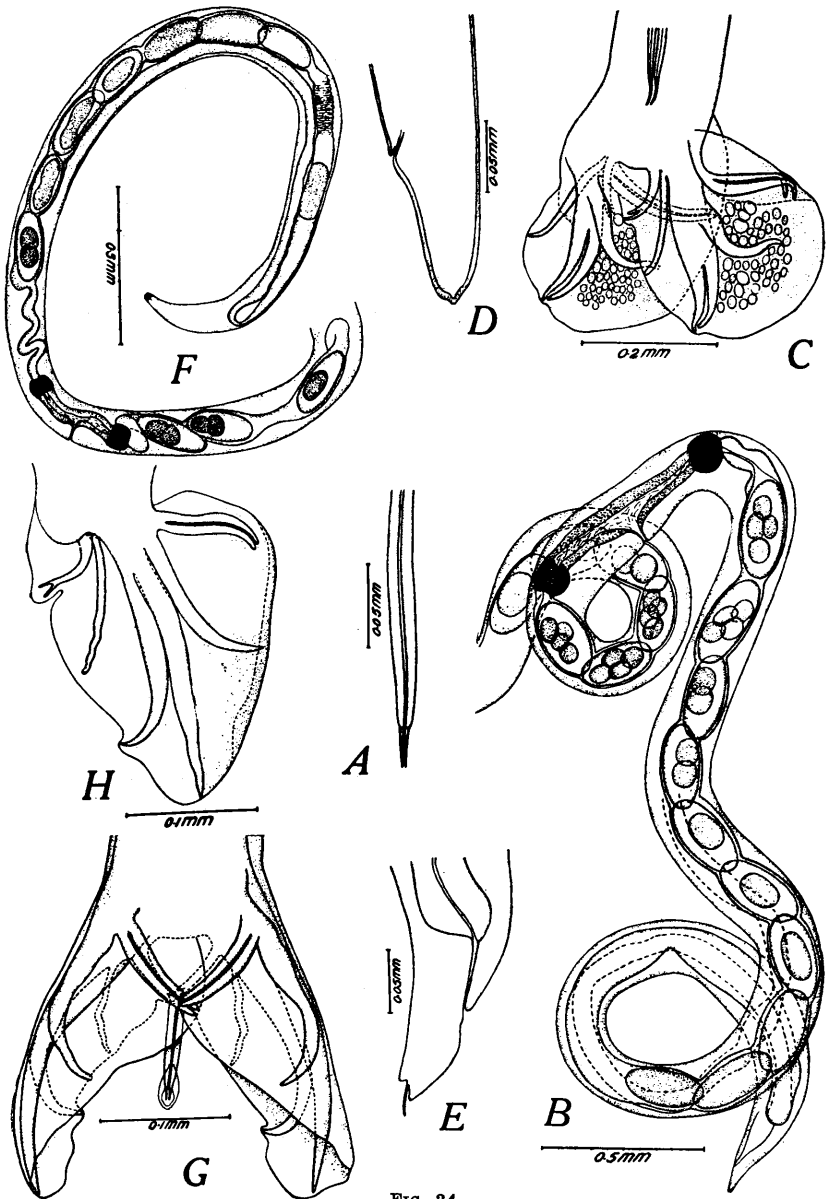


FIG. 24
A-D—*Nematodirus neomexicanus* (A—Terminal portion of spicules. B—Posterior end of female. C—Bursa of male. D—Tail of female.) E-H—*N. arizonensis* (E—Tail of female. F—Posterior end of female. G—Bursa of male, ventral view. H—Bursa of male, lateral view.)

Female 18 to 20 mm long by 170 to 185μ wide in region of vulva, the width remaining the same as far as anus where body gradually narrows to tip of tail. There is no abrupt narrowing behind the vulva as described by Chandler (1924, Proc. U. S. Natl. Mus. 66:1-6) for *N. leporis*. Width of head, without cervical inflation, about 30μ; cervical inflation 125 to 135μ long by 55 to 65μ wide. Esophagus 490 to 510μ long. Excretory pore located about 55 to 60μ in front of termination of esophagus. Muscular portions of ovejectors, including sphincters, 470 to 550μ long. Vulva about 4.3 mm from tip of tail; distance from anus to tip of tail, 110 to 120μ. Tail bluntly rounded, without bristle-like process; in some specimens there is a slight knob at the end of the tail. Eggs oval, large, 235μ long by 95μ wide.

Hosts.—Jack rabbit, *Lepus californicus texianus*, and cottontail rabbit, *Sylvilagus nuttallii pinetis*.

Location.—Small intestine.

Localities.—Albuquerque, New Mexico, and Howbert, Colorado.

Specimens.—U. S. N. M. Helm. Coll. No. 30464 (cotypes).

Nematodirus arizonensis, n. sp.

Description.—*Male* 6.5 to 7 mm long by 100 to 120μ wide just anterior to bursa. Esophagus 365 to 430μ long. Cervical inflation about 70μ long by 40μ wide. Bursa with symmetrical lateral lobes, each triangular in outline, about 175μ wide in proximal part, 50μ in distal part, by 250μ long. Ventral rays parallel and close together; externolateral ray runs parallel with mediolateral for a short distance, then diverges ventrad and ends close to margin of bursa, midway between ventral rays and mediolateral ray; mediolateral ray straight and reaching margin of bursa; posterolateral ray runs parallel with mediolateral for approximately one-half its length, then diverges dorsally and ends on dorsal margin of lateral lobe; margin of bursa bulged slightly at point where posterolateral ray terminates; dorsal rays similar to dorsal rays of other members of the genus. Spicules 1.2 mm long, filiform, simple, their ends inclosed in a membranous sheath.

Female 10 to 12 mm long by 150 to 160μ wide in region of vulva. Combined length of muscular portions of ovejectors, including sphincters, is 510 to 520μ. Vagina a simple slit about 60μ long; distance from vulva to tip of tail from 2 to 2.2 mm; distance from anus to tip of tail 80μ. Tip of tail notched, with a longer notch situated ventrally, a terminal spike 20 to 24μ long arising from the depression between the 2 notches. Eggs 185 to 195μ long by 75 to 80μ wide.

Host.—*Lepus alleni*.

Location.—Small intestine.

Locality.—Santa Rita Range Reserve, Arizona.

Specimens.—U. S. N. M. Helm. Coll. No. 30465 (cotypes).

The foregoing species may be separated from other species of *Nematodirus* from rodents by the following key:

Key to the species of Nematodirus in rodents[1]

1. Lobes of bursa rounded; medio- and posterolateral rays parallel 2
   Lobes of bursa triangular, medio- and posterolateral rays divergent 5
2. Spicules 3 mm long ..... *N. neotoma* Hall
   Spicules less than 3 mm long 3
3. Spicules ending in finger-like process ..... *N. leporis* Chandler
   Spicules not ending in finger-like process 4
4. Termination of spicules spatulate ..... *N. spathiger* Railliet
   Termination of spicules pointed ..... *N. neomexicanus*, n. sp.
5. Combined length of muscular portions of ovejectors including sphincters 800 to 850μ; vulva 3.6 to 4 mm from tip of tail ..... *N. triangularis* Boughton
   Combined length of muscular portions of ovejectors including sphincters 500 to 520μ; vulva 2.0 to 2.2 mm from tip of tail ..... *N. arizonensis*, n. sp.

[1] *N. mugosaricus* Schulz is not included in this key because the mature female of this species has not been described.

The hosts of *Diphyllobothrium mansonoides* (Cestoda: Diphyllobothriidae). JUSTUS F. MUELLER, N. Y. State College of Forestry.

McIntosh (1937, J. Parasitol. 23(3): 313-315 gives records of the adult of *Diphyllobothrium mansonoides* from the bobcat (*Lynx rufus*) at Monticello, Fla., and North Carolina, and infers that the bobcat is the natural host of this parasite. This had previously been surmised by the present author on *a priori* grounds, since the house cat is not native to this country, whereas *D. mansonoides* undoubtedly is. Hence it was clear from the beginning that the true host of *D. mansonoides* must be one of the native carnivores, a close relative of the cat: probably the bobcat. In an abstract on the life history of *D. mansonoides* Mueller (1936, J. Parasitol. 22(6):543) it was stated, "Experiments now in progress will determine to what extent wild carnivores may serve as host to the adult." These experiments are reported here.

Attempts were made to infect various carnivores at the State Game Farm at Delmar, N. Y. On October 12, 1936, plerocercoids were fed to an ova-free *Lynx rufus*, and on November 6 the feces showed numerous ova characteristic of *D. mansonoides*. Arecoline was administered several times in attempts to recover the worms but without success. Because of the difficulty of handling a bobcat other medicines were not used, and hence the worms were never recovered. On last accounts the cat was still shedding ova. For lack of the actual worm this experiment was heretofore considered incomplete, but in view of McIntosh's findings it is now clear that we were successful in infecting this animal with *D. mansonoides*. McIntosh's work further demonstrates the important fact that there is no morphological difference between worms from the house cat and those from the bobcat, and thus shows that *D. mansonoides* is a relatively fixed species, and not merely a variant of some other species.

In addition to the bobcat 6 red fox, 1 gray fox, and 1 raccoon were fed spargana, and after an appropriate interval were repeatedly examined for ova. None were found. Apparently these animals cannot be infected with the adult *mansonoides*. However, these experiments might well be repeated, since infection was attempted at the onset of winter, at which season these animals are in their maximum vigor and resistance. Possibly infection experiments during spring or summer might yield different results.

Since the original description of the species, at which time ova similar to those of this form were reported from a dog at Constantia, N. Y., without recovery of the worm, there has been no further information regarding the dog as a possible host of *D. mansonoides*. On January 14, 1937, a small beagle hound was fed numerous spargana from mice. On February 10 numerous ova appeared in the feces and the dog was given arecoline. Five worms were recovered, the largest 50 cm in length. These had the typical morphology of *mansonoides*, but the strobila seemed somewhat thicker and more rugged, and the uterus relatively smaller. The worms were obviously less active in egg production than those from the cat, and the eggs showed a lower degree of viability. Evidently the dog can carry the worm, but is not so favorable a host for the form as is the cat. In this respect *D. mansonoides* differs from the oriental *D. mansoni*, which thrives so well in the dog that this animal is normally used as the definitive host in experiments with the worm.

McIntosh reports spargana presumably of this worm from *Peromyscus gossypinus gossypinus* from Wakulla, Fla.; from the black fox at Medford, Wis., and from an otter at Okefinokee Swamp, Ga. The present writer has found the plerocercoid of *D. mansonoides* in nature only once: in a large, thick-walled cyst attached to the external surface of the duodenum of a cat from Rome, N. Y. This sparganum was fed to another cat and produced a worm 55 inches long, which was determined as *D. mansonoides*. The location of this sparganum, as well as those reported by McIntosh from the fox and otter, must be considered abnormal. Except for this case, however, I have never found the plerocercoid in nature although the following animals were examined: 169 sparrows; 200 *Microtus;* 50 *Zapus, Peromyscus,* and house mice; 15 rats; 21 shrews and moles; 15 chipmunks; 4 marmots; 4 *Natrix;* and 200 frogs—all from the vicinity of Syracuse.

In spite of this it is felt that the host of the plerocercoid must be a mouse. Possibly my sample of mice was too small.

McIntosh suggests, "one might assume that in nature the parasite is primarily one of bobcats and stray house cats, with the plerocercoid stage in *Peromyscus* and possibly other small mammals." This, however, does not seem to tell the whole story for the vicinity of Syracuse, at least, where "tame" cats from the center of the city are found infected as well as "wild" cats from the outskirts. Probably the only difference between infected and uninfected cats is their habits relative to catching and eating mice. Many house cats do not prey on mice and hence would not be subject to infection. Others, with predatory habits, would be. Our findings with reference to the distribution of infected cats would indicate that both house mice and wild mice may be concerned in the transmission of the parasite, since *Peromyscus* or other wild mice do not occur in the center of the city, even though infected cats are found there.

It has been recently determined that about 90 per cent of the *Natrix* from the vicinity of Silver Springs and Sarasota, Fla., are infected with spargana. These spargana have been fed to cats and worms of 2 types recovered. One form is morphologically indistinguishable from *D. mansonoides,* although apparently possessing minor physiological differences. For instance, the ova of the Syracuse strain of *mansonoides* show fully developed oncospheres and are ready to hatch in 9 days, but in the Florida *Natrix* strain hooks do not show in the oncospheres until around the 10th day, and the eggs are not ready to hatch until the 11th or 12th day—eggs of both strains being kept under identical conditions.

The other form shows the general character of *D. mansoni* (*erinacei*), but differs from it in certain important features. *D. mansoni* thrives in the cat, but this species from Florida *Natrix* does not. It ordinarily fails to mature in the cat, and in any case appears to be eliminated within 2 weeks after infection. If cats which have been fed spargana are killed before this time some of these worms may be recovered (an occasional one of which may be producing a few eggs) along with a few immature specimens of *D. mansonoides.* Even though immature, the 2 species can be readily distinguished by the characteristic form of the empty uterus. That of this newly encountered form has from 5 to 7 coils as compared to 2 in *mansonoides,* and the terminal chamber lies on the median line, instead of to one side as in the latter species. If infected cats are allowed to survive 3 weeks before examination only *mansonoides* are found. This behavior is quite different from that of *D. mansoni* which thrives in the cat and after 3 weeks is shedding large quantities of eggs. The failure of the present form to persist and thrive in the cat is taken to indicate that this animal is not its normal host. Dr. Allen McIntosh has called to my attention a specimen in the U. S. N. M. Helm. Coll. No. 42296, from a raccoon from Okefinokee Swamp, Ga., which is badly contracted and poorly preserved, but which roughly resembles this form and may possibly be identical with it. Feeding experiments now under way will determine whether the raccoon is the normal host.

Another significant difference between this form and *mansoni* is that in the Orient in regions where *mansoni* occurs the spargana are commonly found in frogs as well as in water snakes. I have examined 75 aquatic frogs of various species from the same regions in Florida which yielded infected *Natrix* but no spargana were found. Apparently frogs in this country do not carry spargana, whereas in the Orient and in the tropics they frequently do.

Note: It has been still more recently determined that *Natrix* from the vicinity of Syracuse are infected with spargana. The first instance of this was reported by Thomas (1937, Science, 85 (2196):119) on the basis of a single case found near Ithaca by Elmer E. Brown of Cornell. Brown regarded the case as a rare occurrence. We have now found that in a collection made May 13, near Syracuse, 4 out of 7 snakes are infected, and possibly more in some regions. These spargana are *mansonoides,* as proved by feeding experiments. Whether this strain is physiologically identical with or different from the Syracuse mouse strain is not yet known. Evidently the water snake is another normal host of the sparganum.

A new cestode from a shark (*Hypoprion brevirostris* Poey).[1] CORINNE CLAFLIN POTTER, University of Nebraska.

The tetraphyllidean tapeworm described below is one of several species collected from the yellow shark (*Hypoprion brevirostris* Poey), by Dr. H. W. Manter, under whose direction this study was made. The collection was made at Dry Tortugas, Florida (at the Tortugas Laboratory of the Carnegie Institution of Washington). More than 40 specimens of the cestode were collected from a single host.

Platybothrium hypoprioni, n. sp. (fig. 25)

Description.—Entire worms, in balsam, measured 11 to 18 mm in length. The scolex (fig. 25, A) is more or less cuboidal, bluntly pointed at its anterior end, somewhat flattened dorsoventrally. It measures 0.32 to 0.35 mm in length; 0.34 to 0.47 mm in greatest width; and approximately 0.086 mm in thickness (dorsoventral). At the anterior end of each of the 4 elongated bothridia is a small sucker. These suckers do not seem to possess an outer limiting membrane, but definite radial muscles do occur. The bothridia are not tubular. The greater part of each bothridium consists of a long, fairly deep depression with more or less muscular walls (fig. 25, B). At the posterior end of each bothridium occurs a sucker-like cup several times the diameter of the anterior sucker. It probably represents a posterior loculus. An inconspicuous partition divides the chamber of this posterior loculus into 2 parts, the outermost or more anterior apparently being the larger. At least the posterior third of each bothridium is covered by very fine, minute spinules or bristles about 1 or 2μ in length. These seem to be easily lost and could not be seen on all specimens.

The scolex bears 4 pairs of very large hooks (fig. 25, C & D). Each bothridium has a long, curved, 2-pronged hook and a long, curved, 3-pronged hook. The 2-pronged hooks are adjacent to each other on the dorsal and on the ventral surface, while the 3-pronged hooks are adjacent on the lateral surfaces. Each bothridium is thus the mirror image of its neighbor. There is no connecting bar between the hooks, a characteristic distinguishing this species from others in the genus. Figure 25, D, shows typical measurements of these hooks. The bifurcate hook has a long, recurved root and 2 prongs approximately equally long. Measurements on 10 hooks varied as follows: Greatest total length, 0.146 to 0.170 mm; length of prongs, 0.105 to 0.122 mm. The trifurcate hook has a shorter, thicker root, outer and middle long pointed prongs, and an inner short, truncated prong branching from the base of the middle prong. Measurements on 10 trifurcated hooks: Greatest length of entire hook, 0.127 to 0.131 mm; length of outer prong, 0.094 to 0.114 mm; length of middle prong, 0.088 to 0.101 mm; length of inner branch, 0.034 to 0.039 mm.

The neck is long and slender, 3.5 to 6 mm by 0.077 to 0.12 mm. It is armed with spines with bifurcated bases (fig. 25, E). These spines measure 14 to 17μ in length in the neck region, but may be only 7 or 8μ long farther back on the proglottids. Variations in the size and appearance of these spines suggested that they were being regenerated. Ovoid, granular cells showed small spine-shaped structures within them (fig. 25, E).

The earliest proglottids are over 3 times wider than long and possess the same type of spines as those found on the neck. Gradually the proglottids become longer, and the spines disappear. The mature proglottids rapidly increase in length. The most mature proglottid (fig. 25, F), easily broken from the strobila, measured 1.42 mm by 0.577 mm. The preceding proglottid was 1.087 mm by 0.322 mm. Genital pores are irregularly alternating, lateral, very inconspicuous, and approximately in the middle of the proglottid. The testes are numerous, approximately 110 to 132 in number, filling most of the proglottid except the posterior fourth which is occupied by the ovary. The cirrus sac is

[1]Contribution from the Zoological Laboratory, University of Nebraska, No. 190.

large, thin-walled, of almost equal width throughout its length, broadly truncated at its inner end, bluntly rounded at its outer end, extending half-way across the proglottid. It contains a coiled seminal vesicle with at least one pronounced loop in the inner half of the sac, and a vesicle-like terminal (poral) portion of the duct surrounded by conspicuous gland cells. No indication of a protrusible cirrus was seen, and if present, it is not armed. The ovary fills the posterior fourth of the proglottid. Its outline is indistinct, but its cells indicate it has a branching structure. From the ootype the vagina leads straight forward in the center of the proglottid, bends sharply around the anterior edge of the cirrus sac and extends to the genital pore. Gland cells surround the terminal portion of the vagina. The genital atrium is very poorly developed. The 2 sex ducts seem to unite close to the lateral edge of the body and open in a common inconspicuous pore. In many proglottids, the pore could not be recognized. No gravid proglottids were collected.

Diagnosis.—Scolex cuboidal with 4 bothridia; each bothridium with anterior sucker, posterior sucker-like loculus divided by a single inconspicuous transverse septum, and a pair of large hooks, one 3-pronged, one 2-pronged. No connecting bar between bases of hooks. Scolex with very fine spinules. Neck and anterior proglottids with spines with bifurcated bases. Genital pores lateral at middle of proglottid, irregularly alternating. Mature proglottids longer than wide, with 110 to 132 testes; large, broad, thin-walled cirrus sac extending to mid-proglottid, containing coiled seminal vesicle and glandular, terminal vesicle. Sides of cirrus sac almost parallel.

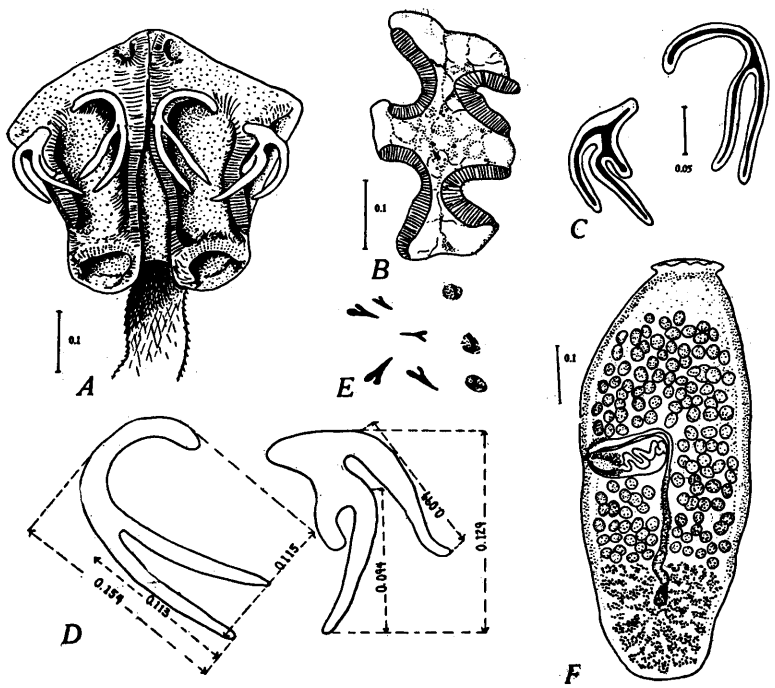


FIG. 25

Platybothrium hypoprioni, n. sp.

A—Dorsal or ventral view of scolex. B—Cross section through bothridia. C—The two types of large hooks. D—A pair of large hooks showing dimensions in millimeters. E—Spines from neck region. F—A mature proglottid. (All camera lucida drawings. Scales of magnification in millimeters.)

Host.—*Hypoprion brevirostris* Poey.

Locality.—Dry Tortugas, Florida.

Discussion.—The genus *Platybothrium* was proposed by Linton (1890 Rept., U. S. Fish Com. (1887), p. 820) for *P. cervinum* from *Carcharias obscurus*. A second species *P. parvum* was described by Linton (1901, Bull. U. S. Fish Com., 19:426) from *Carcharinus milberti*. These forms are well discussed by Southwell (1925, Liverpool School Trop. Med. Mem. n. s. (2), p. 98-106). The genus *Platybothrium* differs from the related genera *Onchobothrium*, *Calliobothrium*, and *Acanthobothrium* in that one of each pair of hooks is bifurcated, the other trifurcated, and this feature should be recognized as the outstanding characteristic of the genus. Both of the 2 species of *Platybothrium* previously described possess a connecting bar between the hooks of a pair. This conspicuous structure was entirely lacking in every specimen of *P. hypoprioni*. *P. hypoprioni* also has a more anterior genital pore and a larger ovary in the mature proglottid.

There is some confusion in the designation of the organs of attachment or the scolex of these cestodes. American authors (e. g. Linton, Pratt, Chandler) usually refer to the organs of the Tetraphyllidea as bothria. Meggitt uses the term bothridia to refer both to the sucking grooves of the Pseudophyllidea and the lobe-like organs of the Tetraphyllidea. Southwell, Fuhrmann, and Baylis use the term bothria for the sucking grooves of the Pseudophyllidea and bothridia for the lobe-like flaps of the Tetraphyllidea. This confusion is of long standing. Beauchamp (1905, Arch. Parasitol., 9(4): 461-539) noted these differences in terminology. His suggestion, based on the probable homologies of the organs as shown by Pintner, was to designate those organs found in the Pseudophyllidea, Tetraphyllidea, Diphyllidea, and Trypanorhyncha as *bothridia*. The sucking grooves of the Pseudophyllidea and the lobe-like structures of the other 3 orders can be further distinguished as *bothria* and *phyllidea*, respectively. According to this terminology, the term bothridia is more inclusive than either bothria or phyllidea, which latter terms are used to designate certain types of bothridia. In the present paper, the lobe-like organs of the Tetraphyllidea are termed bothridia.

Type specimens of *Platybothrium hypoprioni* are deposited in the United States National Museum.

A new species of cestode, *Dendrouterina lintoni* (Dilepidiidae), from the little green heron (*Butorides virescens* (Linn.)).[1]

O. WILFORD OLSEN, Minnesota Agricultural Experiment Station.

Recently the author reported *Dendrouterina nycticoracis* Olsen, 1937 (Proc. Helminth. Soc. Wash. 4:30-32) from the black-crowned night herons in Minnesota, which constituted the first record of this genus in the Western Hemisphere. Linton (1927, Proc. U. S. Natl. Mus. 70(7):18, figs. 45-51) described and figured a small cestode which he found infesting the little green heron from the region of Woods Hole, Mass., as *Dilepis unilateralis* (Rudolphi). When it was noted that this was not *Dilepis unilateralis* but an undescribed species of *Dendrouterina*, Dr. Linton kindly sent his material to the writer for study. The name *Dendrouterina lintoni*, n. sp., is proposed for it.

Dendrouterina lintoni, n. sp.

Synonym.—*Dilepis unilateralis* Linton, 1927 (Proc. U. S. Natl. Mus. 70 (7):18-20, figs. 45-51) (nec Rudolphi, 1819).

Description.—Length 8 to 23 mm; strobila consisting of 50 to 300 proglottides, usually about 50, mature ones broader than long, maximum width 0.696 mm; width and length of distal proglottides about equal.

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[1]Paper No. 1494 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

Rostellar sac 0.039 mm in diameter, extending to near caudal margin of suckers; rostellum protrusible; diameter 0.047 mm. Hooks of 2 sizes, arranged in 2 rows of 10 each; large hooks 0.0332 mm long, shaft 0.0216 mm long, blade 0.0116 mm; small hooks 0.018 mm long, shaft 0.01 mm long, blade 0.008 mm. Entire shaft of small hook bent dorsad; blade considerably longer than ventral root. Scolex angular, width 0.132 mm, length 0.062 mm; suckers about 0.051 mm in diameter. Short "neck" present, width 0.078 mm.

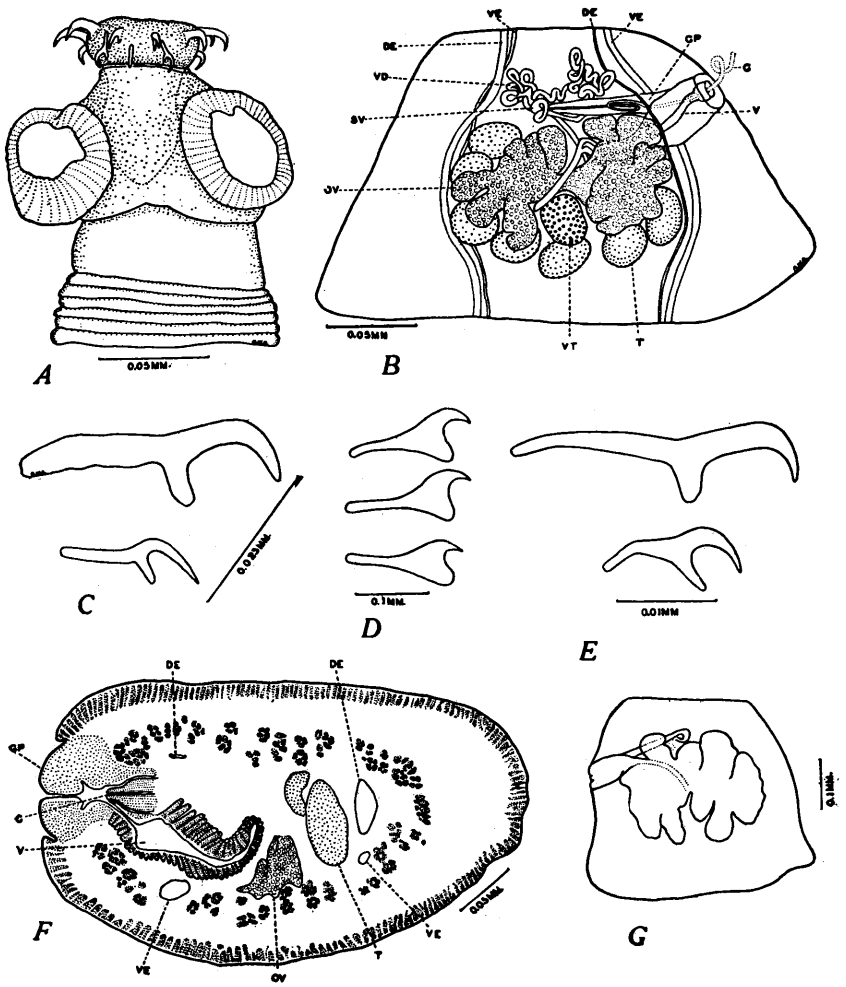

FIG. 26

A-C—*Dendrouterina lintoni*, n. sp. (A—Scolex. B—Mature proglottid, dorsal view. C—Hooks). D—*D. fovea* Meggitt, 1933; hooks (after Meggitt). E—*D. nycticoracis Olsen*, 1937, hooks. F & G—*D. lintoni*. (F—Cross section of mature proglottid. G—Gravid terminal proglottid.) C, cirrus; CP, cirrus pouch; DE, dorsal excretory duct; GP, genital papilla; OV, ovary; SV, seminal vesicle; T, testis; V, vagina; VD, vas deferens; VE, ventral excretory duct; VT, vitelline gland.

The musculature consists of 3 layers of longitudinal fibers; a single cuticular layer of numerous small fibers and 2 layers of much larger parenchymal fibers, the outer consisting of about 31 and the inner of about 20 bundles. Neither dorso-ventral nor transverse fibers were observed.

The excretory system consists of 2 pairs of longitudinal ducts without transverse connections. The ventral duct on the poral side is large, the dorsal very small, while on the aporal side the ventral duct is small and the dorsal very large.

Atrial pores unilateral, dextral, located near anterior end of proglottid. Genital papilla very muscular. Both male and female ducts pass between dorsal and ventral excretory canals. Male genital pore dorsal to female; cirrus long, attenuate, protrusible, and armed with minute spines; it forms a single loop within the cirrus pouch. Cirrus pouch more or less cylindrical, extending directly mesad to median line of proglottid, tapering gradually to a small diameter; seminal vesicle present. The vas deferens forms a compact knot of involved coils anterior to cirrus pouch and between lateral excretory canals. Testes 7 to 8 in number, arranged posterior to ovary except on aporal side where they lie laterally, one usually near anterior margin of ovary.

Vagina thick-walled in poral region, extending to median line of proglottid on ventral side of ovary, then passing to dorsal side of transverse portion of ovary and extending caudad to level of anterior margin of vitelline gland. Oviduct, Mehlis' gland, seminal receptacle, vitelline duct, and uterus not visible in specimens studied. Ovary large, extending across space between excretory ducts, elongated transversely with large and strongly lobed lateral portions connected by a short, narrow transverse piece. Gravid uterus large, multi-lobed, occupying greater portion of proglottid. Vitelline gland immediately caudad from transverse portion of ovary, similar to testes in size and shape.

Eggs densely packed in uterus. Linton described the living eggs as having 2 thin shells, the outer 0.066 mm in diameter and the inner 0.033 mm, and the hexacanth embryo 0.019 mm.

Host.—*Butorides virescens* (Linn.).

Habitat.—Duodenum.

Locality.—Woods Hole, Massachusetts.

Specimens.—Cotypes, U. S. N. M. Helm. Coll. No. 7866; paratypes in the collection of Dr. Edwin Linton and the author.

Diagnosis.—*Dendrouterina lintoni*, n. sp., and *D. nycticoracis* Olsen, 1937, are closely related morphologically and in size but may be readily differentiated on the basis of the hooks and musculature. In *D. lintoni* there are 10 hooks in each row, the smaller ones being 0.018 mm long and with the entire shaft bent dorsad, while in *D. nycticoracis* there are 9 hooks in each row, the small ones which are 0.01 to 0.013 mm long have the distal half of the shaft bent sharply ventrad. The number of bundles of longitudinal parenchymal muscle fibers is very different; in *D. nycticoracis* there are about 65 outer and 30 inner bundles while in *D. lintoni* there are about 30 outer and 20 inner bundles. Likewise the cuticular bundles are more than twice as numerous in the former. *D. lintoni* has 7 to 8 testes (Linton reports 10 with a maximum of 12) while *D. nycticoracis* has 9 to 10. *D. fovae* Meggitt, 1933 has 70 hooks of one size and 11 to 15 testes. Scolex of *D. herodiae* Fuhrmann, 1912, unknown; testes, 44 in number.

Discussion.—The genus *Dendrouterina* was erected by Fuhrmann (1912, Wien Sitzber. Akad. Wiss. 121(1):187) to receive a single species, *D. herodiae* Fuhrmann, 1912, found in the little egret (*Herodias garzetta*) from Africa. In *D. herodiae* both the male and female genital ducts pass between the longitudinal excretory ducts. Johnston (1916, Mem. Queensland Mus. 5:196) regarded *Dendrouterina* as a synonym of *Bancroftiella* Johnston, 1911, which likewise has the genital ducts passing between the longitudinal excretory canals. Meggitt (1924, The Cestodes of Mammals, pp. 55, 58; 1933, Rec. Indian Mus. 35(2):155) accepted the genus *Dendrouterina* as distinct from *Bancroftiella*. The author fol-

lows Meggitt in accepting *Dendrouterina*. While the 2 genera are similar in that the genital ducts pass between the dorsal and ventral excretory ducts there are other fundamental differences. The testes in *Bancroftiella* are divided into 2 fields, an anterior and a posterior separated by the ovary, while in *Dendrouterina* they form a single group posterior and lateral to the ovary. The excretory ducts are different: in *Dendrouterina* the ventral duct on the poral side is large and the dorsal one minute, whereas the opposite condition obtains on the aporal side; in *Bancroftiella* the ventral ducts are large, the dorsal small. The genital pores are unilateral in *Dendrouterina* and alternating in *Bancroftiella*.

Since *D. fovea, D. nycticoracis,* and *D. lintoni* show the nature of the scolex and rostellar armament in the genus and great differences in the number of testes and nature of the mature uterus, it is considered appropriate to emend the generic concept to more adequately include these species.

Genus Dendrouterina Fuhrmann, 1912

Synonym.—Bancroftiella Johnston, 1916 (Mem. Queensland Mus. 5:196) (nec Johnston, 1911).

Diagnosis (emended)—Dilepidiidae: Rostellum armed with double crown of hooks. Larger longitudinal excretory vessel dorsal on one side of the strobilus and ventral on the other. Genital pores unilateral. Genital ducts pass between longitudinal excretory vessels. Cirrus armed. Testes few to numerous, posterior to, or posterior and lateral to, ovary. Uterus present in young proglottides, a simple transversely elongated sac or horse-shoe-shaped, the latter forming a reticulum extending laterally to the longitudinal excretory vessels. Adults in birds.

Type species.—Dendrouterina herodiae Fuhrmann, 1912.

Key to the species of Dendrouterina

1. Testes small, numerous (44); mature uterus horse-shoe-shaped with numerous branches; cirrus pouch short ..... *D. herodiae*
   Testes large, not more than 15 2
2. Seventy hooks on rostellum; cirrus pouch short and thick, extending mesad to near excretory canals; testes 11 to 15 ..... *D. fovae*
   Hooks not more than 20; cirrus pouch long and slender, extending mesad to midline of proglottid 3
3. Small hooks 0.01 to 0.013 mm, i. e., about ⅛ the length of the large ones, end of shaft bent sharply ventrad; testes 9 to 10; longitudinal parenchymal muscle bundles about 95 in number ..... *D. nycticoracis*
   Small hooks 0.018 mm long, which is more than ½ the length of large ones, entire shaft bent sharply dorsad; testes 7 to 8; longitudinal parenchymal muscle bundles about 50 in number ..... *D. lintoni*, n. sp.

Observations on the life history of *Eustomos chelydrae* MacCallum, 1921 (Trematoda: Plagiorchiidae). WENDELL H. KRULL, U. S. Bureau of Animal Industry.

In 1934 (J. Parasitol. 20:326-327), the writer reported briefly the results of experiments to determine the life history of a trematode, *Eustomos chelydrae*, parasitic in the snapping turtle, *Chelydra serpentina*. In these experiments the snails, *Helisoma antrosa, H. trivolvis, Lymnaea traskii* and *Pseudosuccinea columella*, were found to serve as second intermediate hosts. These snails were infected by exposing them to xiphidiocercariae obtained from a naturally infected specimen of *H. antrosa*. Some of the encysted metacercariae obtained from these snails were force fed to a young snapping turtle that had been hatched and raised in the laboratory. On post-mortem examination of the turtle, 42 days af-

ter infection, 48 small but mature specimens and 16 immature specimens of *Eustomos chelydae* were obtained.

Subsequent to the appearance of the writer's (Krull, 1934) report, McMullen (1935, J. Parasitol. 21:52-53) published the results of his work on the life history of this trematode, including a redescription of the adult fluke. Some of the observations obtained, respectively, by McMullen and by the writer are in disagreement as regards certain morphological details, particularly with reference to the structure of the pharynx. McMullen reported this organ as trilobate anteriorly, whereas the writer finds it to be tetralobate; examination of specimens kindly loaned by Dr. McMullen also showed a tetralobate structure. The tetralobate condition prevails in the cercaria and the metacercaria as well as in the adult of *E. chelydrae*.

The present paper contains a detailed description of the larval stages of *E. chelydrae* and records of infection experiments conducted by the writer.

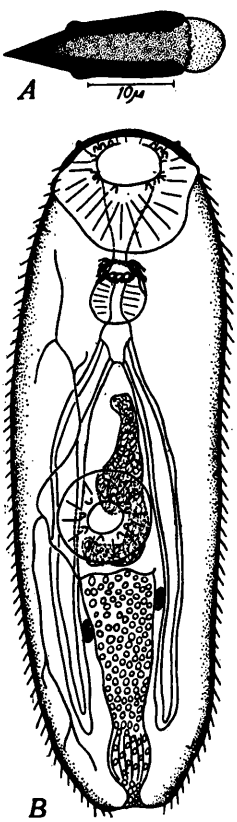

FIG. 27
Eustomos chelydrae
A—Stylet from cercaria.
B—Metacercaria.

DESCRIPTION OF LARVAL STAGES

Cercaria.—Body covered with fine spines. Stylet (fig. 27, A), with small shoulders, widest at posterior end, which is more or less serrated and from which projects a mucilaginous plug. Suckers well developed; oral sucker somewhat larger than acetabulum, the latter equatorial in position; prepharynx broad; pharynx well developed, tetralobate anteriorly, twice as long as prepharynx; esophagus shorter than pharynx, bifurcating to form ceca which extend to level of the muscular terminal part of the excretory bladder. Three pairs of penetration gland ducts and openings present on either side of the stylet; at anterior end of body these are most easily observed in living specimens mounted in egg albumen. Openings of more than 36 smaller subcuticular glands also present at the anterior margin of oral sucker; a number of gland ducts open into the prepharynx just anterior to pharynx. The gland ducts opening anterior to the oral sucker may be traced for some distance posteriorly and the cell bodies appear to be more or less concentrated in the region of the penetration gland cells; the same is true of the cell bodies of the glands opening into the prepharynx immediately in front of the pharynx. Primordia of terminal parts of reproductive systems situated at level of, and somewhat divided by, acetabulum; primordia of testes oblique in position and posterior to acetabulum, one on either side of anterior part of excretory bladder. Excretory pore terminal, dorsal to tail attachment, connected with excretory bladder by short duct. Excretory bladder Y-shaped, posterior part muscular, constricting somewhat anteriorly and broadening again, forming a thick-walled, glandular part which bifurcates anteriorly into 2 relatively short cornua extending to about level of oral sucker. The primary collecting tubules continue anterolaterally, each dividing to form an anterior and posterior collecting tubule; anterior tubule bifurcating at level of pharynx, posterior tubule bifurcating between level of acetabulum and posterior end of body, one of the latter branches continuing and bifurcating again at level of muscular part of bladder. Four pairs of flame cells observed at level of pharynx, 1 pair at level of acetabulum and 5 pairs at posterior end of body. Tail simple, attached in ventro-terminal recess of body.

The essential measurements of the cerceriae are given in table 1.

TABLE 1.—*Measurements of cercariae of Eustomos chelydrae*

Condition of specimens	Body length	Body width	Oral sucker diameter	Acetabulum diameter	Pharynx width	Stylet: length without mucilaginous plug	Stylet: length with mucilaginous plug	Stylet: width at shoulders	Stylet: maximum width	Tail length	Tail width
	μ	μ	μ	μ	μ	μ	μ	μ	μ	μ	μ
Stained and mounted	357	98	60	58	20	22	26	5	7	186	40
Killed and mounted in 10 per cent formalin	463	162	80	71	34	----	----	--	--	298	50
In egg albumen for several hours	416	203	84	68	29	----	----	--	--	210	42
Quiescent, living cercariae	318	170	71	66	32	----	----	--	--	185	50

The cercariae which are produced in orange colored, branching sporocysts are sluggish swimmers and enter the second intermediate snail host by crawling into the mouth as previously described by the writer (Krull, 1934, loc. cit.)

When exposed to the second intermediate snail host, the cercariae immediately attach themselves to the snail, crawl to the mouth and enter. It was observed that the larger snails usually assisted the cercariae in entering by opening their mouths and by manipulation of their radulae. When very young snails were used as hosts the cercariae met active resistance and in some cases as long as 10 minutes elapsed before they were able to gain entrance. When the cercaria entered it elongated and the tail was dropped the moment the posterior end of its body disappeared. The cercaria immediately penetrated the wall of the snail's digestive tract and encysted; the whole process did not take more than 10 minutes in the cases where encystment was studied. The cysts increased in size and changes took place in the encysted cercariae as shown by a comparison of the descriptions of cercaria and metacercaria.

The average measurements of cysts of various ages after having been dissected out of snails and measured in saline solution without pressure are given in table 2.

TABLE 2.—*Average size of cysts of various ages*

Age in days	1	7	14	21	63
Number measured	9	9	6	5	9
Average diameter in μ	196	224	236	244	240

It appears from the data in table 2 that the cysts reached their maximum size in about 3 weeks.

Metacercaria.—Body ovoid; cuticula 3μ thick, spines well developed, about 5μ long, having an alternate arrangement and distributed over entire body. Oral sucker provided with about 16 sensory papillae and acetabulum with 9 papillae as shown in fig. 27, B. There is a row of prominent subcuticular gland openings with terminal parts of the ducts anterior to oral sucker, as well as a ring of similar structures immediately anterior to pharynx; other subcuticular glands having no regular arrangement open to surface of body. Oral sucker muscular, provided with a pair of lateral oral papillae; prepharynx short. Pharynx large, tetralobate anteriorly. Esophagus short, thin-walled, bifurcating and forming

well developed, thick-walled ceca extending to anterior end of specialized posterior part of excretory bladder. Acetabulum somewhat posterior to mid-body region. Excretory bladder elongated, extending anteriad to near posterior border of acetabulum and opening posteriorly through a short duct. Bladder distended by refractile granules, the largest granules 8μ in diameter. Posterior end of bladder provided with longitudinal muscles arranged so as to give it a fluted appearance. Collecting tubules strongly ringed, arranged as shown in fig. 27, B. Flame cells not numerous, 10μ long. Primordia of genital organs well developed, extending from near bifurcation of esophagus to posterior margin of acetabulum; testes separate and distinct, posterior to acetabulum.

The essential measurements of the metacercariae are given in table 3.

TABLE 3.—*Average measurements of metacercaria*

Specimens	*Body* length	*Body* width	*Oral sucker* length	*Oral sucker* width	*Pharynx* width	*Acetabulum* diameter
	μ	μ	μ	μ	μ	μ
Three 83-days old; in egg albumen	647	225	127	145	66	76
Seven 21-days old; stained and mounted	431	154	96	96	45	58

INFECTION EXPERIMENTS

The cercariae used for infecting the snails were obtained from a naturally infected snail, *Helisoma antrosa*, which was collected from a small pond in the vicinity of Beltsville, Md.; this snail remained alive in the laboratory for 21 days. Forty-nine specimens of laboratory-raised *Pseudosuccinea columella*, 7 of *Lymnaea traskii*, 5 of *Helisoma trivolvis* and 3 of *H. antrosa* were exposed to the cercariae; all the snails became heavily infested as determined by the number of cysts recovered in partial or complete dissections. Some specimens of the snail, *Pseudosuccinea columella*, were kept for 3 months after exposure to infection; when the snails were examined the encysted metacercariae were found to be still alive.

A young snapping turtle, *Chelydra serpentina*, was given a total of 9 infected snails as follows: First feeding with 4 snails which had been infected for 24 days; second feeding 37 days later with 3 snails infected for 60 days; and the third feeding a day later with 2 snails infected for 58 days. Three of the snails were very young specimens of *Lymnaea traskii* and the remainder were *Pseudosuccinea columella*. Forty-two days after the first feeding, the turtle was examined and 64 flukes were recovered; 16 of the specimens were about the size of metacercariae and the remaining 48 were young but mature specimens, each containing several completely formed, shelled eggs. The turtle had been hatched and raised in the laboratory and given fresh beef for food; these conditions completely precluded the possibility of extraneous parasite infestation.

Frogs (*Rana clamitans* and *R. catesbeiana*), fish (*Eupomotis gibbosus*), salamanders (*Triturus viridescens*) and a black snake were fed snails containing metacercariae but with negative results.

A new host record for *Brachycoelium hospitale* Stafford (Trematoda: Lecithodendriidae). ELON E. BYRD, University of Georgia.

On January 20, 1937, the writer removed 8 specimens of *Brachycoelium hospitale* Stafford, 1900 (Zool. Jahrb., Abt. Syst., 13:399-414) from the duodenum of the glass snake, *Ophisaurus ventralis* (L.), that had been captured on the high-

way about 2 miles south of Kissimmee, Fla., by Mr. William F. Cantrell. So far as we are able to determine *B. hospitale* has been reported heretofore only from amphibian hosts and the present report records for the first time the presence of this parasite in a reptilian (lizard) host.

Our material agrees with the detailed description of *B. hospitale* as given by Stafford (1903, Centbl. Bakt. [etc.], 1. Abt., Orig., 34: 822-830) in regard to the ratio of sucker sizes and the proportionate sizes and locations of the various internal organs, although the internal organs are slightly smaller than the dimensions given by Stafford. We find the follicles of the vitellaria to extend ventrally from the mesal plane lateral to the caeca far enough to lie ventral to the terminal portions of the caeca. Some variations are noted for the location of certain of the organs. In 6 specimens the ovary lies to the left of the acetabulum while it is right in position in 2 individuals; in a single specimen the ovary has atrophied to such an extent that it is difficult to distinguish. The shell gland is centrally located in 2 individuals, is placed to the left of the acetabulum in 3 forms and is right in position in the other 3; the shell gland is generally on the opposite side of the body from the ovary. The cirrus sac lies along the left margin of the acetabulum in 5 specimens while it is located along the right side of the sucker in 3 forms. The uterus contains a single file of eggs, about half the total number of eggs being mature in all specimens; in 4 individuals the uterus is crowded with eggs while there are relatively few eggs in the uterus of the other worms. In addition to these variations in the location of the several organs we find 5 of our specimens to contain rather large (0.09 mm to 0.13 mm in diameter) concretion granules in the main stem of the excretory bladder; in a single specimen there are 2 such granules, one considerably larger than the other. These granules occur in the slightly dilated portion of the bladder near the excretory pore.

***Pneumatophilus leidyi*, n. sp. (Trematoda: Plagiorchiidae), a new lung fluke from the watersnake.** ELON E. BYRD and J. FRED DENTON, University of Georgia.

During September, 1936, the writers removed 9 fully matured specimens of what appeared to be *Pneumatophilus variabilis* (Leidy, 1856) from the lungs and trachea of the common watersnake, *Natrix sipedon fasciata* (L.), that had been taken from along the edge of an artificial pool near Athens, Ga. On closer examination of these flukes, and after comparing them with specimens previously identified as *P. variabilis*, they were found to differ from this species in respect to so many characters that they could not be identified with *P. variabilis*. In the present paper we present a description of these worms under the proposed name of *Pneumatophilus leidyi*, new species.

Pneumatophilus leidyi, new species (fig. 28)

Description.—Body moderately muscular, dorso-ventrally flattened, somewhat pointed anteriorly, broadly rounded posteriorly, from 4.0 to 4.50 mm long by 2.40 to 2.83 mm wide (averaging 4.30 mm long by 2.60 mm wide), widest at level of testes. Cuticula rather heavy, thickly beset with rather large, triangular shaped spines from about level of equatorial plane of oral sucker to level slightly beyond testes. Oral sucker subterminal, highly muscular, averaging 0.54 mm long by 0.66 mm wide. Acetabulum muscular, larger than oral sucker, averaging 0.82 mm in diameter, located approximately 1.24 mm behind anterior margin of body (0.70 mm behind posterior boundary of oral sucker). Prepharynx present, short. Pharynx muscular, almost round, 0.23 mm long by 0.24 mm wide, surrounded by numerous peri-pharyngeal gland cells. Esophagus approximately 0.21 mm long, with relatively few peri-esophageal gland cells. Caeca well defined, reaching to testes, simple except for 2 or 3 prominent lateral pouches near posterior limits.

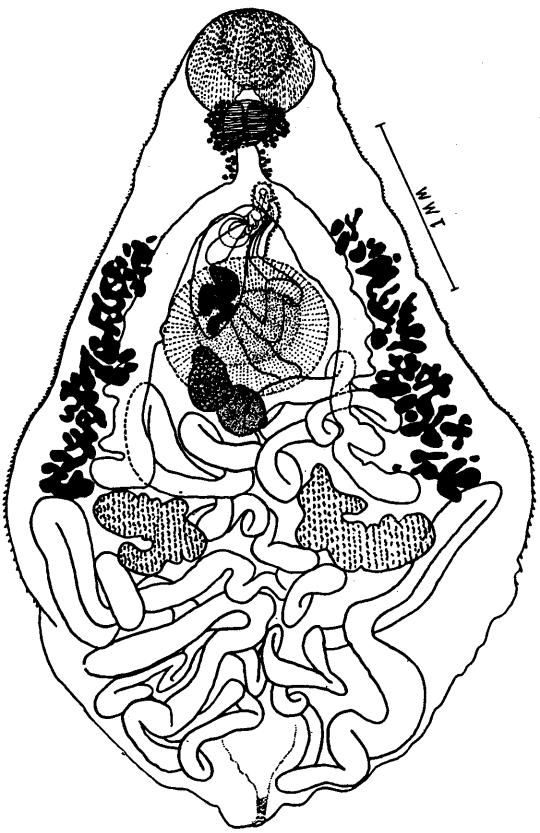

FIG. 28
Pneumatophilus leidyi, n. sp.
Dorsal view; ×12 (Camera lucida drawing).

Ovary slightly irregular in outline, to left of midline, almost entirely dorsal to acetabulum, averaging 0.34 mm long by 0.27 mm wide. Oviduct short. Oötype with shell gland almost in midline behind acetabulum. Laurer's canal present. Uterus almost uniform throughout, descending to near posterior margin of body by series of transverse and dorso-ventral loops, ascending by loops to right testis on right side before passing back to near posterior margin of body, ascending mainly on left side of body by profusion of transverse and dorso-ventral loops both posterior and anterior to testes, extending across caeca anterior to testes, passing up to genital pore along right medial half of acetabular region. Ova numerous, filling entire uterus, dark brown when matured, from 38 to 42μ by 26μ. Metraterm well developed, muscular, about half as long as cirrus sac, with peri-vaginal gland cells. Genital pore ventral, at bifurcation of caeca, slightly to right of midline, approximately 0.28 mm in front of acetabulum, common opening serving both female and male organs. Vitellaria follicular to slightly dendritic, follicles large, lateral to caeca, seldom extending mesad far enough to lie ventral to caeca, extending from a level midway between genital pore and anterior margin of acetabulum to posterior limits of intestinal caeca. Two or three yolk ducts from each set of glands passing in to fuse in midline at level of shell gland; common yolk duct slightly dilated. Testes well behind acetabulum, usually opposite, deeply notched, elongated obliquely; right testis averaging 0.61 mm long by 0.52 mm wide; left testis larger, averaging 0.61 mm long by 0.59 mm wide. Vasa efferentia with 2 or more slightly dilated areas, uniting at posterior end of cirrus sac. Cirrus sac large, averaging 0.95 mm long by 0.26 mm wide, extending from level of equatorial plane of acetabulum to genital pore, slightly sinuous in front of acetabulum, posterior half lying dorsal to acetabulum, containing large, much elongated and convoluted vesicula seminalis, large muscular pars prostatica with gland cells, long, convoluted ductus ejaculatorius and muscular cirrus. Excretory pore dorso-terminal, guarded by muscular sphincter. Excretory bladder wide, extending from pore to near shell gland, bifurcating into 2 cornua. Cornua extending around acetabulum to near pharynx, with lateral pouches. Flame cell formula undetermined.

Host.—Natrix sipedon fasciata (L.).

Habitat.—Lungs and trachea.

Locality.—Athens, Georgia.

Type specimen.—Zoology Department, University of Georgia, Slide No. 115.

Pneumatophilus leidyi is easily separated from its nearest relative, *P. variabilis*, by its larger body, larger suckers, larger pharynx, consistent length of caeca, more posteriorly placed acetabulum, shape and size of ovary, larger ova, smaller testes, larger cirrus sac, well developed metraterm and position of genital pore. From *P. foliaformis* (Talbot, 1934), the other member of the genus, *P. leidyi* is separated by its larger body, larger internal organs and the shape of the testes.

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A new species of the Anopluran genus *Scipio*. H. E. Ewing, U. S. Bureau of Entomology and Plant Quarantine.

Sucking lice of the genus *Scipio* Cummings, 1913 have a very unusual appearance. Each individual has a very long head, the most of which appears to be neck, large crablike legs and a very small discoid thorax. Up to the present 3 species have been described, all Ethiopian. They have come from hosts belonging to 2 rodent genera, *Thryonomys* and *Petromys*. The louse here described as new comes from a species of *Thryonomys*.

Scipio longiceps, new species

Description.—Male: Head very long, approximately twice as long as the thorax, sides almost straight, subparallel. Antennae very long, almost as long as the head, segments with lengths in the following ratio: 6, 7, 15, 8, 5.5; segment IV with a sensory pit at distal margin, above; segment V with a sensory pit on middle of posterior margin, and a tuft of small, subequal setae at the tip. Thorax very small, with rather evenly outcurved, lateral margins; bearing above but a single pair of setae situated between the rather conspicuous thoracic spiracles. Abdomen short, about three-fourths as broad as long. Typical abdominal segments each bearing a transverse row of unequal setae, a poorly sclerotized, irregularly shaped tergal plate, and a pair of poorly sclerotized, ill defined laterotergal plates. Legs large, long, and conspicuous. First pair extending to near the bases of antennae; femur I swollen but shorter than tibia I; tarsal claw long and sharp; accessory claw scarcely half as long as tarsal claw but much more strongly curved. Second and third legs subequal, each with a very thick tibia and a greatly enlarged tarsus and tarsal claw. Tibia II slightly longer than tarsus II, but tibia III shorter than tarsus III. Genital armature simple and typical of the genus; basal plate broad, poorly sclerotized, lateral margins diverging posteriorly; parameres short, stout, free, forceps-like; pseudopenis very sharp-pointed, extending

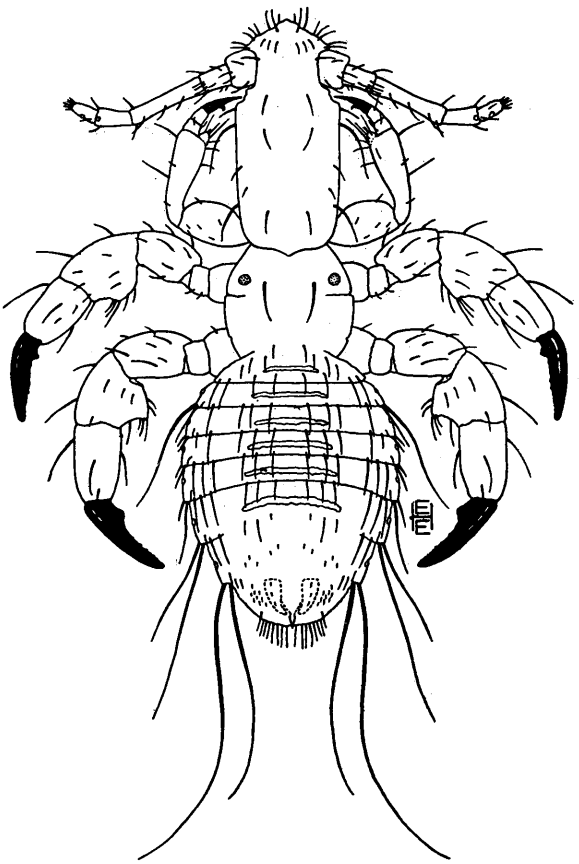

FIG. 29

Scipio longiceps, n. sp.
Dorsal view of male, ×90.

beyond the tips of the parameres; anterior endomere transverse, articulating with bases of parameres; posterior endomere poorly sclerotized, indistinct.

Length of male, 1.49 mm.; width, 0.55 mm.

Type host. — *Thryonomys gregor pusillus.*

Type locality. — British East Africa: Majiya-chumvi.

Type specimen (*holotype*).—U. S. N. M. No. 49919.

Described from 2 male specimens (a female specimen at hand is in too poor condition for describing). Material as follows: Male (holotype) and female from type host (U. S. N. M. No. 184180) and type locality; also a male from type host and type locality but taken from skin, U. S. N. M. No. 184179. This species is nearly related to *Scipio aulacodi* (Neumann), from which it differs in having a longer head, longer legs, and differently shaped tarsal claws, as well as in other characters.

REPORT ON THE BRAYTON H. RANSOM MEMORIAL TRUST FUND, JUNE 1, 1937

Three meetings of the trustees were held during the year. It was decided to consider as principal all the contributions and the accrued interest up to January 1, 1936.

The status of the Fund, since the previous statement in the PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY, July, 1936, is as follows:

On hand, June 1936, Principal			$1,299.91
Received July 1, 1936, Interest		12.50	1,312.41
January 1, 1937, Interest		13.24	1,325.65
May, 1937, Pledges paid		33.00	1,358.65
Paid out to treasurer, reimbursement for:			
Nov. 6, 1936, Helminth. Soc. reprints	$14.11		
Envelopes for reprints		1.60	15.71
Balance			$1,342.94

The Fund is still with The McLachlen Banking Corporation, as a savings account; the question of its investment is being considered, but no decision has been reached.

ELOISE B. CRAM,
Secretary-Treasurer.

CONTENTS