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PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

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Two new nematodes (Trichostrongyloidea) from rodents. G. DIKMANS, U. S. Bureau of Animal Industry.

The nematodes described in this paper were obtained from the small intestines of several woodland jumping mice, *Napeozapus insignis,* collected by Mr. A. H. Howell of the Bureau of Biological Survey in the Great Smoky Mountains, North Carolina, and from the small intestines of a cony, *Ochotona princeps ventorum,* collected by Mr. O. J. Murie of the Bureau of Biological Survey, Jackson, Wyoming.

Family TRICHOSTRONGYLIDAE Leiper, 1912

Citellinoides, n. g.

Diagnosis.—Head surrounded by cervical inflation marked with annular striations. Body marked with fine transverse striations. Two spicules, filiform and simple. Bursa with symmetrical lateral lobes and a separate, small dorsal lobe. Ventral rays arising from a common stem. Ventroventral ray directed anteriorly toward bursal margin; ventrolateral ray diverging from ventroventral, with tip directed slightly ventrad; externolateral ray about equidistant from ventrolateral and mediolateral rays; mediolateral ray diverging sharply from externolateral and approaching posterolateral in its termination; posterolateral ray the shortest of the lateral rays; externodorsal rays comparatively stout, and disposed in the shape of a bow; dorsal ray giving off 2 lateral branches in its distal third, the main stem then bifurcating, and each bifurcation again dividing into 2 terminal branches. Female with 2 short, muscular ovejectors and long vagina. Vulva located in a marked depression of body. Tail of female bluntly rounded, terminating in a bristle-like process.

Type species.—*Citellinoides zapodis,* n. sp.

Citellinoides zapodis, n. sp. (Fig. 1)

Description.—Worms with a distinct cervical inflation of cuticle about 120 μ long and 60 μ wide. Esophagus from 500 to 600 μ long, about 45 μ wide in its anterior portion and 65 μ wide in posterior portion, and narrowing considerably near its junction with intestine. Nerve ring about 230 to 240 μ and excretory pore about 245 to 260 μ from anterior end of body.

Male 10 to 12 mm long by 175 to 200 μ wide just anterior to bursa. Spicules simple, filiform, 850 to 950 μ long; proximal portions expanded for a distance of about 175 μ, ends smooth and sharp. Bursa conforming to description given in generic diagnosis, about 300 μ long by 700 to 750 μ wide.

Female 15 to 18 mm long and about 300 μ wide in region immediately adjoining vulva. Vulva in a depression about 65 to 70 μ deep, about 4.8 to 5 mm from tail end. Ovejectors short and muscular, the end of each about 850 μ from vulva. Anus 140 to 160 μ from tip of the tail. Tail bluntly rounded and adorned with a ''spike'' 15 to 20 μ long. Eggs 50 to 55 μ long by 30 to 32 μ wide.

Host.—Woodland jumping mouse, *Napeozapus insignis.*

Location.—Small intestine.

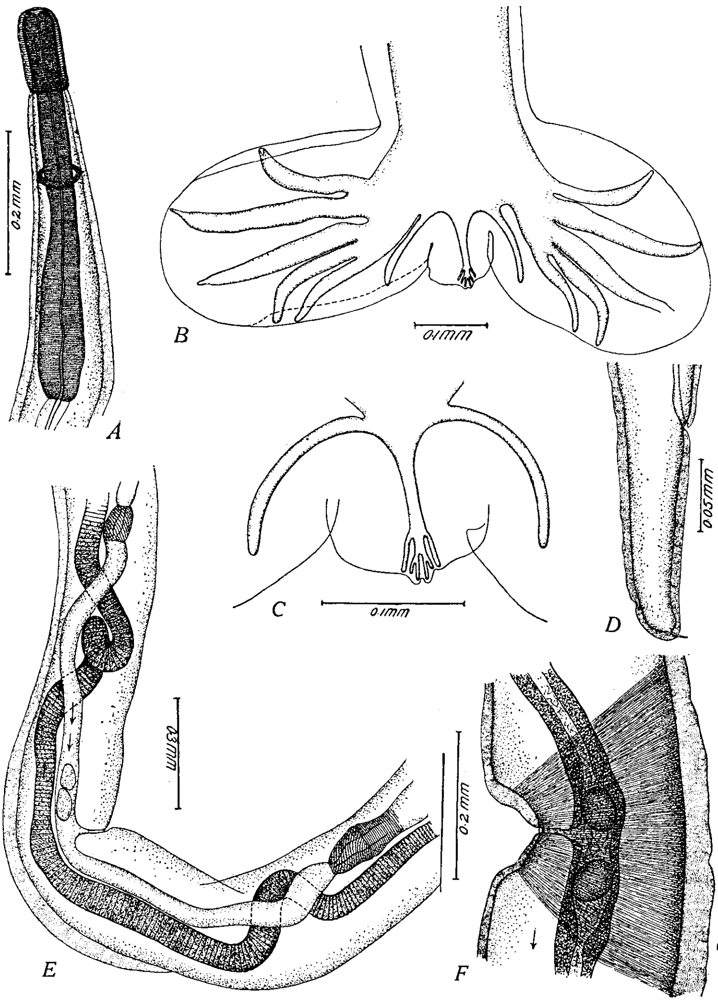

FIG. 1. *Citellinoides zapodis.* A—Anterior portion of body. B—Bursa. C—Dorsal rays of bursa. D—Tail end of female. E—Female genitalia. F—Vulva region.

Locality.—Great Smoky Mountains, North Carolina, U. S. A.

Specimens.—U.S.N.M. Helm. Coll. No. 30467 (type).

This nematode resembles the members of the genus *Citellinema* in some of its morphological characters, but the appearance of the male bursa separates it sharply from this genus, and since it does not appear to fit into any known genus of the family Trichostrongylidae, a new genus has been proposed for it.

Family HELIGMOSOMIDAE Cram, 1927

Murielus, n. g.

Diagnosis.—Body with fine longitudinal and transverse striations. Bursa with 2 completely separated dorsal rays, originating at distinct and separate points on the dorsal margin of the body and with 2 accessory externodorsal rays taking origin with the externodorsal rays. Ventral rays close together, approximately equal in size and directed slightly anteriorly; externolateral rays widely separated from the other lateral rays and directed anteriorly; mediolateral rays largest of the rays, directed straight toward margin of bursa; posteriolateral rays slightly divergent and directed posteriorly. Spicules filiform and with proximal portions slightly expanded and terminal portions enclosed in a harpoon-shaped sheath. Female with a single ovary. Eggs large (150 to 160 μ by 70 to 80 μ in the known species). Tail provided with spike.

Type species.—*Murielus harpespiculus,* n. sp.

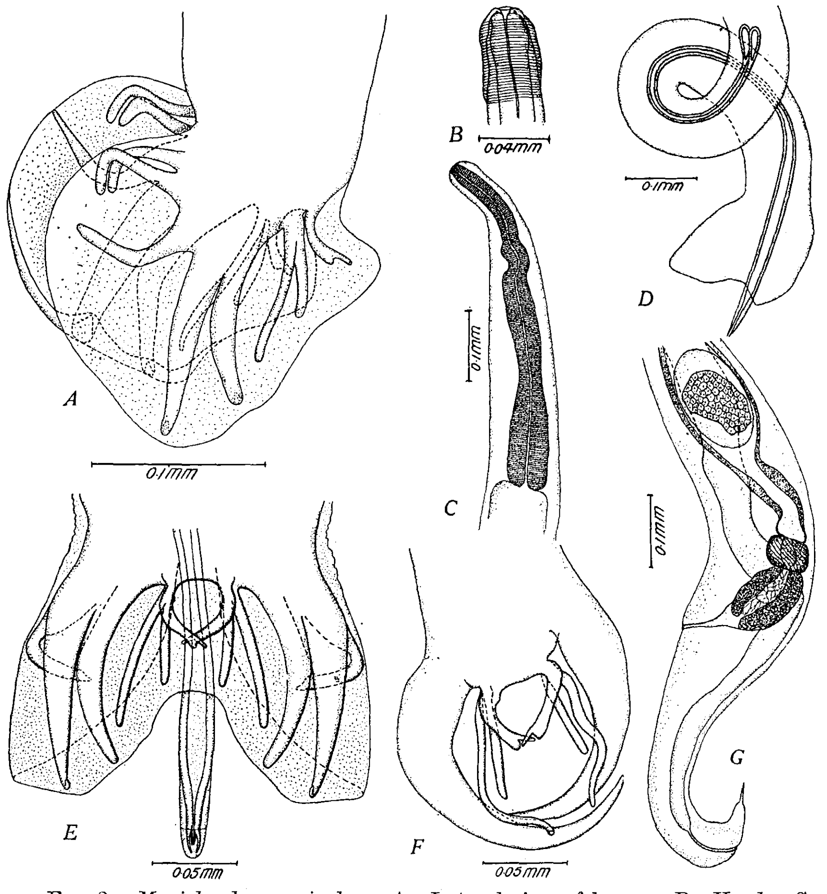

FIG. 2. *Murielus harpespiculus.* A—Lateral view of bursa. B—Head. C—Anterior portion of body. D—Posterior portion of male showing spicules. E—Dorsal view of bursa. F—Dorsal rays of bursa. G—Posterior portion of female.

Murielus harpespiculus, n. sp. (Fig. 2)

Description.—Male 6.6 to 7 mm long and 90 to 100 μ wide immediately in front of bursa. Bursa symmetrical, 380 μ long and 320 μ wide, with deep marginal indentation dorsally. There are 2 completely separated dorsal rays arising at distinct and separate points on the bursa. There are 2 accessory externodorsal rays which take origin at the same place as the externodorsals. The dorsal ray complex consists, therefore, of 6 rays, 2 dorsals, 2 externodorsals, and 2 accessory externodorsals. Ventral rays about equal in size, parallel and run close together on the anterior margin of bursa. Externolateral rays widely separated from other lateral rays, directed anteriorly. Mediolateral rays largest, directed straight toward edge of bursa. Posteriolateral rays directed slightly dorsally. Spicules 700 to 900 μ long, with slightly expanded proximal ends, and with terminal ends enclosed in harpoon-shaped sheath.

Female 8 to 8.5 mm long and 165 to 170 μ wide in the region of posterior portion of ovejector; behind this region, the body narrows gradually but markedly to about 60 μ in region of terminal portion of intestine. Ovejector single, lying in posterior portion of body; vagina about 75 μ long; distance from the vulva to anus about 425 μ, that from anus to tip of tail about 90 to 100 μ. Tail bearing terminal spike about 25 μ long. In some specimens there is no clear line of demarcation between the end of the tail and the terminal spike, and the body appears to be continuous with the spike, ending in a very sharp point. Eggs large, 150 to 160 μ long by 75 to 80 μ wide.

Host.—Cony, *Ochotona princeps ventorum.*

Location.—Small intestine.

Locality.—Jackson, Wyoming, U. S. A.

Specimens.—U.S.N.M. Helm. Coll. No. 30461.

This nematode bears a remarkable resemblance to *Nematodirus* in the shape and position of the dorsal and ventral rays of the bursa and in the size of the eggs. The single ovary, uterus and ovejector, however, place it in the family Heligmosomidae.

Notes on parasites of horses in Hawaii. A. O. FOSTER, Gorgas Memorial Laboratory, Panama, and J. E. ALICATA, University of Hawaii, Honolulu.

The present report is chiefly a series of notes on the species of endoparasites (29 in all) which are known to infect equines in Hawaii, and is presented as a contribution to our knowledge of the economically important parasites of the Islands.

No detailed report was heretofore available relative to the kinds of parasites of horses in Hawaii. Four species were recorded by Hall (1936) and the following quotation is from his "Problems of Parasitism in Hawaii" (p. 382):

> Horses in the Islands are infested with ascarids, strongyles, and bots. Specimens in the collection of the U. S. Bureau of Animal Industry include specimens of *Ascaris equorum, Strongylus vulgaris,* and *Gastrophilus equi.* . . . In the writer's experience, horses in the tropics are usually heavily parasitized. . . . Specimens of *Fasciola hepatica* from the horse in Honolulu were sent to the U. S. Bureau of Animal Industry by Rowat in 1894.

In addition, one of us (Alicata, 1936) reported briefly that the most common parasites of horses in Hawaii were *Habronema* sp., *Trichostrongylus* sp., *Parascaris equorum, Strongylus* spp., *Oxyuris equi,* small cylicostomes, bots and tapeworms.

The material covered in this report was collected by one of us (J. E. A.) during 1936 and 1937 from a few horses born and raised on the islands of Oahu and Maui. The exact number of animals from which these specimens were taken is unknown, since, at first, the examinations were conducted primarily to ascertain the presence of liver flukes, and in most of these cases the intestinal species were collected casually or not at all.

The fact that the species listed herein are established on the Islands is apparent from the sources of the material, although it is equally true that not only the parasitic species, but the hosts also, were originally imported, as is the case with practically all the livestock in Hawaii. According to a report by Henke (1929) the first horses, from California (a horse and a mare with foal), were imported in 1803 as a gift to King Kamehameha I. Following this, it is recorded that by 1854 horses were so numerous on the streets of Honolulu as to be regarded as a nuisance. Subsequent importations have been from England, Australia, Arabia, India, and the continental United States. It is not unlikely therefore that some of the species encountered have existed on the Islands for over a century, nor is it remarkable that a rather varied parasitic fauna has become established there.

In the following paragraphs the several species of endoparasites identified by us are recorded and those noted by Hall (*loc. cit.*) are reviewed. A zoo-numerical arrangement is adopted to insure clarity.

TREMATODA; FASCIOLIDAE

1. *Fasciola gigantica* Cobbold, 1885.

No flukes have been encountered by us in horses at any time, and we are indebted to Dr. E. W. Price and Mr. A. McIntosh of the U. S. Bureau of Animal Industry for this identification. In a personal communication in response to a request by one of us (J. E. A.) they state that the specimens submitted by Rowat in 1894 (referred to by Hall, *loc. cit.*) have been re-examined by them and found to be *F. gigantica.* This appears to be the first published record of the occurrence of this species in the horse, although a few cases of *F. hepatica* infection have been reported from scattered sources.

CESTODA; ANOPLOCEPHALIDAE

2. *Anoplocephala perfoliata* (Goeze, 1782).

This is probably the commonest and most injurious tapeworm of equines although it is rare in some regions, notably the continental United States.[1] Its normal habitat is the cecum where the presence of 20 or more may produce proliferation, stenosis, and ulceration at the ileo-cecal junction. Only 10 specimens were identified from the Hawaiian material but these were collected purely for determination and are not an index of the occurrence of the species. Two other tapeworms, *A. magna* and *A. mamillana,* which are of cosmopolitan but less frequent occurrence, were not encountered in our study.

Monnig (1928) has described a fourth anoplocephalid species from domestic equines, *Moniezia pallida* Monnig, 1926, but this appears to have been found but once in South Africa.

NEMATODA; STRONGYLIDAE

3. *Strongylus equinus* Mueller, 1780.
4. *S. edentatus* (Looss, 1900).
5. *S. vulgaris* (Looss, 1900).

These 3 species were abundant in the Hawaiian material, as might be expected from the fact that all of them have been encountered wherever equines have been examined for parasites. Specimens of *S. vulgaris* were the most numerous, which probably means that verminous arteritis and aneurysms are not infrequent among equines on the Islands although the extent of arterial invasion by the larvae of this species was not noted. In their adult life all strongyles are blood-suckers and live firmly attached by their powerful buccal walls to the lining of the cecum and colon.

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[1] The literature on the occurrence of tape-worms in horses in the United States has been recently reviewed by Olsen (1938, Jour. Amer. Vet. Med. Assoc., n.s., **45** (4): 557–559).

A fourth species of this genus, *S. asini,* was described by Boulenger (1920) from the intestine and liver of donkeys in Africa, but this appears to be the only record of its occurrence. This species, like *Cylicocyclus adersi* and *Cyathostomum tetracanthum,* but unlike the majority of strongylid species, may be of limited distribution and best adapted to the donkey host.

6. *Triodontophorus serratus* (Looss, 1900).
7. *T. brevicauda* (Boulenger, 1916).

Species of the genus *Triodontophorus* attach themselves to the lining of the large bowel, usually the ventral colon, and suck blood. The two most injurious species, *T. minor* and *T. tenuicollis,* associated with the production of ulcers, are conspicuous absences from this record, since both are generally distributed and fairly common.

8. *Gyalocephalus capitatus* Looss, 1900.

This species, the only member of the genus, is relatively rare, but is quite generally distributed. Three specimens, from the ventral colon, were among some 1500 strongylid specimens from Hawaii.

9. *Poteriostomum imparidentatum* Quiel, 1919.

This is a generally distributed species but rarely occurs in large numbers. Two specimens were among the Hawaiian material. The other member of the genus, *P. ratzii,* was not encountered.

10. *Cyathostomum coronatum* (Looss, 1900).

This is probably the most characteristic "cylicostome" species of the cecum infecting equines everywhere, but was represented by only 16 specimens in the Hawaiian material.

The genus *Cyathostomum* Molin, 1861, the *tetracanthum* group of Looss, contains 4 definitely valid species (viz. *tetracanthum, coronatum, labratum,* and *labiatum*), all described by Looss, and 1 questionable species, *C. ornatum* (Kotlán, 1919). Outside of its original record from Hungary, this latter species appears to have been reported only from Puerto Rico (McIntosh, 1933). This species appears, on the one hand, to be very close to *C. labratum* from which it differs, according to Kotlán's description, only by a slightly more elongated dorsal gutter, while, on the other hand, according to Kotlán's figure, the structure of the mouth capsule is not like that of the *Cyathostomum* spp., but more like that of the genus *Cylicocercus.*

Although but one species of this genus was among the Hawaiian material, it is probable that *C. labratum* and *C. labiatum* will be found on the Islands since both are common and distributed all over the world. *C. tetracanthum* on the other hand, may not be presumed to occur here since it is almost exclusively an Egyptian species and highly specific to the donkey.

11. *Cylicocercus catinatus* (Looss, 1900).
12. *C. goldi* (Boulenger, 1917).
13. *C. pateratus* (Yorke and Macfie, 1919).

These 3 species are harbored by equines everywhere and are relatively common in Hawaii. The genus contains one other equine species, *C. alveatus,* the type of the genus, which has not yet been reported outside of Africa.

14. *Cylicostephanus calicatus* (Looss, 1900).
15. *C. longibursatus* (Yorke and Macfie, 1918).
16. *C. minutus* (Yorke and Macfie, 1918).
17. *C. asymetricus* (G. Theiler, 1923).

The first 3 of the above were among the most abundantly represented species from Hawaii. All are of cosmopolitan distribution. *C. asymetricus* is the most recently discovered, valid "cylicostome" species. It was described from South African material by G. Theiler (1923) who found a "few specimens" (p. 656).

One specimen occurred among about 1500 strongylid worms from Hawaii. In Panama (Foster and Ortiz, 1937), 7 specimens were identified from a total of about 85,000 strongylid worms. This species has also been reported from Puerto Rico (McIntosh, 1933) and Poland (Skladnik, 1935). It is interesting to consider the possible significance of the fact that probably less than 20 specimens, in all, of a definitely fixed species of ''cylicostome'' have been taken from equines in such scattered localities as South Africa, Puerto Rico, Poland, Panama, and Hawaii.

The genus *Cylicostephanus* contains 2 other valid species which did not occur in the material from Hawaii, namely; *C. poculatus* and *C. hybridus*. A seventh species, *C. parvibursatus* Vaz, 1934, was described from a single male specimen and its validity is questionable. Lacking knowledge of the structure of the posterior end of the female one cannot with certainty preclude this species, as described, from the genus *Cylicocercus*, and indeed it appears both from Vaz' figure and his description that one can hardly differentiate Vaz' species from *C. goldi*.

18. *Cylicocyclus nassatus* (Looss, 1900).
19. *C. leptostomus* (Kotlán, 1920).

The former was abundantly represented in the Hawaiian material, while the latter occurred once. Both are widely distributed throughout the world and, with the possible exception of *Cylicostephanus longibursatus*, *Cylicocyclus nassatus* is the most common of the ''cylicostomes'' of equines.

The genus contains 5 other species (*radiatus, auriculatus, insigne, adersi,* and *elongatus*) which were not encountered during the present survey. Of these latter, *C. insigne* is common in most parts of the world as a characteristic species of the dorsal colon and for this reason its absence from the Hawaiian equines already examined is unusual.

20. *Cylicodontophorus bicoronatus* (Looss, 1900).
21. *C. euproctus* (Boulenger, 1917).

Two specimens of the former species and one of the latter were encountered in this survey. Both species occur in most parts of the world but appear never to occur in large numbers. The genus contains 2 other equine species, viz., *C. mettami* and *C. ultrajectinus*.

NEMATODA OTHER THAN STRONGYLIDAE

The following extra-Strongylidae were identified from native Hawaiian equines:

22. *Trichostrongylus axei* (Cobbold, 1879).
23. *Parascaris equorum* (Goeze, 1782).
24. *Oxyuris equi* (Schrank, 1788).
25. *Probstmayria vivipara* (Probstmayr, 1865).
26. *Habronema muscae* (Carter, 1861).
27. *H. microstoma* (Schneider, 1866).

In addition to the above, the following botflies were identified from larvae which parasitized the intestinal tract of these equines:

28. *Gastrophilus intestinalis* (de Geer, 1776).
29. *G. nasalis* (Linné, 1761).

DISCUSSION AND SUMMARY

In the above paragraphs we have listed 29 species of endoparasites from equines in Hawaii. There were 19 strongylid species representing 9 genera. The genera from domestic equines not represented in this survey are *Oesophagodontus* (only species, *O. robustus*), *Craterostomum* (*C. mucronatum* and *C. acuticaudatum*) and *Cylicobrachytus* (*C. prionodes* and *C. brevicapsulatus*). In commenting on the Strongylidae, mention was made of all the valid species contained within the several genera and such notations were made upon their distribution and relationships as seemed desirable for a foundation to further study both in Hawaii and elsewhere.

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MAURICE CROWTHER HALL

1881–1938

The Helminthological Society of Washington deeply regrets the untimely death, on May 1, 1938, of Dr. Maurice C. Hall, one of its most distinguished members. Dr. Hall was one of that small group of early Washington parasitologists who met at the Hygienic Laboratory of the U. S. Public Health Service on October 8, 1910, and organized the Helminthological Society. He was the first secretary of the Society, serving in that capacity from 1910 to 1916, and from 1919 to 1922, when he was elected president. In addition, he made the only report of the proceedings of the Society during the years between 1916 and 1919. It was largely through Dr. Hall's energy and reportorial ability that the early transactions of the Society were recorded in such consummate detail, thus forming an unusual record of the early years of the organization.

Dr. Hall, together with Stiles, Cobb and Ransom, formed that quadrumvirate of brilliant minds whose scientific background, ability and enthusiasm carried the Society along on the high tide of success over many years of its existence. During his career, Dr. Hall presented before the Society more than 80 notes, many of these notes representing the first reports of his outstanding research work. At the 48th meeting on December 10, 1920, he announced for the first time his discovery of carbon tetrachloride as an anthelmintic for the removal of hookworms, one of the most epoch-making discoveries of all time in the field of medical zoology. Those who had the privilege of attending the meetings of the Society over the long period of years during which Dr. Hall took an active part in its deliberations will remember always his interesting reports, his apt comments, his geniality and his active encouragement of younger workers. He seemed to be at his best during these meetings and his mere presence was always a source of inspiration.

Dr. Hall's scientific work is so well known and has been so thoroughly reviewed that it need not be summarized here. His accomplishments placed him in the front rank of the world's parasitologists.

Dr. Hall gained the admiration of his colleagues not only on account of his scientific achievements but more because of his friendliness, his charming personality, his thoughtfulness for others, and his never failing consideration and courtesy to all with whom he came in contact. In mourning his death, the Society takes pride in his achievements and is grateful for the many happy years of association with him. In his death the world lost a distinguished scientist and the Society a devoted member and friend.

The Society extends to his widow and to his daughters its sincerest expressions of sympathy.

On the life history of *Moniezia expansa* and *Cittotaenia* sp. (Cestoda: Anoplocephalidae). WENDELL H. KRULL, U. S. Bureau of Animal Industry.

From July, 1936, to July, 1938, an investigation of the life cycles of the common sheep tapeworm, *Moniezia expansa,* and of one of the rabbit tapeworms, *Cittotaenia* sp., was carried out by the writer at the National Agricultural Research Center, Beltsville, Maryland. The purpose of this paper is to give a brief summation of the results of this investigation.

Observations on the longevity and viability of the eggs of *Cittotaenia* sp. under various conditions, revealed that the eggs of this tapeworm could withstand alternate freezing and thawing for more than 100 days. It was also determined that the hexacanth embryos remained alive for as long as 325 days, when the eggs were kept in a small amount of water at a temperature of 36° to 38° F. However, at room temperature and under varying degrees of drying the viability of these embryos was impaired.

Attempts were made to infect invertebrates commonly found on pastures and in wet or moist places to which animals serving as hosts for anoplocephaline tapeworms would have access. Eggs of *Cittotaenia* sp. were fed to *Cyclops* spp., mosquito larvae, fungus fly larvae, millipeds, earthworms, springtails, pill bugs, and ants, but in no instance was any development of the embryos observed to take place in any of the invertebrates tested.

Since none of the invertebrates tested could be infected by feeding the eggs and since sheep and rabbits acquire infestation with adult tapeworms through grazing, an attempt was made to narrow the problem by feeding washings from grass and grass from infected pastures. Samples of grass were collected at various times from different plots, washed in water, the washings screened, and the material obtained by sedimentation was administered to tapeworm-free lambs. Two feeding experiments were conducted as follows: Two lambs, each about 4 months old and raised under conditions such as to preclude tapeworm infestation, were selected as test hosts. One of the lambs was given sediment obtained as described above, while the other received the washed grass. The lambs were examined post mortem on August 24, 1937, 57 days after the first feeding and 4 days after the final feeding. From the lamb receiving the sediment, 30 specimens of *Moniezia expansa* were recovered; the worms ranged from 3 mm to several feet in length. One worm, 2 mm long, was recovered from the lamb which had fed on the washed grass. During August and September, 1937, 2 lambs were each given sediment obtained from the washings of 14 pounds of grass. One of the lambs was examined post mortem 31 days after the first feeding and 2 large immature tapeworms were recovered. The other lamb was examined 35 days after the first feeding and 3 large immature tapeworms were recovered.

When the investigation had reached this point, Stunkard (1937, Science, **86**: 312) reported the finding of various developmental stages, including fully developed cysticercoids in oribatid mites, *Galumna* sp., that had fed on eggs of *Moniezia expansa.* The remainder of the present investigation was directed toward confirming this report.

A survey of the oribatid mites occurring under various pasture conditions revealed that more than 20 species were present on grass in the area studied. The mites were quite generally distributed, the number on grass at any particular time depending largely on weather conditions. Drought and prolonged wet spells did not reduce appreciably the number of mites available in a given area. The mites were collected from grass exposed to sub-freezing temperatures and also from grass collected from beneath snow. However, the oribatid mites were more numerous during the spring than during the winter, the maximum number occurring at the time the new growth of grass appeared.

From the data obtained it was found that the greatest number of mites were recovered from a given area during the first daylight hours following a rain sufficiently heavy to soak the ground. Mites were also abundant on cloudy days, especially after a soaking rain. Judging from the data so far obtained, it is possible that under favorable conditions a grazing sheep may ingest more than 1,200 mites per pound of grass.

Of the 20 or more species of oribatid mites obtained, only 1 species, *Galumna emarginata* Banks (identified by Dr. H. E. Ewing of the U. S. National Museum), was found to be infected with cysticercoids. This mite was one of the largest species encountered and was widely distributed. It was collected from pastures at all seasons of the year but was never found in large numbers, as only 586 specimens of the 11,310 oribatids collected were of this species. The infective cysticercoids were recovered from the mites in April, May, and November. Infected mites were not abundant as only 5 out of 286 specimens examined during April and May harbored cysticercoids.

The cysticercoids, 5 in number, were collected on May 11, 20, 21, and 28, 1938. They were dissected from the mites, placed on small bits of moist filter paper, enclosed in gelatin capsules, and administered immediately to a 2-month old lamb. The lamb was examined post mortem on June 13, 1938, and 2 specimens of *Moniezia expansa* (determined by Mr. A. McIntosh), one 99 inches long and other 2¾ inches long, were recovered from the small intestine. Another lamb, a twin, which served as a control, was examined post mortem the same day and was found to be negative for tapeworms. Both of the lambs used in this experiment had been reared under conditions which precluded the possibility of extraneous tapeworm infestation. Furthermore, numerous lambs which had been reared under similar conditions during past years had remained free from tapeworm infestation.

The results of this experiment confirm the findings of Stunkard (1937, *loc. cit.*) as regards the rôle of oribatid mites as intermediate hosts of *Moniezia,* and demonstrate conclusively that sheep can acquire infestations with *Moniezia expansa* through ingestion of infected mites.

Attempts to infect a wild rabbit by feeding oribatid mites collected from grass from areas contaminated with feces of wild rabbits were unsuccessful. However, 3 of 5 domestic rabbits became infected with *Cittotaenia* species as a result of being kept on a plot near the shore of a pond where the mite, *Galumna emarginata,* was present; each infested rabbit harbored 2 immature tapeworms.

Attractiveness of roots and excised shoot tissues to certain nematodes.[1] M. B. LINFORD.

Despite the thoroughness with which the parasitism and biology of various plant-parasitic nematodes have been investigated, little is known of the relationships of nematodes to their potential hosts prior to penetration into their tissues. In common with various free-living nematodes, species parasitic in roots are more abundant in soil close to roots than at a distance from them. Soil bacteria, and other constituents of soil flora and fauna, similarly are more abundant in what has been termed the "rhizosphere," the zone of immediate influence of roots. This local population density may result either from direct attractiveness of roots or of the soil environment as modified by roots, or from more rapid multiplication in the rhizosphere, where food is abundant, with little migration. Steiner's (1925) review of the problem of host selection suggests an actual attractiveness to nematodes of the roots of favorable hosts, and shows the probability that amphids are the sensory organs involved.

[1] Published with the approval of the director as Technical Paper No. 120 of the Pineapple Experiment Station, University of Hawaii.

This paper reports direct microscopic observations that demonstrate attractiveness to certain nematodes of growing roots and of excised leaf and stem tissues, both fresh and decomposing.

METHODS

Relationships of nematodes to roots or to excised pieces of plant tissue were observed in suitable media, through glass, with a dissecting binocular microscope. Soil was used as the medium in some tests but its colloidal content interferes with observation and retards nematode reactions. A superior medium for direct observation, spoken of in this paper as "black sand," is a dark-colored volcanic ash, a basaltic pumice. This was pulverized, washed to remove water-soluble constituents and very fine fragments, then dried and screened through a 40-mesh brass screen for root studies and a 100-mesh screen for other uses. This black sand is almost completely insoluble and highly inert. It wets readily, is retentive of water and, when wet, its cohesion is excellent and its dark color makes it a suitable background for observation of nematodes under reflected light. Photographic records were obtained with white quartz sand, against which nematodes blackened with osmic acid stand out sharply.

Observations of relationships to roots were made on new roots from vegetative cuttings or seedlings grown in Petri dishes with one side of the bottom of the dish filled with the culture medium. Such dishes were tipped, during growth, at an angle favoring the development of roots downward through the medium along the glass, letting the shoot grow upward into the illuminated, unfilled half of the dish. For observation, these dishes were inverted on the stage of the microscope and illuminated from above with a beam of light concentrated and cooled by passage through a spherical flask of water.

Pieces of leaf or stem tissue, trimmed to discs or squares 1.5 to 2 mm across and approximately 1 mm thick, were rinsed and placed individually onto glass slides, covered with black sand and moistened. Then nematodes were added in suspension and more sand was added to absorb excess moisture. In this way, flat domes of sand approximately 15 mm in diameter were built over the tissue sections. Such preparations, always at least in duplicate, were held in moist chambers between observations, and water was added as needed.

Nematodes were added in large numbers to facilitate observations and make indications decisive. Larvae of *Heterodera marioni* (Cornu, 1879) Goodey, 1932, were hatched from exposed egg masses on roots of cowpea and sugarcane. *Rotylenchus multicinctus* (Cobb, 1893) Filipjev, 1936,[2] adult females and larvae mixed, were obtained from pots of pineapple plants grown in sterilized soil infested earlier with small numbers of individuals of this species alone. *Pratylenchus pratensis* (de Man, 1881) Filipjev, 1936, females and larvae, were obtained only in mixtures with other nematodes in washings from naturally infested roots of various plants. *Aphelenchus avenae* Bastian, 1865, females and larvae, were taken from cultures of fungi on agar that had been maintained, with occasional transfers, for over a year.

OBSERVATIONS

Attractiveness of roots.—After a suspension of *H. marioni* larvae has been added to a black-sand culture having young roots against the glass, the nematodes may be seen congregating along the roots almost as soon as any are visible against the glass, often within an hour. Moving actively back and forth along the root, they gradually work toward the growing point and accumulate in the elongating

[2] Although this species has sometimes been regarded as free-living around roots, unpublished studies by the writer show it to feed freely in the roots of varied plants.

zone. Once in contact with a root, they seem never to leave it, at least in the black sand where observations have been most complete. Individuals may be seen to start away but then hesitate and turn back. Within 2 or 3 hours almost all visible individuals are immediately around the root, and by far the greater number of them are massed near the growing point, leaving very few in the piliferous region. The zone of greatest attractiveness for *H. marioni* appears to lie just behind the root cap, where penetration of this parasite occurs most commonly.

Similar results are obtained with quartz sand (Fig. 1) and, more slowly and somewhat less decisively, with soil.

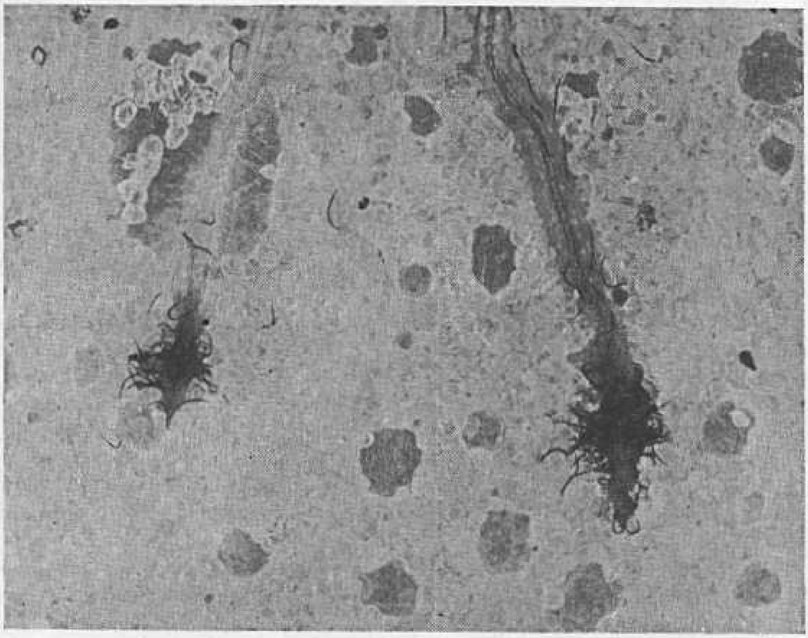

FIG. 1. *Heterodera marioni* larvae massed at tips of *Portulaca oleracea* roots, with a few larvae distributed along older parts of the root.

Pratylenchus pratensis and *Rotylenchus multicinctus*, when observed in black sand, show a somewhat different response. Both of these species, relatively sluggish in their movements, group along the roots more slowly than do the *H. marioni* larvae but ultimately, all of them except molting individuals, find their way to the root and remain there. Avoiding the elongating zone, however, these species accumulate in the piliferous region where their penetration and feeding are not disturbed by the thrusting of the root through the substratum. When observed in mixture with *H. marioni*, this selection of different root zones is striking, nearly all of the *H. marioni* accumulating in the elongating or apical region while these remain farther back. These 2 species respond in the same way in quartz sand and, more slowly, in soil.

All 3 species are attracted to fresh wounds. In sand, and more frequently in black sand, elongating roots sometimes injure themselves in contact with sharp-edged particles. At such injuries these nematodes assemble. Similarly, where one nematode has begun to penetrate, others congregate, resulting, with *H. marioni*, in such mass invasions as were illustrated by Godfrey and Oliveira (1932), but much more extreme when large numbers of larvae are present. Sometimes masses of dozens of nematodes are seen crowded compactly together, with their heads all entering or trying to approach large penetration wounds wedged open in the side of the root tip.

The test plant employed most frequently in this work has been *Portulaca oleracea* L., but all 3 nematodes respond as described to the Whippoorwill variety cowpea, *Vigna sinensis* Endl. Other plants, tested only with *H. marioni*, include *Amaranthus gracilis* Desf., *Cyperus rotundus* L., *Drymaria cordata* (L.) Willd., *Erigeron albidus* (Willd.) Gray, *Euphorbia hirta* L. and *Panicum barbinode* Trin. Roots of all but *Drymaria* proved highly attractive, even though, under Hawaiian field conditions, *Cyperus* appears somewhat resistant and *Erigeron, Euphorbia,* and *Panicum* appear highly resistant to the root-knot nematode. In limited tests, no grouping at all was detected around roots of *Drymaria.*

Roots of a single plant frequently differ markedly in their apparent attractiveness to nematodes. From one *Erigeron* plant, for example, 2 root tips grew parallel and abreast, separated by little more than 1 mm. After 12 hours and still after 33 hours, *H. marioni* larvae were massed around one root tip but only an occasional larva was seen around the other. Similar but less striking examples were observed with other test plants.

In contrast with the 3 nematode species discussed, *Aphelenchus avenae* showed very little grouping around *Portulaca* roots.

Attractiveness of leaf and stem tissues.—Leaves and stems of various plants were tested for attractiveness to *H. marioni, R. multicinctus* and *Aphelenchus avenae,* with the technique already described. Tested in black sand, *R. multicinctus* grouped strikingly around green pineapple leaf, *Portulaca oleracea* stem, and tomato petiole, coming to rest on the surface of the tissue or partially penetrating it. After a few hours, only the few individuals that lay motionless remained in the sand at a distance from the piece of tissue. In the same test, white stem tissue of pineapple and green stem of *Ageratum conyzoides* L. appeared somewhat less attractive.

In parallel observations, *A. avenae* was tested on tissues similar to those enumerated for *R. multicinctus,* but no striking grouping was observed around any of them during 48 hours.

In the same way, *Heterodera marioni* larvae have been tested more extensively and have been found to group strikingly around tissues of many diverse plants. In all these tests, only a single piece of tissue has been enclosed in one dome of sand or soil, but the use of standardized conditions of testing and uniform suspensions of larvae has permitted tentative judgments as to relative degrees of attractiveness.

Tissues found highly attractive to this nematode include green pineapple leaf, tomato petiole, and green stems of *Crotalaria juncea* L., *Portulaca oleracea,* and *Vernonia cinerea* (L.) Less. After 1 to 2 hours following the arrangement of a preparation, *H. marioni* larvae are distinctly more numerous close around the tissues than at a distance from them. During several hours, grouping continues until essentially all nematodes visible at one time are crawling over the surface of the piece, working into intercellular spaces or xylem vessels, or massed between the tissue and the glass. Activities of these larvae may gradually lift the piece of tissue from the slide and work sand grains under it until it can no longer be seen, but its location remains plainly marked by the congregated nematodes still visible between it and the glass.

Only slightly less attractive, as indicated by somewhat slower grouping of nematodes and sometimes by the failure of all nematodes to respond, are onion leaf, young pineapple stem, potato stem and tuber, green stems of *Ageratum* *conyzoides*, *Bidens pilosa* L., *Casuarina equisetifolia* L., *Cenchrus echinatus* L., *Oxalis martiana* Zucc., and midribs of *Murraea exotica* L. and *Nephrolepis exaltata* Schott. Pieces of mature pineapple stem have appeared only slightly attractive while fresh. Green twigs of *Tamarix* sp. in repeated tests have appeared only slowly and weakly attractive. Slightly more attractive than *Tamarix* during the first few hours but less attractive than the other tissues mentioned, is commercial sugar pine lumber, small pieces cut from fresh boards having shown distinct but mild attractiveness in repeated tests. Commercial cork, however, has shown no attractiveness whatever, until after 48 hours.

In the absence of aseptic precautions and with suspensions of soil microorganisms introduced along with nematodes, pieces of plant tissue soon begin to decompose, but they remain attractive to *H. marioni* larvae for several days at least. Mature pineapple stem has become much more attractive as it decayed and cork has been attractive only after 2 days exposure when darkening has become evident. As decomposition of various tissues proceeds, larvae tend to react somewhat differently than before, distributing themselves more uniformly throughout a circle centering on the rotting tissue. This suggests the establishment of a zone of equal attractiveness, perhaps by the diffusion of an attractant at or above the maximum concentration distinguished by the nematodes.

Tissues rendered unattractive by cooking become attractive as they rot. Fresh sections, washed in distilled water, were compared with sections cut from the same

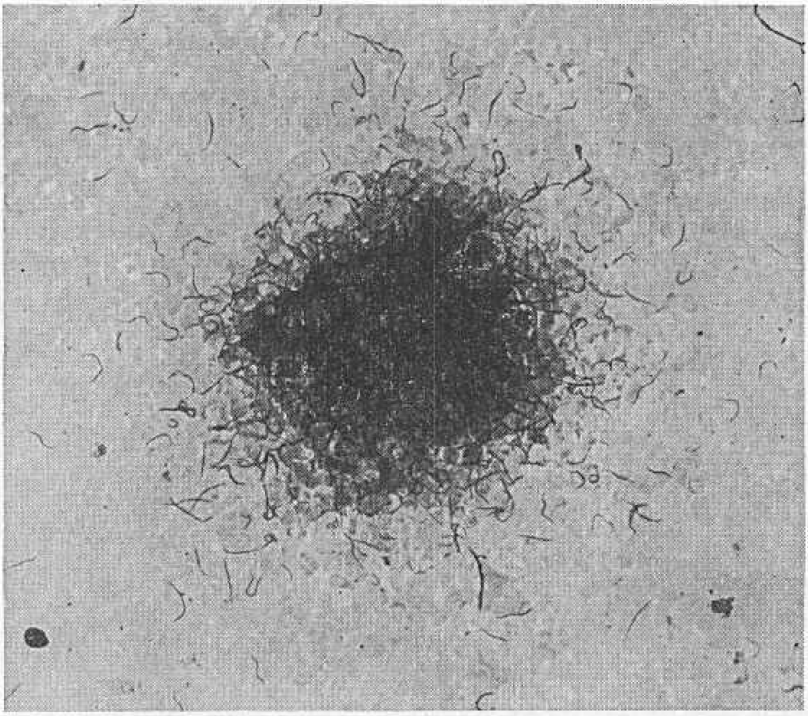

FIG. 2. *Heterodera marioni* larvae massed between a piece of decomposing pineapple stem tissue and the glass, and grouped in the surrounding sand. A few larger nematodes of other species are included. Sand grains between the tissue and the glass were moved into position by activities of the nematodes.

plant parts at the same time but simmered 10 minutes in distilled water and rinsed in fresh distilled water. Tomato petiole and pieces of *Casuarina, Crotalaria, Portulaca, Tamarix* and *Vernonia* stems gave the responses already indicated, but the cooked pieces gave no indication whatever of attractiveness to *H. marioni* larvae during 24 hours. After 32 hours, however, when decomposition was in progress, cooked *Crotalaria* and *Vernonia* became strongly attractive, as did all the others after somewhat longer periods.

Similar responses to fresh and decomposing tissues have been observed in white sand (Fig. 2) and in soil.

Several unidentified infusoria, commonly present in the black sand, respond much as do *H. marioni* larvae, grouping around excised tissues and congregating at root tips.

Response of H. marioni to yeast colonies on agar.—Having occasionally observed the grouping of *H. marioni* larvae under coverslips left on the surface of contaminated agar in Petri dishes, the writer was led to test the attractiveness to this nematode of yeast colonies on nutrient agar. Two culture media were employed, a corn meal agar with yeast extract added at the rate of 2 grams per liter and a synthetic medium containing yeast extract. Three yeast cultures were tested: a culture of *Saccharomyces cerevisiae*, no. 538, and 2 unidentified species, designated M–1 and M–32, known to differ markedly in their physiology. Two small drops of yeast suspension were placed approximately 5 cm apart in 9-cm Petri dishes. After 48 hours incubation, a drop of nematode suspension was placed at the center of each dish, midway between the two yeast colonies. In one dish of each combination of agar and yeast species, the yeast colonies were covered with 18-mm circular coverslips, and 2 similar slips were placed on the agar equidistant from those over the colonies and, like them, 2.5 cm from the center of the dish. Another series of cultures was established in the same way except that no coverslips were placed until data were taken.

After approximately 24 hours, nematodes were counted under each coverslip in dishes of the first series. Two additional slips were then dropped onto the agar, between pairs of slips with and without yeast, to permit measurement of the population density in the uncovered agar (Table 1). Into each dish of the second

TABLE 1. *Numbers of H. marioni larvae under 18-mm circular coverslips that had been in place 24 hours and under freshly placed coverslips*

Agar	Yeast	Covers in place 24 hours before count						Covers freshly placed, not over yeast colonies		
		Over yeast colonies			Not over yeast colonies					
		a	b	Sum	a	b	Sum	a	b	Sum
Corn meal	M–1	48	103	151	7	9	16	10	2	12
" "	M–32	46	40	86	6	9	15	7	9	16
" "	538	41	9	50	4	5	9	6	1	7
Synthetic	M–1	33[a]	22[a]	55	2	3	5	11	9	20
"	M–32	58	61	119	3	12	15	24	16	40
"	538	35[a]	19[a]	54	8	7	15	5	11	16

[a] Yeast colonies too opaque for satisfactory visibility.

series, in which the yeast colonies had been left uncovered when larvae were added, 4 slips were now placed, 2 over the yeast colonies and 2 over the agar surface. Counts were then made of numbers of nematodes under each cover (Table 2).

Table 1 indicates that numbers of larvae under coverslips not over yeast colonies were essentially the same whether these coverslips had been placed 24

TABLE 2. *Numbers of H. marioni larvae under 18-mm circular coverslips placed immediately before counting*

Agar	Yeast	Over yeast colonies			Not over yeast colonies		
		a	b	Sum	a	b	Sum
Corn meal	M–1	4	1	5	4	12	16
" "	M–32	12	7	19	6	6	12
" "	538	0	0	0	2	0	2
Synthetic	M–1	4	0	4	16	38	54
"	M–32	3	5	8	27	30	57
"	538	1	0	1	11	19	30

hours earlier or immediately before counting. Under coverslips covering yeast colonies, however, the numbers of larvae were from 3.6 to 11 times the numbers under the check slips. The data of table 2, on the contrary, indicate somewhat fewer nematodes immediately around yeast colonies that had been left uncovered during growth on the synthetic medium than in equal areas of agar remote from the yeast colonies. This was not apparent on the corn meal agar. Taken together, these results indicate a pronounced grouping of larvae around covered yeast colonies, suggesting some relationship to anaerobic growth of the yeast. Reduced activity of these larvae leaves open the question of whether the yeast was attractive or whether, by chance alone, the nematodes moved into an anaerobic zone from which they could not escape.

DISCUSSION

These varied tests, demonstrating responses of plant-parasitic nematodes to stimuli emitted by roots and by fresh and decomposing organic matter, have served chiefly to open a field of investigation but they are significant in relationship to several aspects of nematode biology. The nature of the stimuli that attract plant-parasitic nematodes is not defined, nor is the distance through which they operate, but chemotropic responses to more than one attractive substance are indicated. While it is possible that the roots and excised plant parts all emit a common attractant, the specific response of *Heterodera marioni* larvae to root tips, not shared by *Pratylenchus pratensis* and *Rotylenchus multicinctus* suggests the operation of a second attractant.

The more rapid grouping of nematodes around roots in sand or black sand than in soil may result from the freer movement of nematodes through these open media, or may result from adsorption of the attractive substances by soil colloids, reducing the intensity and extent of attraction. Whatever factors are involved, however, the greater attractiveness of roots in sand helps to explain the commonly reported greater severity of root-knot in sandy soils than in heavy silts and clays.

These observations also have a bearing on the problem of nematode migration through soil, for they suggest that it occurs chiefly along roots, rather than away from them, and that, in the presence of growing plants, the rate of migration may be expected to depend upon whether or not root systems of adjacent plants intermesh in the soil.

Relative to resistance and host selection, it is significant that larvae of the root-knot nematode group around the roots of plants which, under Hawaiian field conditions, appear never or very rarely to develop galls. Plants probably differ in attractiveness, as indicated by negative results with *Drymaria*, but it appears that larvae of *H. marioni* may fail to distinguish roots of suitable hosts from those that are either difficult to penetrate or inhospitable after penetration.

This nematode responds not selectively to the presence of an appropriate food supply, but rather generally to stimuli emitted by materials incapable of being utilized as food.

The attractiveness of fresh and decomposing leaf and stem tissues has an important bearing on the influence of decomposing organic matter in soil upon development of the root-knot nematode, probably explaining the temporary benefit of organic matter demonstrated by Linford, Yap and Oliveira (1938) in their experiment 5, as distinct from the destruction of nematodes by natural enemies in soil.

The failure of *Aphelenchus avenae* to respond to materials attractive to 3 parasitic species is of interest in relationship to the disputed status of this nematode as a plant parasite (Steiner, 1936).

SUMMARY

Direct microscopic observations through glass show that larvae of *Heterodera marioni* congregate around roots and move down to the elongating zone just behind the root cap. Larvae and females of *Pratylenchus pratensis* and *Rotylenchus multicinctus* congregate more slowly around roots and remain in the mature root zone where they penetrate and feed. *Aphelenchus avenae,* reared in agar cultures of fungi, shows little grouping around sound roots.

Pieces of fresh tissue cut from green leaves and stems of diverse plants are strongly attractive to *H. marioni* larvae and remain attractive as they decompose. More limited tests indicate that *R. multicinctus* similarly responds to green tissues but that *A. avenae* does not.

H. marioni larvae in agar congregate around yeast colonies over which glass coverslips have been placed, indicating either an attraction or a trapping through the mechanism of retarded locomotion through anaerobiosis.

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A new dicrocoeliid trematode, *Eurytrema komareki,* n. sp., from a white footed mouse. ALLEN MCINTOSH, U. S. Bureau of Animal Industry.

Herein is described a new species of trematode belonging to the family Dicrocoeliidae. The species is based on 2 entire specimens and fragments of what appear to be parts of 2 or 3 other specimens, all of which were obtained by Mr. E. V. Komarek from *Peromyscus gossypinus gossypinus* (Le Conte, 1853). The host was taken December 2, 1934, in Okefenokee Swamp, Ga. The stomach was indicated as the organ from which the parasites were obtained. However, since related species of this group of trematodes are generally found in the liver of the host, it is most likely that the parasites described here had escaped from that organ during evisceration.

Eurytrema komareki, n. sp.

Description.—Body oblong, 2.82 mm long by about 800 μ wide at ovarian level; the extremities, in some specimens, taper greatly. Cuticula without spines. Oral sucker subterminal, 200 μ in diameter; acetabulum preequatorial, 320 μ by 370 μ. Pharynx about 100 μ in diameter; esophagus longer than pharynx; intestinal crura extending posteriorly beyond vitellaria and terminating near posterior end of body. Excretory pore terminal, the long Y-shaped bladder forking near equatorial level of body. Testes from almost spherical to elongate oval, 90 to 200 μ in diameter with fields well separated and zones overlapping posterior rim of acetabulum. Cirrus sac 140 μ long by 50 μ wide, ventral to esophagus; cirrus protruding in type specimen; genital pore median, at basal level of pharynx. Ovary oval, 130 to 140 μ in diameter, lateral to median line, preequatorial. Seminal receptacle 70 μ by 85 μ; Laurer's canal not observed; vitelline reservoir and Mehlis' gland median, preequatorial. Vitellaria extracecal, extending from within zone of acetabulum and terminating in anterior portion of posterior third of body. Uterus confined to intercecal area, with coils extending posteriorly to beyond cecal tips. Eggs oval, 23 μ by 30 μ, lemon yellow.

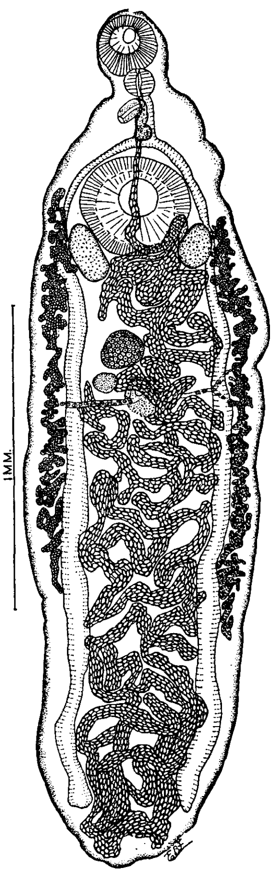

FIG. 1. *Eurytrema komareki*, n. sp., dorsal aspect.

Habitat.—Liver (?) of *Peromyscus gossypinus gossypinus.*

Distribution.—Okefenokee Swamp, Georgia, U. S. A.

Specimens.—U.S.N.M. Helm. Coll. Nos. 43414 (type; Fig. 1), 40884 and 43415 (paratypes).

The species described herein is assigned to the genus *Eurytrema* Looss, 1907, as most of the characters of the species are typical of that genus. The shape of the body, with greatest width preequatorial, however, is typical, of the genus *Platynosomum* Looss, 1907, which, according to many recent writers, is not sufficiently different from *Eurytrema* to be regarded as a distinct genus. The large acetabulum in comparison with the small oral sucker is characteristic of the genus *Oswaldoia* Travassos, 1919, but the position of the testes and the location of the genital pore would exclude the species from that genus as now defined.

In a recent paper Bhalerao (1936, Jour. Helminth. 14: 163–180) proposed the division of the genus *Eurytrema* into 5 subgenera. According to Bhalerao's key, *E. komareki*, n. sp. has characters in common with the group of 3 species constituting the subgenus *Lubens* Bhalerao, 1936, namely, *Eurytrema lubens* (Braun, 1901), *E. polymorphum* Travassos, 1919, and *E. intermedium* Travassos, 1919. In these 3 species the acetabulum and oral sucker are about equal in size, while in *E. komareki*, n. sp. the acetabulum is much larger than the oral sucker.

In connection with Bhalerao's paper it may be noted that if his subgenera are to be accepted the name *Eurytrema* must be retained for the typical subgenus instead of the subgeneric name *Pancreaticum* as proposed by that author.

The occurrence of the fluke *Plagiorchis potanini* Skrjabin, 1928, in Franklin's Gull (*Larus pipixcans* Wagl.) in North America.[1] O. WILFORD OLSEN.

Skrjabin (1928, Ann. Parasitol. **6**: 80–87) described the trematode *Plagiorchis potanini* from the intestine of the mallard duck (*Anas boschas*) from Siberia. The following diagnostic description is taken from Skrjabin: Body length 1.77 mm, width 0.47 mm. Oral sucker 0.158 by 0.136 mm; acetabulum round diameter 0.136 mm. Pharynx large, round, diameter 0.1 mm. Genital pore somewhat anterior to acetabulum; cirrus pouch greatly elongated (0.454 mm), only slightly curved, extending dorsad from acetabulum and beyond posterior margin of ovary; seminal vesicle elongated. Testes in third quarter of body length, obliquely placed, margins entire, size 0.18 by 0.18 mm. Ovary median, about midway between acetabulum and anterior testis; uterus filling spaces between ovary and anterior testis and between two testes then extending behind posterior testis a distance not greater than diameter of the latter. Vitellaria begin at level of pharynx and extend to posterior extremity of body, uniting medially anterior to acetabulum and posterior to testes. Eggs measure 0.039 by 0.018 mm.

From a juvenal Franklin's gull found at Watertown, South Dakota, the writer collected 2 small trematodes which have been identified as *Plagiorchis potanini.* The principal difference in the specimens from the duck and the ones from the gull occurs in the size, the latter being somewhat larger. The following measurements were taken on the specimens from the gull: Body length 1.86 to 2.78 mm, width 500 to 633 μ; oral sucker 216 to 266 μ long by 233 μ wide; acetabulum 152 to 200 μ long by 120 to 200 μ wide; pharynx 88 to 120 μ wide by 72 to 116 μ long; oesophagus 40 μ long; intestinal caeca extend to posterior extremity of body; cirrus pouch 383 to 648 μ long; anterior testis 188 to 250 μ long by 184 to 200 μ wide, posterior testis 233 to 283 μ long by 188 to 183 μ wide; ovary 233 μ long by 150 μ wide. Further differences appear in that the caudal end of the cirrus pouch extends only to the middle of the ovary instead of beyond it posteriorly, and the ovary is dextrad instead of median. These differences are considered as being individual variations rather than of specific value.

This constitutes a new host record for *P. potanini* and extends its geographical range to the North American continent, making it circumpolar in occurrence.

The cysticercoid of the tapeworm *Dendrouterina nycticoracis* Olsen, 1937 (Dilepidiidae).[1] O. WILFORD OLSEN.

Black-crowned night herons (*Nycticorax nycticorax hoactli* (Gmelin)) are commonly parasitized with the small tapeworm *Dendrouterina nycticoracis.* Juvenal birds that have not left the rookery show heavy infections. This indicated that the tapeworm passed its life cycle in the nesting range of the host which in the instance under consideration is Minnesota.

When *Dendrouterina nycticoracis* was first reported (Olsen, 1937, Proc. Helminth. Soc. Wash. **4**: 30–32), nothing was known regarding the intermediate

[1] Paper No. 1642 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station, St. Paul. A joint contribution by the University of Minnesota Agricultural Experiment Station and the Minnesota Department of Conservation, Division of Game and Fish.

stages or their hosts, although it appeared likely that either frogs or fish might

[1] Paper No. 1645 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station. A joint contribution by the Department of Entomology and Economic Zoology, University of Minnesota and the Minnesota Department of Conservation, Division of Game and Fish.

serve as the final transfer host. During the course of routine examinations for parasites, a number of specimens of the black bullhead (*Ameiurus melas*), from Twin Lakes, Anoka County, Minnesota, was found to harbor minute cysticercoids in the gall bladder. The size and shape of the hooks indicate that they are the cysticercoids of *Dendrouterina nycticoracis*. The finding of the cysticercoids in the bullhead is suggestive that an arthropod, probably a water flea, may serve as the first intermediate host. The water fleas feeding upon the eggs or hexacanths become infected, forming the source of infection for the fish.

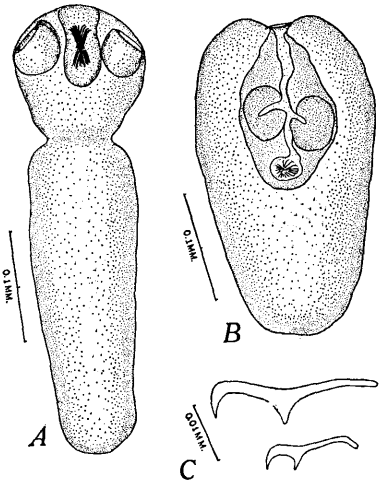

FIG. 1. *Dendrouterina nycticoracis*. A—Cysticercoid with scolex partially everted. B—Cysticercoid with scolex inverted. C—Hooks from a cysticercoid. Drawings made with the aid of a camera lucida.

Description of the cysticercoid.—Slight differences in the size and the number of hooks in the cysticercoid from that found in *Dendrouterina nycticoracis* occur but the general shape indicates their identity. Body length including the everted scolex 316 to 416 μ, with scolex inverted 233 to 366 μ; body width 56 to 116 μ. Scolex 83 to 116 μ long by 51 to 116 μ wide; suckers 44 to 48 μ in diameter. The rostellum is difficult to measure but appears to be about 32 μ long; it bears a double crown of hooks arranged in 2 rows of 9 to 10 hooks each; large hooks 26 to 30 μ long, with the blade and dorsal root being about equal in length. In the cotypes of the adult worms, the dorsal root is about twice the length of the blade. The small hooks measure 13 to 15 μ long and have the distal end of the dorsal root bent ventrad thus being similar to the adult (Olsen, 1937, Proc. Helminth. Soc. Wash. 4: 74).

So far as known, this is the only information on the life cycle of members of the cestode genus *Dendrouterina*. Efforts are being made to complete the cycle experimentally.

Effectiveness of the swine sanitation system in controlling swine stomach worms in the South. DALE A. PORTER, U. S. Bureau of Animal Industry.

The swine sanitation system, as modified for the control of kidney worms (Spindler, 1934, U. S. Dept. Agr. Technical Bull. 405, pp. 1–17; Schwartz, 1934, U. S. Dept. Agr. Leaflet 108, pp. 1–5), has been found effective in controlling the spread of these parasites among swine, when applied under conditions existing on farms in southern United States (Schwartz, 1934, *loc. cit.;* Hall, 1935, Rept. Chief Bureau Animal Industry, U. S. Dept. Agr. (1934–35), pp. 48–55; Schwartz, 1936, *Ibid.* (1935–36), pp. 53–60). However, no data are available to show whether this system will also control effectively the various species of stomach worms. It is the purpose of this paper to present data obtained from a survey on the prevalence and intensity of infestation of the red stomach worm (*Hyostrongylus rubidus*) and the spirurid stomach worms (*Physocephalus sexalatus* and *Ascarops strongylina*) in hogs raised under the sanitation system as compared to those raised without particular attention to sanitation.

METHODS

To obtain the desired information, post-mortem examinations for stomach worms were made from September, 1936, to February, 1938, of a series of 2,164 swine originating in southern Georgia and northern Florida. Of the 2,164 hogs examined, 1,467, designated as group A, were selected from the general run of hogs coming to slaughter at a packing plant in southern Georgia; these animals had been raised without any particular attention to parasite control. A series of 423 animals, designated as group B, were raised on farms where the swine sanitation system had been carefully followed. Group C consisted of 274 swine raised in accordance with some of the essential requirements of the sanitation system. The average weight of all the hogs examined was about 180 pounds. The hogs from groups B and C averaged 7 months of age, whereas those constituting group A were probably from 7 to 14 months of age. Post-mortem examinations for the presence of stomach worms were made in the manner described below.

The stomach, separated from the remaining viscera, was opened and the food content discarded. Since stomach worms adhere firmly to the stomach lining and are not ordinarily removed by gentle washing, the glandular surface of the stomach was washed free of adhering food particles under a gentle spray of cold tap water. Any worms present became visible on close inspection of the stomach lining. *H. rubidus* could readily be differentiated from the spirurids (*A. strongylina* and *P. sexalatus*) by macroscopic inspection. No attempt was made to differentiate between the 2 species of spirurid stomach worms, which resemble each other closely and cannot be differentiated macroscopically. When it was apparent that large numbers of either red or spirurid stomach worms were present, the infestations were arbitrarily classed as heavy. Counts of the worms present in a series of stomachs considered to be heavily infested indicated that such infestations probably consisted of 500 or more worms. The following brief discussion of the data will serve to point out some of the more outstanding facts elicited.

RESULTS

Group A (hogs raised without attention to sanitation).—Of the 1,467 hogs in group A, 41 per cent were infested with *H. rubidus,* and 89.2 per cent with spirurid stomach worms; only 6 per cent were entirely free of stomach worms. Of the positives, 32 per cent of the *H. rubidus* infestations and 23.4 per cent of the spirurid infestations were classed as heavy. The incidence of stomach worms in these animals is much higher than reported by Spindler (1934, Proc. Helminth. Soc. Wash., **1**: 40–42). In Spindler's survey, conducted from 1929 to 1931, 15 per cent of 348 hogs were reported as infested with *H. rubidus* and 53 and 47 per cent with *A. strongylina* and *P. sexalatus,* respectively.

Group B (hogs raised under complete sanitation).—Infestations of hogs raised on farms where recommendations of the sanitation system were completely followed were noticeably light. Of the 423 hogs in group B, 17.2 per cent and 67.4 per cent were infested with red stomach worms, and spirurids, respectively. This represents a reduction in each instance of over 20 per cent from the percentage of animals infested in group A. Furthermore, 27.2 per cent of the hogs examined were entirely free of stomach worms. Of the positive cases only 1.4 per cent of the red stomach worm infestations and 9.1 per cent of the spirurid infestations were recorded as heavy.

Group C (hogs raised under partial sanitation).—Published reports on the effectiveness of the sanitation system in controlling kidney worms indicate that best results, both in raising pigs for market and in parasite control, were obtained when the hog growers followed every detail of the system. That the omission of some of the steps in the sanitation system also resulted in less effective control of stomach worms was indicated by the findings in group C, where *H. rubidus* and spirurid stomach worms occurred in 51.5 and 82.8 per cent, resnectively, of the 274 animals examined.

As can be seen from the table, the incidence of stomach worms in this group is comparable to that in group A. However, as shown in the table, the percentages of heavy infestations with each of the 2 types of stomach worms in the animals comprising this group were noticeably smaller than in group A. These findings indicate that although partial adherence to the modified sanitation system may not effectively prevent the spread of stomach worms among swine, such measures, even if carried out only in part, may be instrumental in keeping down the number of heavy infestations.

SUMMARY

1. The incidence of red stomach worms (*Hyostrongylus rubidus*) and of spirurid stomach worms (*Physocephalus sexalatus* and *Ascarops strongylina*) in hogs raised under the sanitation system was compared with that in hogs raised without sanitation.

2. The incidence and percentage of heavy infestations were markedly lower in swine raised in accordance with the steps of the sanitation system.

3. With the exception of a reduction in the percentage of heavy infestations, particularly in the case of the spirurids, the stomach worms were not so well controlled in swine from projects in which the sanitation system was not closely followed.

TABLE 1.—*Infestations with stomach worms in various groups of hogs*

Designation	Number animals examined	Percentage not infested	Percentage infested with *H. rubidus*	Percentage infested with spirurids[a]	Percentage of infested animals harboring more than 500 *H. rubidus*	Percentage of infested animals harboring more than 500 spirurids[a]
Group A Raised without attention to sanitation	1467	6.0	41.0	89.2	32.0	23.4
Group B Raised under complete sanitation plan ...	423	27.2	17.2	67.4	1.4	9.1
Group C Raised under conditions of partial sanitation	274	8.4	51.1	82.8	20.7	9.7

[a] *Physocephalus sexalatus* and *Ascarops strongylina* not differentiated in this study.

A new genus and two new species of digenetic trematodes from a marine turtle.
EMMETT W. PRICE, U. S. Bureau of Animal Industry.

Among some trematodes collected by Dr. B. G. Chitwood and the writer from a marine turtle, *Chelone mydas,* which died in the National Zoological Park, Washington, D. C., March 8, 1932, were a few specimens belonging to the family Rhytidodidae Odhner. These specimens represent 2 new species which apparently belong to a new genus for which the name *Rhytidodoides* is proposed. This genus resembles in many respects *Rhytidodes* Looss but differs in characters that appear to warrant regarding it as new.

Rhytidodoides, n. g.

Diagnosis.—Small unarmed flukes; gonads confined to posterior third of body; vitellaria extending into preacetabular zone. Other characters as in *Rhytidodes.*

Type species.—*Rhytidodoides intestinalis,* n. sp.

Rhytidodoides intestinalis, n. sp.

Description.—Body slender (Fig. 1, A), 2 to 2.1 mm long by 320 to 335 μ wide, slightly attenuated anteriorly. Cuticula smooth, without spines. Oral sucker subterminal, 110 to 130 μ in diameter, with small projection on each side; acetabulum 103 to 115 μ in diameter, slightly postequatorial. Prepharynx inconspicuous; pharynx 60 to 70 μ long by 55 to 70 μ wide; esophagus slender, 730 to 830 μ long; intestinal ceca slender, extending to near posterior end of body. Excretory aperture subterminal, dorsal; remainder of excetory system not observed. Genital aperture median, about 90 μ posterior to intestinal bifurcation; cirrus pouch ovoid, 110 to 137 μ long by 105 to 115 μ wide, almost entirely preacetabular. Testes globular, tandem, in posterior fourth of body, each about 130 μ in diameter. Ovary 90 to 110 μ in diameter, median, separated from anterior testis by Mehlis' gland; seminal receptacle absent; Laurer's canal not observed. Vitellaria consisting of relatively large follicles extending from a short distance caudal to pharynx to level of tips of intestinal ceca, uniting in esophageal region. Uterus nearly straight, in median line. Eggs 60 to 63 μ long by 45 to 52 μ wide.

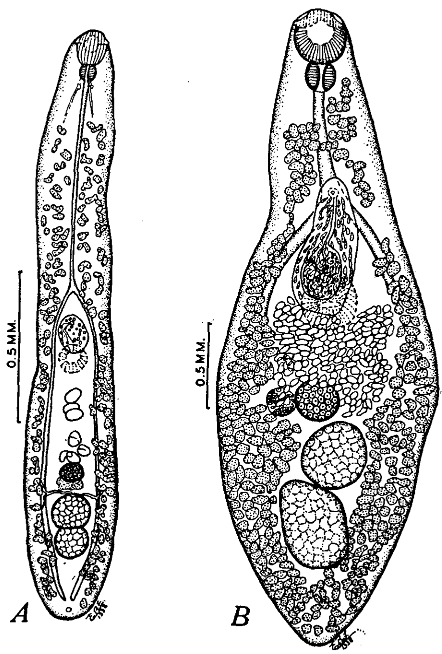

FIG. 1. A—*Rhytidodoides intestinalis;* complete worm, dorsal view. B—*Rhytidodoides similis;* complete worm, dorsal view.

Host.—*Chelone mydas.*

Location.—Small intestine.

Distribution.—United States (Washington, D. C.).

Specimens.—U.S.N.M. Helm. Coll. Nos. 4147 (type) and 4148 (paratype).

Rhytidodoides similis, n. sp.

Description.—Body somewhat lanceolate (Fig. 1, B), 1.3 to 3.8 mm. long by 0.51 to 1.4 mm wide in vicinity of ovary. Cuticula smooth and without spines. Oral sucker subterminal, 150 to 320 μ in diameter, with lateral projections as in the preceding species; acetabulum 165 to 370 μ in diameter, preequatorial. Prepharynx inconspicuous; pharynx 74 to 165 μ long by 63 to 160 μ wide; esophagus 220 to 720 μ long; intestinal ceca simple. Excretory pore subterminal, dorsal; remainder of excretory system not observed. Genital aperture median, at or slightly anterior to intestinal bifurcation; cirrus pouch elongate piriform, 200 to 800 μ long by 160 to 430 μ wide, largely preacetabular. Testes in posterior third of body, placed slightly oblique to long axis of body; anterior testis globular, 185 to 400 μ in diameter, posterior testis ovoid, 220 to 480 μ long by 135 to 400 μ wide. Ovary globular, 90 to 300 μ in diameter, submedian, pretesticular; Mehlis' gland to left of ovary; Laurer's canal not observed. Vitellaria consisting of relatively large, more or less elongated follicles, extending from level of base of pharynx to posterior end of body and uniting in esophageal and posttesticular zones. Uterus filling intercecal space between ovary and acetabulum. Eggs 63 to 70 μ long by 37 to 40 μ wide.

Host.—*Chelone mydas.*

Location.—Gall bladder.

Distribution.—United States (Washington, D. C.).

Specimens.—U.S.N.M. Helm. Coll. Nos. 4149 (type) and 4150 (paratype).

This species is similar to *Rhytidodoides intestinalis* but differs from it in body shape, shape and position of the testes and in the position of the genital aperture. Both *R. intestinalis* and *R. similis* are in each case based on only 2 specimens, consequently it is not possible to determine the amount of variation within the species. However, the fact that in both specimens of each species the differences are constant and this coupled with the location in the body—small intestine in *R. intestinalis* and gall bladder in *R. similis*—seem to warrant regarding them as distinct species.

Report on the Brayton H. Ransom Memorial Trust Fund, December 31, 1938

Two meetings of the trustees were held during the year. The status of the Fund, since the previous statement in the Proceedings of the Helminthological Society, July, 1937, is as follows:

Balance on hand June 30, 1937	$1,332.91
Receipt from pledges	4.00
Interest to July 1, 1938	50.46
	$1,387.37

The trustees voted that, for the year 1939 and annually thereafter, an award of at least $25, if available, be made to the Proceedings of the Helminthological Society of Washington, and that it be proposed to the Helminthological Society that the printed Proceedings carry a statement to the effect that publication is supported in part by the proceeds of the Brayton Howard Ransom Memorial Trust Fund.

ELOISE B. CRAM
Secretary-Treasurer

Nematodes observed on diseased rhizomes of ginger from Peru. G. STEINER and J. R. CHRISTIE, U. S. Bureau of Plant Industry.

The species *Diploscapter coronatus* (Cobb, 1893) Cobb, 1913, *Neocephalobus peruënsis*, n. sp. and *Aphelenchoides hunti* Steiner, 1935, are here added to the nematode fauna of Peru. They were found on diseased rhizomes of ginger (*Zingiber* sp.) which were intercepted by W. N. Wheeler, Inspector of the Bureau of Entomology and Plant Quarantine in San Francisco (September 7, 1938). The first species, *D. coronatus*, apparently is of regular occurrence but as yet of unknown significance in diseased ginger rhizomes; it has been observed again and again by the senior writer in various shipments originating from Japan, China and the continental United States. The fact has been definitely established that *A. hunti* feeds on fungi and *N. peruënsis* feeds on bacteria. It appears therefore that these species are not primary disease agents.

Neocephalobus peruënsis, n. sp. (Figs. 1, A–K)

Because the male of the present form has the single adanal papilla characteristic of *Neocephalobus*, it is classed with this genus. Other features are much in accordance with those of *Panagrolaimus* Fuchs as recently defined by Thorne. It appears that *Neocephalobus* should be considered a subgenus of *Panagrolaimus* rather than a separate genus, but in view of the fact that the Cephalobidae are an extremely numerous family, of which only a small number of genera and species are as yet described, the present status is retained until a more comprehensive revision of the whole family is deemed possible.

Ecological observations.—*N. peruënsis* may easily be cultured on agar plates. In the present case it was seen moving slowly in a winding and gliding motion through the webs of fungal hyphae on such plates. Locomotion is forward as well as backward; in the latter case the tail end is frequently bent, as shown in figure 1, H. During motion the head is constantly searching in all directions. The esophagus simultaneously and almost without interruption sucks or pumps. This is accomplished by an alternate and exceedingly rapid contraction and relaxation of the radial muscles of the corpus portion of the esophagus; an alternate dilation and closing of the esophageal canal in this portion is thus effected, and a powerful sucking and pumping action produced which results in the intake of food. The wide oral opening and the adjoining wide anterior portion of the buccal cavity function as a collecting and intake funnel. The valves in the terminal bulb of the esophagus follow the action of the corpus within an almost imperceptible interval of time and make a combined rolling and backward motion, which in turn sucks the ingested material from the corpus portion through the esophageal isthmus and transports it into the intestine. The esophagus is therefore interpreted in its physical function as a double pump, arranged tandem, with the isthmus functioning as an attachment and also as an intersection between the 2 pumps, timing their action interval. The pumping or sucking motions go on almost without interruption and with such speed that an analysis is almost impossible. Sometimes one sees small particles of ingested material slip down the esophageal canal but otherwise one gets the impression that mainly fluid material is swallowed. As already mentioned, the present species is supposed to be bacteriophagic. This conclusion is based on the contents of the intestine. In many specimens the intestine was seen to contain large numbers of bacteria, apparently of 2 kinds (one of the bacilli type (1 by 2 μ) and the other spherical (2 to 3 μ diameter). Since they were alike in all parts of the intestinal canal and since those in the end portion showed no changes attributable to digestive action, it is concluded that these bacteria are not themselves the food. The latter may consist of metabolic prod-

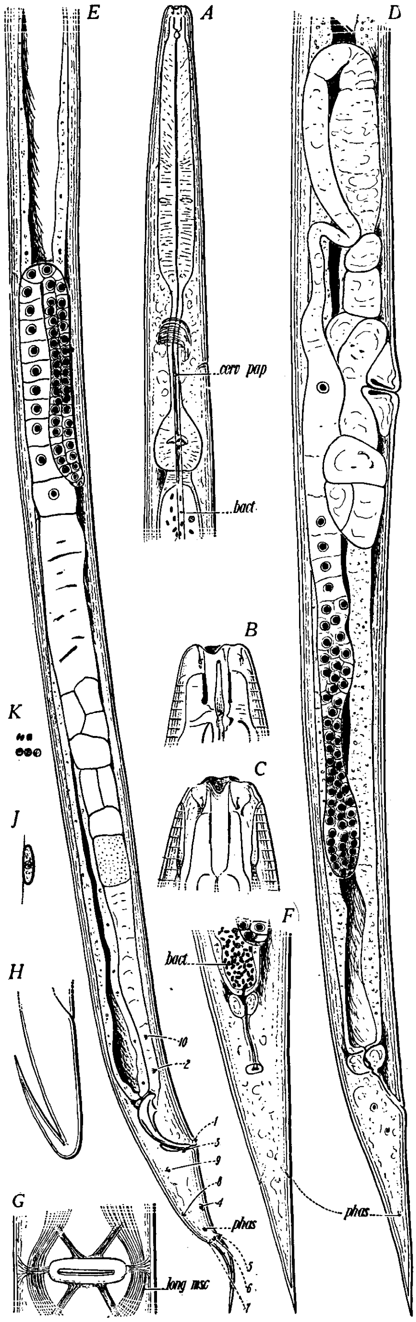

FIG. 1. *Neocephalobus peruënsis,* n. sp. A—Anterior end; *bact,* bacteria in intestine; *cerv pap,* cervical papilla; × 450. B—Head in lateral view; × 1200. C—Head in ventral view; × 1200. D—Posterior end of female with sexual apparatus; *phas,* phasmid; × 450. E—Posterior end of male with sexual apparatus; *phas,* phasmid; 1–10, copulatory papillae; 1, adanal papilla; 9 and 10, papillae present in rare specimen; × 450. F—Tail end of female in ventral view; *bact,* bacteria in end portion of intestine; × 450. G—Ventral view of vulva and its dilatator muscles, one anterior oblique, one posterior oblique and one lateral transverse pair; *long msc,* longitudinal body muscles (about 8 fibers) as they curve around vulva; × 450. H—Tail end as often folded during backward movement of body; sketch. J—Unicellular organism attached to the body surface of mematode; sketch. K—Two types of bacteria as seen in intestine; × 600.

ucts or of some slimy cover of the bacteria. Or are these bacteria ingested to help digest some other fluid or submicroscopic food? If the bacteria pass through the intestinal tract in viable condition, then the present nematode species must function as their distributing agent. In the case of a pathogenic bacterium, the nematode would become an important secondary disease agent in the rôle of carrier and distributor. In figure 1, J, a unicellular organism is shown in profile view as observed attached to the ventral surface of the nematode a short distance behind the vulva. It did not change during an observation time of about 2 days. In surface view its form is circular.

Description.—Body of female quite stout, that of male more slender, tapering uniformly toward head end. Tail end elongate-conical, similar in male and female but in male end portion somewhat set off and spicate because of a group of 6 copulatory papillae arranged around its base (Fig. 1, E). Terminus acute. Cuticle very finely annulated in the subsurface layer, most clearly near the head end. Lateral fields narrow (3 μ wide where body width is 22 μ). Head not set off; front broad-obtuse with 3 low rounded lips separated by deep rounded incisions and each consisting of 2 more or less completely amalgamated lips, the ventrosubmedial pairs somewhat asymmetrical. Inner circle of 6 papillae; outer circle of only 4 (submedial); all low, fine. Amphidial opening in latitude of outer circle; pouch long, flask-shaped. Buccal cavity panagrolaimoid (about 3.5 μ wide); cheilorhabdions absent, prorhabdions well developed; dorsal metarhabdion forming a toothlet; ventral wall with a naviculate thickening in region of telorhabdion. Corpus of esophagus cylindrical, $\frac{2}{3}$ as wide as body diameter, sometimes with a break in the tissue between the second and last third as the only mark of differentiation into pro- and metacorpus. Isthmus narrow, about half as long as corpus. Terminal bulb almost spherical, with full set of valves. Esophago-intestinal valve cylindrical, with radial muscles. During locomotion this valve and part of the terminal esophageal bulb is constantly pushed in and out of the intestine, the intestinal tract thus adjusting itself to the longitudinal contractions and extensions caused by locomotion and by the swallowing of food. Nerve ring in living specimens usually surrounding anterior end of isthmus; excretory pore, in fixed material ventral to nerve ring. Cervical papillae and phasmids as shown in figure 1, A, D & F. Female sexual apparatus with postvulvar uterus branch; wall of uterus peculiarly folded, causing the impression of a division into chambers. Ovary usually extending to about $\frac{2}{3}$ the distance from vulva to anus but sometimes almost reaching rectum. Oögonia arranged in 3 or more longitudinal series. Eggs deposited undivided, with thin, smooth shell; size 21.5 to 23.6 μ by 45 to 53 μ. Male with copulatory papillae as shown in figure 1, E. Papillae 9 and 10 were seen in a single specimen and were lacking in the others. Spicula and gubernaculum much like those of the panagrolaims; gubernaculum less than $\frac{1}{3}$ length of spicula. End of testis reflexed ventrad; spermatogonia arranged in 3 longitudinal series.

Measurements.—5 ♀♀: total length = 0.636 to 0.86 mm; $\alpha = 18.7$ to 22.3; $\beta = 4.7$ to 5.6; $\gamma = 10.2$ to 12.3; v = 57 to 58 per cent. 5 ♂♂: total length = 0.586 to 0.77 mm; $\alpha = 25.7$ to 26.8; $\beta = 4.3$ to 4.8; $\gamma = 10.5$ to 13.1.

Diagnosis.—*Neocephalobus* resembling *N. aberrans* (Steiner, 1934) Steiner, 1936, but with only 3 lips, each consisting of 2 more or less distinctly amalgamated lips (in *N. aberrans* 6 uniform lips). Male copulatory papillae 8 to 10 in number and of different arrangement, the ventromedian papilla adanal, not in latitude of proximal end of spicula as in *N. aberrans.*

Type association.—Diseased rhizomes of ginger.

Type locality.—Peru.

Aphelenchoides hunti Steiner, 1935

In addition to *Neocephalobus peruënsis*, n. sp., the diseased ginger roots harbored *Aphelenchoides hunti* in considerable numbers. With reference to general morphology these specimens agreed so closely with the senior author's description and drawings (Steiner, 1935, Proc. Helminth. Soc. Wash. 2(2): 106–107) that further comments are unnecessary. On being transferred to agar cultures on which a fungus (*Alternaria* sp.) was growing this nematode thrived and reproduced rapidly building up very large populations. It is a rapid and voracious feeder. After the head has been placed against a hypha there are a few rapid backward and forward movements of the stylet followed by the characteristic pulsating movements of the bulb and the contents of the fungal cell are quickly sucked out. The operation requires only a few seconds and the nematode quickly moves away to seek another hypha.

In some of his specimens the senior author (Steiner, 1935, *loc. cit.*) occasionally found an egg containing a well developed larva and he concluded that females were probably viviparous. In one of his drawings such an egg is shown in the postvulva uterine sac. In the present instance, however, females are not viviparous. The exact developmental stage of eggs at the time of deposition was not determined and doubtless there is some variation in this respect but eggs in 2, 3, or 4-cell stages could be found on the cultures. Although consistently present, males were greatly outnumbered by the females. Each culture usually provided hundreds of specimens but it required considerable searching to find as many as 3 or 4 males.

A note on the parasite fauna of the Hawaiian Islands. LEONARD E. SWANSON, U. S. Bureau of Animal Industry.

During 1936 and 1937, while at the Hawaii Agricultural Experiment Station, the writer had an opportunity to conduct post-mortem examinations on representatives of all classes of livestock existing in the Hawaiian Islands. The following list gives the species encountered, as well as the location in their respective hosts:

	TREMATODA	
Fasciola gigantica	Cattle, water buffalo, [man]	Liver and elsewhere
	CESTODA	
Anoplocephala magna	Horse and mule	Large intestine
Anoplocephala perfoliata	Horse	Ileo-cecal region
Raillietina tetragona	Chicken	Small intestine
	NEMATODA	
Habronema majus (Syn. *H. microstoma*)	Horse and mule	Stomach
Habronema muscae	do	do
Strongylus edentatus	do	Large intestine
Cylicocercus goldi	do	do
Cylicocyclus insigne	do	do
Cylicodontophorus bicoronatus	do	do
Cylicostephanus longibursatus	do	do
Gongylonema sp.	Cattle	Esophagus
Haemonchus contortus	Cattle and sheep	Abomasum
Oesophagostomum radiatum	Cattle	Small intestine
Ascaris suis	Swine	do
Hyostrongylus rubidus	do	Stomach
Stephanurus dentatus	do (wild)	Kidney, kidney fat, liver
Trichuris suis	do	Cecum
Trichinella spiralis	do	Muscle
Dirofilaria immitis	Dog	Heart
Ancylostoma caninum	do	Small intestine
Physaloptera muris-brasiliensis	Rat	do
Ascaridia galli	Chicken	do
Heterakis sp.	do	Ceca

Subulura sp.	do	do
Tetrameres americana	do	Proventriculus
Cheilospirura hamulosa	do	Gizzard
Dispharynx spiralis	do	Proventriculus
Oxyspirura mansoni	Chicken, pheasant, maynah bird	Eye
Gongylonema ingluvicola	Pheasant	Esophagus
	ARTHROPODA	
Gastrophilus nasalis	Horse	Stomach
Gastrophilus intestinalis	do	do
Oestrus ovis	Sheep	Nasal sinuses
Demodex folliculorum suis	Swine	Skin

In connection with the occurrence of *Fasciola gigantica* in man, 3 cases of infection have come to the attention of the writer. Of these cases, records of 2 were supplied by a physician in Honolulu, one being from the throat and coughed up with the sputum and the other of a live fluke sneezed from the nasal passages. The third case was found during an operation where a live specimen was taken from the abdominal cavity of a girl; this case was witnessed by the writer.

Of special interest is the fact that of 14 wild cattle, 8 deer and about 20 goats examined, all were negative for parasites occurring in related domestic animals. These observations, however, do not signify that wild animals in certain sections may not be parasitized.

Notes on free-living and plant-parasitic nematodes, V. GERALD THORNE, U. S. Bureau of Plant Industry, Salt Lake City, Utah.

(1) A NEW GENUS AND SPECIES OF NEMATODES

Panagrobelus nov. gen.[1]

Cephalobidae, Panagrolaiminae (?): Lip region bearing 6 inward-pointing, flap-like processes with strongly sclerotized borders. Of these cephalic processes, the dorsal and the 2 ventrosubmedian are wide with broad termini while the ventral and the 2 dorsosubmedian are much narrower and more pointed. Cheilorhabdions fused, forming a shallow, triquetrous cheilostom (Fig. 1, E). Prorhabdions prominent, plate-like, rather elaborate in form (Fig. 1, F). The thin meso-, meta- and telorhabdions are fused until their identity is lost in the pharyngeal lining but frequently distinct breaks in the surrounding musculature mark their approximate positions. Esophagus with well-developed corpus, narrow isthmus and strongly-valved bulb. Nerve ring encircling isthmus near middle. Female sexual branch first extending forward, then reflexed far past the vulva with the ovary outstretched. Testis single, the terminus reflexed. Spicula broad, cephaloboid. Gubernaculum appearing in cross section as an irregular polygon. Preanal supplement present. Male ventrosubmedian papillae present. Tails of sexes similar.

Type species.—*Panagrobelus incisus,* n. sp.

Diagnosis.—Panagrolaiminae (?) with the above general description. This genus is distinctive because of the 6 cephalic processes with their sclerotized borders which immediately differentiate it from all other members of the subfamily.

Panagrobelus incisus, n. sp.

♀: 1.0 mm; $\alpha = 20$; $\beta = 5.5$; $\gamma = 21$; V—^{22} 59.^{32}

♂: 0.9 mm; $\alpha = 28$; $\beta = 4.1$; $\gamma = 20$; T—60

With the above characters of the genus. Cuticle with transverse striae 1.5 μ

[1] The generic name "*Panagrobelus*" is composed of portions of the subfamily names *Panagrolaiminae* and *Acrobelinae,* the 2 groups to which this genus appears to be most closely related.

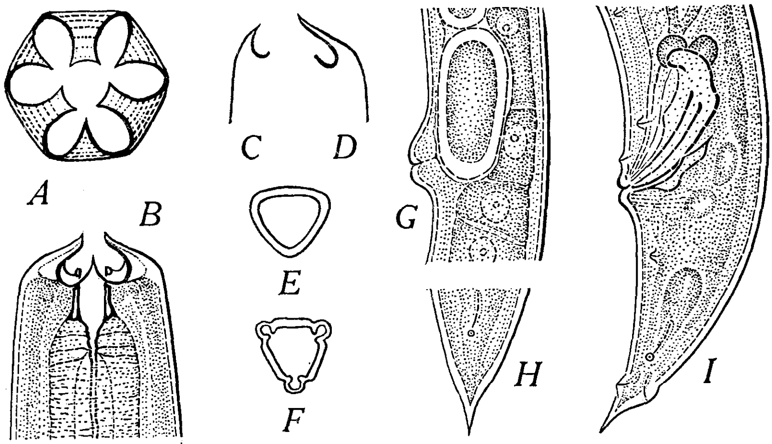

FIG. 1. *Panagrobelus incisus.* A—Front view of cephalic processes; ×2000. B—Head, ventral view; ×2000. C—Profile of ventral and dorsosubmedian cephalic processes; ×2000. D—Profile of dorsal and ventrosubmedian cephalic processes; ×2000. E—Cross section of cheilorhabdions; ×4000. F—Cross section of prorhabdions; ×4000. G—Vulvar region; ×375. H—Female terminus; ×750. I—Posterior portion of male; ×750.

apart. Wing area marked by 2 faint lines. Details of lip region and pharynx as illustrated (Fig. 1, B). Cephalic papillae not observed. Amphid apertures appearing as minute oval markings slightly dorsal to the median line, located at the bases of the lateral cephalic processes. Corpus of esophagus enveloping only the bases of the prorhabdions, then gradually broadening so that it is uniformly about ½ as wide as the neck until it abruptly narrows to the isthmus. Isthmus 2 to 3 times as long as neck width. Bulb ½ to ⅗ as wide as the neck with a strong valvular apparatus. Lips of vulva protuberant. Vagina extending inward and forward. Ovary reflexed straight back without additional flexures, sometimes reaching as far as the rectum. Testis single, the terminus reflexed a distance equal to 2 to 3 times the body width. Spicula broad, arcuate, cephalated, with a rather indefinite ventral contour. Gubernaculum elongate, irregular in contour. A single ventromedian supplement slightly anterior to the anus. Four pairs of ventrosubmedian and 1 pair of dorsosubmedian ♂ papillae located as illustrated (Fig. 1, I). Tails of both sexes with somewhat spicate termini.

Diagnosis.—*Panagrobelus* with above measurements and general characters. Differentiated from the only other known species, *P. coronatus,* by its greater length, ♀ 1.0 mm, ♂ 0.9 mm, as compared to ♀ ♂ 0.5 mm, and by the presence of only 2 pairs of preanal, and 2 pairs of postanal ventrosubmedian ♂ papillae.

Habitat.—Under bark of a dead twig of the umbrella-pine, *Sciadopitys verticillata* Sieb. & Zucc., collected by C. J. Gilgus at Waltham, Mass., U. S. A., and kindly forwarded to the writer by J. R. Christie.

The general appearance of *Panagrobelus incisus* is very much like that of *Panagrolaimus subelongatus* except for the probolae-like processes of the head. Probably it represents a new subfamily which possesses characters of both the *Panagrolaiminae* and *Acrobelinae.*

Plectonchus coronatus Fuchs, 1930, doubtless is a member of this genus and therefore becomes *Panagrobelus coronatus* (Fuchs, 1930), n. comb. This species is differentiated from the type by its much shorter length, ♀ ♂ 0.5 mm, and by the presence of 3 pairs of preanal and 3 pairs of postanal ventrosubmedian ♂

papillae. Fuchs does not figure the ventromedian preanal supplement for *P. coronatus* and if this organ is absent it is not of generic diagnostic value as given above.

(2) ON THE HABITS OF PRATYLENCHUS PRATENSIS (DE MAN) FILIPJEV

Frequently roots of plants are collected which bear all of the symptoms of infestation by *Pratylenchus pratensis* but in which it is impossible to find specimens of this nema. This is due to the fact that *P. pratensis* may heavily infest the succulent young roots of various plants but as they mature and become hardened the nemas find them inhospitable and migrate into the soil. This condition frequently has been observed by the writer in connection with wheat, oats, barley, corn and cotton. Parasitism within the roots is not essential for the reproduction of *P. pratensis* and, during the growing season, gravid females and young of all stages may be found in almost any infested soil. This fact emphasizes the advisibility of collecting some of the soil adhering to the roots and examining it by the Cobb sifting and gravity methods if the nemas are not found within the root tissues.

At present the specific name *Pratylenchus pratensis* includes a complex group of forms or species. The form to which these notes apply is one that at present is distinguished only by the absence of males, the females closely resembling those of the type. It has been found as a serious plant parasite in many widely-separated localities in the United States.

New genera and species of Filarioidea. II. Quadriplotriaena dolichodemus, n. gen., n. sp. E. E. WEHR, U. S. Bureau of Animal Industry.

On December 28, 1928, while stationed at the U. S. Range Livestock Experiment Station, Miles City, Montana, the writer collected a number of nematodes from the abdominal cavity of a magpie, *Pica pica hudsonia*. These belong to the subfamily Diplotriaeniinae Skrjabin, 1916, and are regarded as representing a new genus and new species for which the name *Quadriplotriaena dolichodemus* is proposed.

Quadriplotriaena, new genus

Diagnosis.—Oral opening oval. Cephalic papillae consisting of an external circle of 4 pairs; internal circle of papillae absent (Fig. 1, A). Cuticular tridents 4 in number; the 2 dorsal tridents bearing 1 tooth each and the 2 ventral bearing

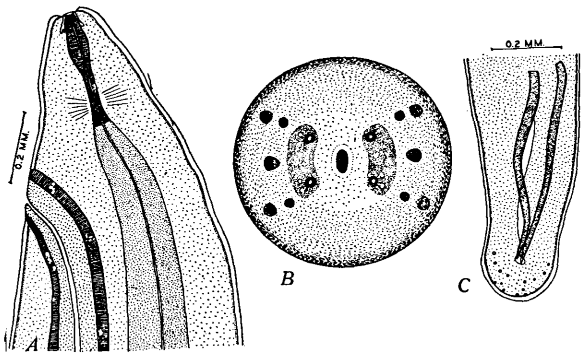

FIG. 1. *Quadriplotriaena dolichodemus*, n. sp. A—Cephalic extremity, lateral view. B—Head, *en face* view. C—Posterior extremity of male, ventral view.

2 teeth each (Fig. 1, B). The tips of the 4 manubria of the tridents project finger-like above the surface of the body surrounding the oral opening. Esophagus divided externally into an anterior short, narrow, muscular part and a posterior long, broad, glandular part. *Male* without caudal alae; small caudal papillae present. Posterior extremity rounded, slightly swollen. Spicules unequal and dissimilar; short spicule stout, spirally twisted and winged on one side, long spicule delicate, slightly arcuate and winged in posterior half. *Female* with vulva a short distance posterior to junction of the 2 portions of esophagus. Posterior extremity rounded but not swollen. Parasites of abdominal cavities of Icteridae.

Type species.—*Quadriplotriaena dolichodemus,* new species.

Key to genera of Diplotriaeninae

1. Cuticle lateral to oral opening raised in form of 4 cuticular finger-like projections .... *Quadriplotriaena,* n. g.
   Cuticle lateral to oral opening raised in form of 2 cuticular finger-like projections 2
2. Trident-like structures large and heavily cuticularized .... *Diplotriaena* Railliet and Henry
   Trident-like structures very small and weakly cuticularized .... *Diplotriaenoides* Walton

Quadriplotriaena dolichodemus, new species

Description.—With characters of genus.

Male 73 mm long by 450 μ wide. Cuticular tridents very small, 15 to 16 μ in length. Anterior portion of esophagus about 378 μ long; posterior portion 5.1 mm long. Nerve ring about 300 μ from anterior end of body. Long spicule 1.3 mm and short spicule 558.5 μ in length. Cloacal aperture subterminal. Caudal alae absent. Six or seven pairs of very small caudal papillae present (Fig. 1, C).

Female 178 mm long by 710 μ wide. Cuticular tridents 20 to 22 μ long. Anterior portion of esophagus 215 μ long; posterior portion 5.7 mm long. Vulva 500 μ from anterior end of body. Vagina broad, 2.9 mm long. Posterior branch of uterus extending to within 6.6 mm of end of body before turning anteriorly. Anus subterminal. Eggs 51 μ by 34 μ.

Host.—*Pica pica hudsonia.*

Location.—Abdominal cavity.

Distribution.—United States (Montana).

Specimens.—U.S.N.M. Helm. Coll. No. 32328 (type, male and female).

CONTENTS