

TWO NEW LARVAL NEMATODES BELONGING TO THE
GENUS PORROCAECUM FROM MAMMALS OF THE
ORDER INSECTIVORA

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Under date of October 22, 1924, Dr. Paul Bartsch of the United States National Museum, forwarded to this laboratory encysted larval nematodes, collected by Miss F. A. Cook from under the skin of a short-tailed shrew (*Blarina brevicauda*) in the District of Columbia. The cysts are spherical in shape, from 2 mm. to 4 mm. in maximum diameter, each containing a spirally coiled nematode, visible through the rather transparent cyst wall. Two nematodes were freed from their cysts by dissecting the cyst wall and several cysts were cleared without injuring the cyst wall. Examination of the worms showed that though they were sexually immature, they could be readily identified as belonging to the genus *Porrocaecum*, on the basis of the oblong esophageal ventriculus, the absence of an esophageal appendix, and the presence of an intestinal cecum.

Owing to the feeble development of the lips and accessory mouth structures in the worms in question it is neither possible nor desirable to assign them to any of the known species of the genus, and following a common usage among zoologists, these parasites, though sexually immature and otherwise incompletely developed, are given specific rank, the name *Porrocaecum encapsulatum* being proposed for them.

PORROCAECUM ENCAPSULATUM, new species

Immature worms, occurring in globular cysts from 2 mm. to 4 mm. in maximum diameter, lodged under the skin of the host. The worms are long, slender, superficially resembling filaria, lying spirally coiled within their cysts (fig. 8). The cuticle is striated transversely throughout the entire length of the worms. One specimen extracted from the cyst measures 36 mm. in length by 0.365 mm. in maximum width. The head when viewed from the side shows

two small cuticular protuberances (fig. 7) whose morphological nature appears uncertain. When viewed *en face*, three feebly developed lips surrounding a small opening, the mouth, and what appear to be six rather large papillae could be made out. The esophagus consists of two portions, namely (*a*) the muscular esophagus proper and (*b*) the ventriculus (fig. 6). The esophagus proper is filariform in shape, its diameter increasing in the posterior portion. In one specimen the esophagus is 1.2 mm. long by 125μ in maximum width in the region of the base, and 62μ in minimum width just below the head. In another specimen the maximum width of the esophagus is 178μ . The ventriculus is oblong in shape (fig. 6) from 223μ to 232μ long by 125μ to 178μ wide. The intestinal cecum (fig. 6) is long and slender and lies alongside the esophagus. The distance from the top of the intestinal cecum to the base of the ventriculus, slightly below which the former originates, is 630μ and 756μ respectively, in two specimens examined. The intestine terminates at a distance of 133μ from the posterior extremity (fig. 5) and has a more or less uniform diameter, which measures 115μ in the region of the middle of the body. In the anal region a number of structures presumably glands, stand out rather prominently. The tail (fig. 5) ends in a spinose tip which measures about 25μ in length. No opening of the reproductive system or any evidence of the presence of gonads could be distinguished in the specimens examined.

Host.—*Blarina brevicauda*.

Location.—Under the skin.

Locality.—District of Columbia.

Type specimens.—United States National Museum, Helminthological Collections No. 26052.

On June 27, 1923, Dr. E. A. Chapin of this bureau discovered an encysted nematode under the skin in the costal region of a mole (*Scalopus aquaticus*), that had been trapped at Falls Church, Virginia. On July 10, 1923, Doctor Chapin found another encysted nematode under the skin of the same species of mole, trapped in the same locality. Doctor Chapin freed these larvae from the cysts and identified them as belonging to the genus *Porrocaecum*, basing his generic determination on the structure of the esophagus and on the presence of an intestinal cecum. One specimen was evidently lost or destroyed. The second specimen was returned to Dr. N. A. Cobb of the Bureau of Plant Industry, to whom the material in question belonged and to whom the present writer is indebted for the privilege of studying it. The present writer is also indebted to Doctor Chapin who furnished information concerning the location of the cysts in the host and the appearance of the larvae within the cysts.

An examination of Doctor Cobb's specimen showed it to be an immature *Porrocaecum* considerably smaller than *Porrocaecum encapsulatum*, the mouth structures being, however, somewhat more developed than those in the latter species. The larval nematode from the mole (*Scalopus aquaticus*) is quite distinct from the form found in the shrew (*Blarina brevicauda*) and is described as a new species, the name *Porrocaecum americanum* being proposed for it.

PORROCAECUM AMERICANUM, new species

The worm in its preserved state has been removed from its cyst, and is coiled in a loose spiral, having the shape of the figure 6 (fig. 3). Doctor Chapin states that the worm in its encysted condition was tightly coiled, completely filling its capsule. The specimen is 7.9 mm. long and 225μ wide in the middle of the body. The cuticle is cross striated throughout the entire length of the specimen, the striations in the middle of the body being approximately 15μ apart, the distance between the striations diminishing as the two extremities are approached. The mouth structures are more developed than those of *Porrocaecum encapsulatum*, the three lips (fig. 2) appearing as distinct and well-defined structures, the dorsal lip being larger than the two lateral lips. In lateral view, cuticular prominences, such as those in *Porrocaecum encapsulatum*, are not distinguishable. The esophagus (fig. 4) consists of two parts, namely, the esophagus proper and a ventriculus. The former is about 690μ long and the ventriculus which is oblong in shape is 133μ long by about 80μ in maximum width. The nerve ring is located at a distance of 178μ from the anterior extremity. The intestinal caecum (fig. 4) is 440μ long and lies alongside the esophagus. The intestine whose diameter is more or less uniform, measuring about 80μ in the middle of the body, terminates at a distance of 107μ from the posterior extremity (fig. 1). The tip of the tail (fig. 1) is apparently broken off as the posterior extremity of the specimen has a truncate appearance that suggests an artifact. No evidence of a genital opening or of gonads could be found in this specimen.

Hosts.—*Scalopus aquaticus*.

Location.—Under the skin.

Locality.—Falls Church, Virginia.

Type specimen.—United States National Museum, Helminthological Collections No. 26060.

EARLIER REPORTS OF ENCYSTED NEMATODES IN INSECTIVORA

The first record of the occurrence of encysted nematodes in Insectivora was published by Goeze (1782), who found some spirally coiled worms inclosed in cysts and lodged in the peritoneal cavity of

a European mole, presumably *Talpa europaea*. The worms which have the shape of the figure 8 as they lie in the cyst are described and figured by Goeze, who recognized their ascarid structure and placed them in the genus *Cucullanus*. The specific name *Cucullanus talpae* was proposed for these parasites by Schrank (1788). Zeder (1803) named them *Fusaria incisa* and Rudolphi (1802) called them *Ascaris incisa*, by which name they have been commonly known to helminthologists. Leuckart (1842) records encysted larval nematodes from the abdominal cavity and liver of the European shrew (*Sorex tetragonurus*) similar to and possibly identical with *Ascaris incisa*. Leuckart's specimens are from 10 mm. to 18 mm. long, whereas *Ascaris incisa* is only from 8 mm. to 10 mm. long according to various observers. Without expressing any definite opinion, Leuckart considers the possibility that the forms from the shrew are distinct from *Ascaris incisa* and proposes the tentative name *Ascaris acanthura* for his specimens. According to Seurat (1916) *Spiroptera strumosa* Mégnin (1881) is synonymous with *Ascaris incisa* Rudolphi (1802). Under the name *Spiroptera strumosa* Mégnin records encysted nematodes from the surface of the stomach and intestines of a European mole. This writer finds that although these cysts are six times as large as Trichinae cysts, they have been mistaken for the latter. Baylis (1924) expresses the opinion that encysted nematodes from small mammals, such as shrews, belong to the genus *Porrocaecum*. This opinion is apparently based on Leuckart's idea that *Ascaris incisa* is a larval stage of *Ascaris depressum* (*Porrocaecum depressum*).

The two species of *Porrocaecum* larvae described in this paper are related to the various forms described from Europe, but they differ from the latter as regards location, occurring subcutaneously, whereas the European specimens have been recorded from the abdominal cavity. *Ascaris incisa*, is in all probability, a group name, similar to *Ascaris capsularia*, a collective name including various agamic nematodes encysted in fishes. According to Seurat's diagnosis (1916) *Ascaris incisa* occurs in branching cysts, the capsules being multiple and connected to each other by peduncles given off from the cyst wall. This is borne out by Leuckart's figures of *Ascaris incisa* (Leuckart, 1876). Mégnin's figure of *Spiroptera strumosa* likewise shows a pedunculated cyst. Goeze's figures of *Cucullanus talpae*, and Leuckart's figures of *Ascaris acanthura*, which he considered as probably identical with *Ascaris incisa*, show nonpedunculated cysts, from which it may be concluded that under the name *Ascaris incisa* two or more species are probably included.

Porrocaecum encapsulatum differs strikingly from all previously described nematode larvae from Insectivora in size, since it is four times as long as *Ascaris incisa* and twice as long as the longest specimens of *Ascaris acanthura*. *Porrocaecum encapsulatum* is

tightly coiled, the comparatively large number of coils filling the cyst completely, whereas *Ascaris incisa* assumes the shape of the figure 6 or 8 within the cyst, the interior of the latter being but partially filled by the parasite. *Ascaris acanthura* has a shape more or less resembling the figure 8, and only partially fills the cyst, so far as can be judged from Leuckart's figure. The species from the mole described in this paper (*Porrocaecum americanum*) is similar in size to *Ascaris incisa*, but in view of the fact that the latter appears to be a group name, and that a precise account of its morphology has not been published, it is more desirable not to add to the already existing confusion, and accordingly the form from the American mole (*Scalopus aquaticus*) may best be considered distinct from that from the European mole (*Talpa europaea*).

THE GENUS PORROCAECUM RAILLIET AND HENRY 1912

The genus *Porrocaecum* is included in the family Ascaridae, and according to a recent revision of this family by Baylis (1920), it is assigned to the subfamily Anisikinae Railliet and Henry, 1921, emended by Baylis, 1920. Baylis defines the genus *Porrocaecum* as follows: "Esophagus with anterior muscular portion and posterior ventriculus of oblong shape, the latter short in the genotype, but in other species frequently long and bent at an angle so as to open into the intestine laterally. An intestinal cecum present. No esophageal appendix. Interlabia present, usually small dentigerous ridges present." Fifteen species belonging to this genus are listed in the catalogue of the Zoological Division of the Bureau of Animal Industry, the hosts being fishes, amphibia, birds, and marine mammals. At least one species (*Porrocaecum crassum*) is probably of economic importance, since it occurs in ducks. It is not improbable that further investigations will add to the number of species of *Porrocaecum* on the one hand and subtract from it on the other hand. Only five species listed under this genus are regarded by Baylis (1920) as probably belonging to it, while the same writer regards certain species from fish with a type of alimentary canal characteristic of the genus, but not as yet included in it, as requiring further investigation. It may be concluded, therefore, that our knowledge of the genus is as yet incomplete, and that further investigation will probably result in bringing to light additional species which may lead to a new conception regarding the affinities of the various members now included in it.

LIFE HISTORY OF SPECIES OF PORROCAECUM

Our present knowledge of the life history of species of *Porrocaecum* is very fragmentary, the essential facts being understood in only two species, so far as the present writer has been able to ascer-

tain. In the case of *Ascaris decipiens* (= *Porrocaecum decipiens*) of the Alaskan seal, the source of infection with this parasite according to Stiles and Hassall (1899) is to be found in certain fish that constitute part of the food of the definitive host. Stiles and Hassall (1899) say that immature ascarids, representing various stages intermediate between the adult forms of *Ascaris decipiens* and the so-called *Ascaris capsularia*, which is a collective name applied to larval nematodes found encysted in various species of fish, occur in the stomach of seals, and that this suggests that these animals acquire the infection with *Porrocaecum decipiens* as a result of eating infected fish. Although Stiles and Hassall did not carry out any feeding experiments, they report finding encysted ascarids in the Alaskan pollock and the Pacific cod, which were identical with the youngest forms, presumably of *Porrocaecum decipiens*, found in seals. Since these fishes are known to be eaten by seals, Stiles and Hassall conclude with a fair degree of certainty that the definitive host acquires the infection as a result of eating the intermediate host. So far as concerns *Ascaris incisa* it was suggested by Leuckart (1876) that it is the larval form of *Ascaris depressa* (= *Porrocaecum depressum*), a nematode that occurs in various birds of prey such as hawks and owls. Leuckart's view has been commonly accepted by helminthologists, although no experimental evidence has been obtained to prove this relationship.

The occurrence of encysted *Porrocaecum* larvae in mammals suggests a relationship between the intermediate and the unknown definitive hosts similar to that described by Stiles and Hassall (1899) for *Porrocaecum decipiens*. The unknown definitive hosts in the cases reported by the present writer and by others are in all probability birds, presumably hawks and owls, and other flesh-eating birds. Two species of *Porrocaecum* from hawks are represented in the Helminthological Collections of the United States National Museum. One species is from *Circus hudsonicus* and the other is from *Falco columbarius*, both from Fishers Island, New York. The form from *Circus hudsonicus* has a very small intestinal cecum. An American species of *Porrocaecum* is described by Smith, Fox, and White (1908) as *Ascaris ardea* (= *Porrocaecum reticulatum*) according to Baylis and Daubney (1922), from a North American blue heron (*Ardea herodias*). Smith, Fox, and White fail to mention the ventriculus and the esophageal bulb. Baylis and Daubney (1922) are convinced, however, that the species described by Smith, Fox, and White is a synonym of *Ascaris reticulata* von Linstow 1899 (= *Porrocaecum reticulatum*). According to the former writers this species has a well-developed intestinal cecum and a less conspicuous ventriculus, which they describe as short and oblong. While the larval

forms described by the present writer have a well-developed intestinal cecum, they also have a conspicuous ventriculus, and are therefore probably not identical with *Porrocaecum reticulatum*. However, as already stated elsewhere in this paper, the immaturity of the present writer's specimens does not warrant comparison with any known adult forms.

The determination of the adult stages of *Porrocaecum encapsulatum* and *Porrocaecum americanum* must await the examination of probable definite bird hosts in the vicinity of the District of Columbia and Virginia for parasites of the digestive tract, and the experimental infection of birds with *Porrocaecum* as a result of feeding them encysted larvae from intermediate hosts.

SUMMARY

Two encysted larval nematodes occurring in Insectivora are described for the first time from the United States, and are definitely shown to belong to the genus *Porrocaecum*. These forms appear to be related to encysted nematodes described from moles and shrews in Europe under the name *Ascaris incisa* and under other names, but are distinct from the European forms as regards location in the host as well as regards certain morphological characters. *Porrocaecum encapsulatum* described in this paper from the shrew (*Blarina brevicauda*) is strikingly larger than any of the related forms heretofore known, and *Porrocaecum americanum* from the mole (*Scalopus aquaticus*) though agreeing in size with *Ascaris incisa* is considered distinct, because the latter is probably a group name and has been incompletely described, so that there exists no definite basis on which to make morphological comparisons.

The adult forms of the larvae here described (*Porrocaecum encapsulatum* and *Porrocaecum americanum*) probably occur in birds of prey, such as hawks and owls. Owing to the incomplete state of development of these larvae, particularly as regards the mouth parts, it is impossible to compare them to any advantage with adult specimens of *Porrocaecum* collected from American birds of prey. The ultimate solution of the question of the adult stages of the larvae described in this paper will have to be based on more complete knowledge of the species of *Porrocaecum* that occur in American birds of prey and on feeding experiments.

REFERENCES TO LITERATURE CITED

BAYLIS, H. A.

1920.—On the classification of the Ascaridae. 1. The systematic value of certain characters of the alimentary canal, *Parasitology*, Cambridge [Eng.], vol. 12, ser. 3, Sept., pp. 253-264, figs. 1-6.

——— 1924.—Some considerations on the host-distribution of parasitic nematodes, *Linnean Soc. Journ., Zool.*, vol. 36, April, pp. 13-23.

BAYLIS, H. A.; AND DAUBNEY, R.

1922.—Report on the parasitic nematodes in the collection of the Zoological Survey of India, Mem. Indian Mus., Calcutta, vol. 7, ser. 4, Dec., pp. 263-347, figs. 1-75.

GOEZE, J. A. E.

1782.—Versuch einer Naturgeschichte der Eingeweidewürmer thierischer Körper. xi+471 pp., 44 pls., quarto. Blankenburg.

LEUCKART, FRIEDRICH S.

1842.—Helminthologische Beiträge (Zoologische Bruchstücke). Part 2, 60 pp., 2 pls., quarto. Freiburg.

LEUCKART, KARL G. F. R.

1876.—Die menschlichen Parasiten und die von ihnen herrührenden Krankheiten. vol. 2, pt. 3, pp. 513-882, 119 figs., octavo. Leipzig.

MÉGNIN, JEAN-PIERRE.

1881.—Sur de petits helminthes enkystés qui peuvent être facilement confondus avec la *Trichina spiralis* (Owen), Gaz. méd. de Par., vol. 52, ser. 6, vol. 3, juin, pp. 332-333.

RUDOLPHI, CARL A.

1802.—Fortsetzung der Beobachtungen über die Eingeweidewürmer, Arch. f. Zool. u. Zoot., Braunschweig, vol. 2, ser. 2, pp. 1-67, pl. 1.

SCHRANK, FRANZ VON PAULA.

1788.—Verzeichniss der bisher hinlänglich bekannten Eingeweidewürmer, nebst einer Abhandlung über ihre Anverwandtschaften. 116 pp. München.

SEURAT, L. G.

1916.—Contribution a l'étude des formes larvaires des nématodes parasites hétéroxènes, Bull. scient. de la France et de la Belg., Par. & Lond., ser. 7, vol. 49, 6 juillet, pp. 297-377, figs. 1-14.

SMITH, ALLEN J.; FOX, HERBERT; AND WHITE, C. Y.

1908.—Contributions to systematic helminthology, Univ. Penn. Med. Bull., Phila., vol. 20, Feb., pp. 283-294, pls. 2-10.

STILES, C. W.; AND HASSALL, A.

1899.—Internal parasites of the fur seal. (In Jordan, David Starr, and others. The Fur Seals and Fur Seal Islands of the North Pacific Ocean. Pt. 3, pp. 99-177, figs. 1-100. quarto. Washington)

ZEDER, J. G. H.

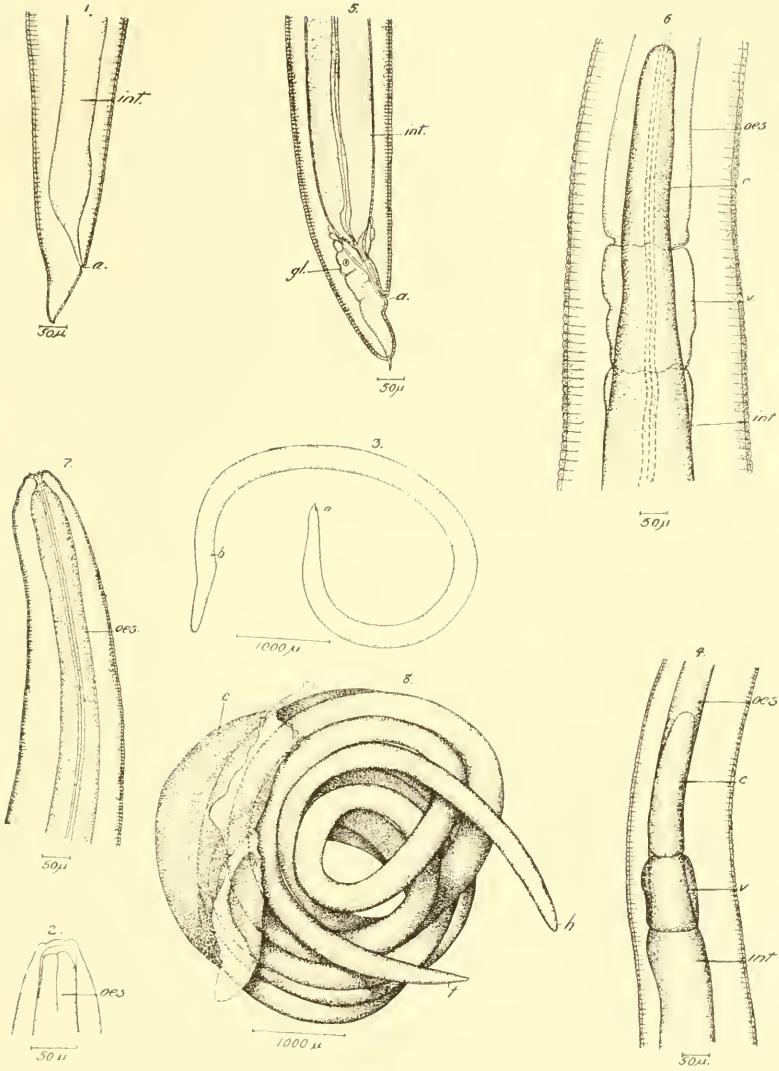
1803.—Anleitung zur Naturgeschichte der Eingeweidewürmer. xvi+432 pp., 4 pls., octavo. Bamberg.

EXPLANATION OF PLATE

a.—anus.		int.—intestine.
b.—base of esophagus.		oes.—esophagus.
c.—intestinal cecum.		t.—posterior extremity.
gl.—glands.		v.—ventriculus.
h.—anterior extremity.		

FIGS. 1-4.—*Porrocaecum americanum*, new species (lateral views). 1, posterior end; 2, anterior end; 3, outline drawing of entire worm; 4, esophageal region.

FIGS. 5-8.—*Porrocaecum encapsulatum*, new species (lateral views). 5, posterior end; 6, esophageal region; 7, anterior end; 8, encysted worm with cyst partially removed to show the worm.



NEW LARVAL NEMATODES OF THE GENUS PORROCAECUM

FOR EXPLANATION OF PLATE SEE PAGE 8

