

NEMATODE PARASITES OF MAMMALS OF THE ORDERS  
RODENTIA, LAGOMORPHA, AND HYRACOIDEA.

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PREFACE.

While engaged in the preparation of this paper the writer has had the great advantage of association with and criticism and assistance from a number of eminent and competent workers. I take especial pleasure in acknowledging the advice and the conservative and constructive criticism of Dr. Ch. Wardell Stiles. Among others should be mentioned Dr. B. H. Ransom, the Chief of the Zoological Division of the United States Bureau of Animal Industry, to whose policies I am indebted for the opportunity to carry on this investigation in connection with other work and whose previous study of the nematodes of ruminants has served as a model. I am further indebted to Dr. Albert Hassall, assistant zoologist of the United States Bureau of Animal Industry, for frequently assisting me in the tracing of obscure references and for the many nematodes of rodents and rabbits which were available to me as a result of his years of collecting. I am indebted to Miss Carrie Myers, of the Zoological Division of the United States Bureau of Animal Industry, for the preparation of the bibliography and host list and for assistance in the verification of numerous titles. For the selection of the proper host names and the designation of synonyms among host names I am indebted to the courtesy of Mr. Gerrit S. Miller and Mr. Ned Hollister, of the United States National Museum; while practically all of the illustrations, originals or copies, were drawn by Mr. W. S. D. Haines, artist of the United States Bureau of Animal Industry.

Outside of Washington, I am especially indebted to Mr. E. R. Warren, curator of the museum at Colorado College, and to Mr. Herman Douthitt, of the University of Illinois, for numerous specimens of rodent nematodes. Many of the nematodes furnished me by

Messrs. Warren and Douthitt are still in my possession undescribed, as the restudy of old forms left too little time for the description of all the new ones.

#### INTRODUCTION.

There are several reasons which led to the writing of this paper. In the first place, it has always appealed to the writer as a considerable service to scientists, even though to a less degree a contribution to science, to gather together under one cover the scattering notes and papers of other writers, often concealed under nonsignificant or even misleading titles. Few reprints or separates ever come to hand which are more acceptable than these. They are easily kept in mind and are an incentive to study material which would otherwise be laid aside owing to the difficulties involved in getting together the literature necessary for an adequate study of that material. Too little of this sort of work is done, possibly for the reason that systematic work of this character is thankless work. The frequent criticism "mere compilation" carries a slur which is rather poor return for the months of studying over poor descriptions and the tracing of obscure references.

In the second place, it has seemed desirable to cover in some systematic way the genera, species, and groups of nematodes involved in this study in such a way that the work of other writers might be rendered available to the average worker. This work of systematizing and correlating is neglected by some of our best workers. In fact, only a rather small minority apparently deem it necessary or desirable to indicate in the publication of a new species or genus the relationships to other species or genera or the family to which it belongs. More than that, many excellent writers publish new genera with merely the name of the type-species to fix the genus, and do this when no respectable diagnosis of the type-species is in existence and no specimens of the type-species are available to the majority of the world's scientific workers.

A third reason for writing this paper was to add descriptions of new genera and species to the forms previously published from rodents. This is frankly a subordinate reason. It seems much more important that the preliminary work of compiling and systematizing be done for the benefit of workers in general than that new species be added by the writer. In fact, much new material has been left unstudied in order to benefit by the use of this paper after its appearance in print rather than delay publication in order to study that material.

The reason for treating a group of parasites with reference to a host group rather than with reference to some grouping of the parasites themselves is that it is often simpler to work from the standpoint

of the host than that of the parasite. It commonly happens that the host is a known animal and that it is easy to look up the parasites of the host group if they have been brought together in some paper such as this. On the other hand, the parasite is the unknown thing, and without literature based on the host group it must be studied apart from its literature before any writings can be consulted.

The reason for working on rodents and allied forms as a host group instead of on some other group is partly casual. The writer had the good fortune to have considerable material turned over to him by Mr. E. R. Warren, of Colorado Springs, Colorado, including some nematode material from rodents, and its possession was a deciding factor. The collection of the Bureau of Animal Industry is also rich in nematodes from rodents as a result of the work of Dr. Albert Hassall, an indefatigable collector, and of the policies of the present and former chiefs of the zoological division, Doctor Ransom and Doctor Stiles. Incidentally the increasing recognition of the importance of rodents, as reservoirs of disease and as destroyers of property of various sorts, lends additional value to a study of their parasites.

The inclusion of the Hyracoidea is quite casual. It is a small, rather isolated group that might be ignored in general works on the larger groups unless included, as here, without any particular reason.

Much of the material collected in this paper is in unsatisfactory shape. The older diagnoses are frequently worthless, and most modern authors have found it easier to describe a new *Strongylus* or *Ascaris* than to examine the literature for genera, old or new, that would fit the case and give readers some inkling as to what place the new parasite occupied. Recently the writer counted the species listed in the index catalogue of the Zoological Division of the United States Bureau of Animal Industry under the genus *Ascaris*. In round numbers there were a thousand species, many, of course, synonyms or errors. Under such conditions it is obvious that a new *Ascaris* will probably prove to be an ascarid in the most extended meaning of that general term, but it is unlikely that it will be congeneric with *Ascaris lumbricoïdes*. The same general rule holds for such a genus as *Strongylus*. In dealing with descriptions of this sort the writer has often been able to determine that whatever it was that an author had before him when he described his new *Ascaris* or *Strongylus* it was certainly not *Ascaris* or *Strongylus*. Unfortunately, such descriptions are almost always inadequate to show anything more than this. They have been worked into this paper as well as possible. The writer has taken the position that it is not incumbent on him or other workers to send to Europe or around the world for specimens of species where he is unable to obtain the essential or significant facts from the author's description. Such a pro-

cedure is proper, but it is a gratuitous task, not always feasible and not always to be encouraged. It is understood, of course, that generic concepts change, but this is all the more reason why modern workers should abandon the use of the old extended generic concept.

#### GENERAL REMARKS.

The nematodes known from rodents include representatives of all the large groups of parasitic nematodes and make up a considerable total of species. A number of species parasitic in such animals as the rat have a cosmopolitan distribution and have been recorded from practically everywhere that they have been looked for. Others are known only from obscure rodents in the heart of Africa or America. Many of them are of no known importance, while others, such as *Trichinella spiralis*, have long been known as medically important parasites of man, and others, such as *Gongyloplasma neoplasticum*, are of considerable medical and scientific interest.

The large groups of parasitic nematodes represented by rodent species were formerly regarded as families, but the recent tendency has been to bring together the genera which are closely related to form new families, and I have treated the old family groups as of superfamily rank.

I have not undertaken to give here any notes on the technique for the collection or study of nematodes. That topic has been well covered by other writers, one of the most recent studies being that of Ransom (1911a).

#### TAXONOMY AND MORPHOLOGY.

### Phylum NEMATHELMINTHES.

*Phylum diagnosis.*—Elongated, cylindrical, unsegmented worms. This phylum is a little difficult to characterize. It is commonly held to include three classes—the Nematoda, the Acanthocephala, and the Chaetognatha—but this grouping is based on convenience rather than on demonstrable affinities. The Nematoda may be looked on as the typical representatives of the phylum, as they constitute by far the most important and largest group.

#### Class NEMATODA.

*Class diagnosis.*—Nemathelminthes (p. 4): Body limited by a chitinous cuticle which may be either plain, striate, or ornamented with markings which may be simple or elaborate. A simple complete digestive system is present in typical forms, consisting of a terminal mouth at the anterior end of the body, followed by an esophagus, and this in turn by an intestine which terminates in an anus in the posterior portion of the body. The nervous system con-

sists of a nerve ring surrounding the esophagus and of the nerve cords directly or indirectly connecting with this ring. The sexes are usually separate, though there are a number of genera, especially in free-living forms, which are hermaphroditic, or what Cobb terms syngonic, a condition which perhaps grades into parthenogenesis in some forms. In syngonism the same gonad produces sperm cells and, later, eggs. The genital glands of both sexes are tubular structures lying in the body cavity. The males are usually smaller than the females and are usually equipped with chitinous copulatory organs known as spicules. Frequently the males have a membranous structure at the posterior extremity of the body known as a bursa. This structure reaches its highest development in the strongyliform nematodes. The vulva may be located anywhere on the ventral surface from near the mouth to near the anus. The ovary and uterus form a continuous structure. The ovary has the double function of an ovary (*s. str.*) and a vitellarium. There is no vitellarium distinct from the ovary. Usually there are two ovaries and uteri, but there may be more than two or only one. The worms may be oviparous (in which case the egg may or may not contain a developed embryo when oviposited), ovoviviparous, or viviparous. The word "ovoviviparous" is commonly used in two senses, the correct use referring to an egg in which the embryo develops and from which it later escapes while still in the uterus. The condition in which an egg containing a developed embryo is oviposited is here referred to as oviparous, with a specification as to the presence or absence of a developed embryo. The eggs are simple, not compound, and are usually ovoid or elliptical in outline.

ANALYTICAL KEY TO SUPERFAMILIES OF NEMATODA.<sup>1</sup>

1. No parasitic males. The parasitic females very small, not over 6 mm. long, and with not over 30 eggs in uterus; eggs ellipsoidal and with very thin shells.....Angiostomoidea, p. 6.  
Parasitic males and females, the latter commonly with more than 30 eggs in uterus..... 2.
2. Forms with the esophagus consisting of a chitinous tube which is embedded along the greater part of its length in a single row of cells. Male with a single spicule or without spicules. Female with a single uterus and ovary. Eggs, in oviparous forms, lemon-shaped, with rather thick shells, with an opening at each end closed by an opercular plug.  
Trichinelloidea, p. 9.  
Forms with esophagus composed of several cells arranged about a lumen. Male with 1 or 2 spicules. Female with 1 or more ovaries. Eggs without opercular plug, or rarely with an inconspicuous operculum..... 3.
3. Males provided with a well-developed membranous bursa supported by a system of rays typically consisting of 6 paired rays and 1 median dorsal

<sup>1</sup> In this paper the term *anterior* means toward the head, and *posterior* means toward the tail.

- unpaired ray; and with a buccal capsule present or absent in both sexes, or if the male is not provided with a well-developed bursa, the buccal capsule is usually present in both sexes; eggs usually (except one group) with thin shells.....Strongyloidea, p. 106.
- A buccal capsule never present (except in some fish parasites of the superfamily Filarioidea) and bursa never developed to the extent or in the form of the typical bursa of strongyles..... 4.
4. Usually comparatively thick in relation to length. Mouth usually with three lips, but may be without lips. Oviparous.....Ascaroidea, p. 39.
- Usually very long, slender forms. Mouth with 2 lips or surrounded with papillae. Oviparous, ovoviviparous, or viviparous.....Filarioidea, p. 178.

#### ANGIOSTOMOIDEA Hall, 1916, new superfamily.

*Superfamily diagnosis.*—Nematoda (p. 4): Two heterogenetic generations, one of free-living rhabditiform males and females and one of parasitic hermaphroditic, syngonic, or parthenogenetic filariform females.

*Type-family.*—Angiostomidae Braun, 1895.

#### Family ANGIOSTOMIDAE Braun, 1895.

*Synonym.*—Rhabdiasidae Railliet, 1915.

*Family diagnosis.*—Angiostomoidea (p. 6): With the characteristics of the superfamily.

*Type-genus.*—*Angiostoma* Dujardin, 1845.

Since this paper was written, Railliet (1915) has published a paper in which he places *Strongyloides* in the family Rhabdiasidae. This family is proposed by him casually and without comment, diagnosis, or indication that it is new, and the present writer is unable to state the grounds for this action. Previously Railliet (1893) had listed *Strongyloides* in the family Angiostomidae as given here.

#### Genus STRONGYLOIDES Grassi, 1879b.

*Synonyms.*—*Strongiloides* Grassi, 1879a; *Pseudo-rhabditis* Peronico, 1881.

*Generic diagnosis.*—Angiostomidae (p. 6): Parasitic form with mouth opening directly into the relatively very long subcylindrical esophagus. Mouth surrounded by small papillae, apparently six in number, according to Ransom (1911a) and surrounded by four lips, according to Gedoelst (1911). Cuticle finely striated transversely, sometimes presenting also the appearance of longitudinal striation. Vulva posterior of the middle of the body. Uterus double. Two ovaries. Eggs ellipsoidal, with thin shells. Free-living form with mouth opening into a vestibule or pharynx, followed by an esophagus of which the anterior portion is fusiform and the posterior portion is globular. The posterior bulb of the esophagus in the free-living form is furnished with a toothed masticatory apparatus. Free-living male with two short equal spicules.

*Type-species.*—*Strongyloides intestinalis* (Bavay, 1877) Grassi, 1879=*Strongyloides stercoralis* (Bavay, 1876).

**STRONGYLOIDES PAPILLOSUS** (Wedl, 1856) Ransom, 1911a.

*Synonyms.* — *Trichosomum papillosum* Wedl, 1856; *Rhabdonema longus* Grassi and Segré, 1887; *Strongyloides longus* (Grassi and Segré, 1887) Rovelli, 1888a.

*Specific diagnosis.*—*Strongyloides* (p. 6): *Parasitic generation.*—Length 3.5 to 6 mm., thickness 50 to 60  $\mu$ . Body (fig. 1) filiform, of nearly equal thickness throughout most of its length, gradually attenuated anteriorly to a diameter of about 15  $\mu$  at the head. Posterior end of body (fig. 2) diminished in size backward beginning some distance in front of the anus near the loop of the posterior ovary, then suddenly reduced just behind the anus, and terminating in a short slightly tapering tail with rounded tip. Esophagus increases gradually in size posteriorly, and is 650 to 800  $\mu$  long. Diameter of body at base of esophagus 40 to 50  $\mu$ .

Anus 55 to 70  $\mu$  from tip of the tail. Diameter of body at anus about 20  $\mu$ . Vulva (fig. 3) a transverse slit with rather salient lips situated 1.6 to 2 mm. from the posterior end of the body. Eggs ellipsoidal with very thin shells, 40 by 20  $\mu$  to 60 by 25  $\mu$  in diameter. Not more than a dozen or 15 fully formed eggs present in the two uteri at any one time. Eggs when passed in the feces of the host usually contain vermiform embryos which hatch in a few hours under suitable conditions of temperature.

*Free-living generation.*—*Male* undescribed. *Female* (fig. 4) 1 to

1.2 mm. long by 40  $\mu$  in thickness. Esophagus one-tenth to one-seventh of the total length of the body. Vulva with salient lips, near the middle of the body. Tail slender, acutely pointed. Anus about one-tenth of the length of the body from the posterior end. Eggs with thin shell, 65 by 30  $\mu$  in diameter.

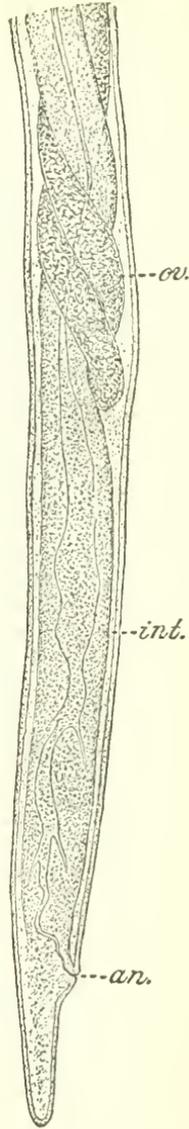


FIG. 2.—*STRONGYLOIDES PAPILLOSUS*. POSTERIOR END OF BODY OF PARASITIC ADULT. *an.*, ANUS; *int.*, INTESTINE; *ov.*, OVARY.  $\times 300$ . AFTER RANSOM, 1911.

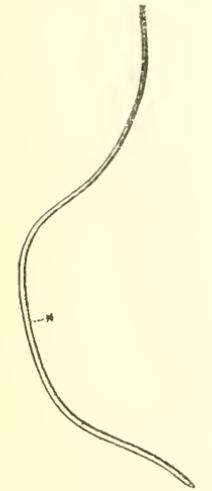


FIG. 1.—*STRONGYLOIDES PAPILLOSUS*. PARASITIC ADULT. \*VULVA.  $\times 15$ . AFTER RANSOM, 1911.

*Life history.*—The life history presents several possibilities:

*First.* The parthenogenetic female parasitic in the intestine produces eggs which are deposited in the epithelial cells lining the crypts and covering the villi in the small intestine. From these eggs embryos develop which transform to rhabditiform larvae, escape to the lumen of the intestine, and are passed out in the feces; outside of the body these become mature free-living males and females, mate, and produce free-living rhabditiform embryos; these transform into free-living filariform larvae, and these may enter the body of the host by the mouth or through the skin and develop into the parthenogenetic females.

*Second.* The parasitic female produces eggs, which give rise, as above, to rhabditiform larvae, which are passed out in the feces and there transform into filariform larvae; these latter infect the host animal, thus omitting the free-living adult stage.

*Third.* It is also thought that the parasitic female may give rise to rhabditiform larvae, which transform to filariform larvae in the intestine of the host, and by subsequent development to adults cause autoinfection.

*Hosts.*—*Oryctolagus cuniculus* (*Lepus cuniculus*), *Epimys norvegicus* (*Mus decumanus*), "and other rodents."

*Location.*—Small intestine.

*Localities.*—Europe. United States, ? South America.

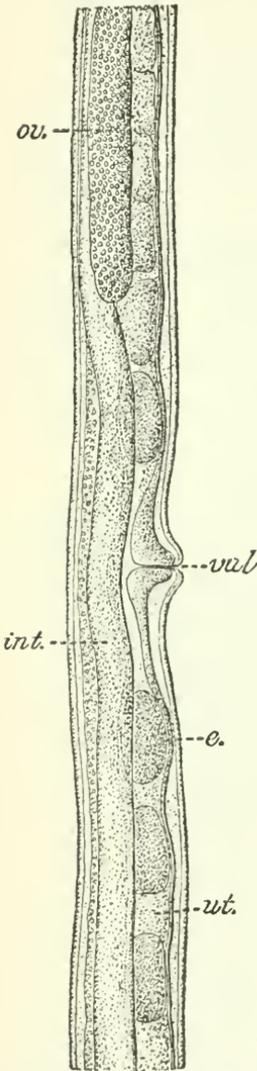


FIG. 3.—STRONGYLOIDES PAPILLOSUS. BODY OF PARASITIC ADULT IN REGION OF VULVA. *e.*, EGG; *int.*, INTESTINE; *ov.*, OVARY; *ut.*, UTERUS; *vul.*, VULVA.  $\times 300$ . AFTER RANSOM, 1911.

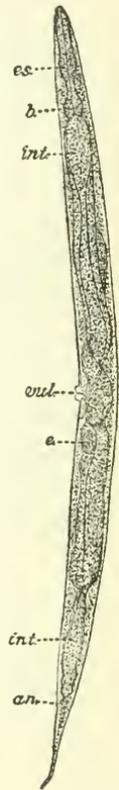


FIG. 4.—STRONGYLOIDES PAPILLOSUS. FEMALE OF FREE LIVING GENERATION. *an.*, ANUS; *b.*, POSTERIOR BULB OF ESOPHAGUS; *e.*, EGGIN UTERUS; *es.*, ESOPHAGUS; *int.*, INTESTINE; *vul.*, VULVA.  $\times 100$ . AFTER RANSOM, 1911.

In Ransom's (1911a) excellent monograph of the nematodes of ruminants he has covered this species so well that I have been able

to cover the topic to my satisfaction by practically transcribing his descriptions and figures. These are adequate for all purposes of identification, which is the standard proposed for this paper. Ransom has adequately discussed the literature relating to this worm, and I have adopted his views of the nomenclature as set forth in his paper.

STRONGYLOIDES species Parona.

I have seen a reference to *Strongyloides* species from a rodent, said to have been noted by Parona, but I have been unable to locate any paper by Parona covering this observation.

TRICHINELLOIDEA Hall, 1916, new superfamily.

*Superfamily diagnosis*.—Nematoda (p. 4): Esophagus consists of a chitinous tube which is embedded along the greater part of its length in a chain of single cells. The anterior portion of the body, occupied by the esophagus, usually very slender; the posterior portion, occupied by the intestine and reproductive organs, more or less swollen, or at least thicker than the anterior portion. Anus terminal or subterminal. Male with only one spicule or with no spicule. One testis. Female with one ovary. Vulva situated at the junction of the anterior and posterior portion of the body. Oviparous or ovoviparous. In digestive tract or adnexa or in urinary bladder as adults. Life history usually simple. Larva of at least one intestinal form penetrates to and encysts in the musculature of the host of the adult worm.

*Type-family*.—Trichinellidae Stiles and Crane, 1910.

Family TRICHINELLIDAE Stiles and Crane, 1910.

*Family diagnosis*.—Trichinelloidea (p. 9): Characters of the superfamily.

*Type-genus*.—*Trichinella* Railliet, 1895.

ANALYTICAL KEY TO SUBFAMILIES OF TRICHINELLIDAE.

1. Male with 1 spicule or at least with a copulatory sheath\_\_\_Trichurinae, p. 19.  
Male without spicule or copulatory sheath\_\_\_\_\_ 2.
2. Egg spherical, without true egg shell; ovoviviparous; males not parasitic in females; adult worms in digestive tract\_\_\_\_\_Trichinellinae, p. 10.  
Eggs variable in shape and with true, thick shell and opercular plugs; oviparous; males parasitic in the uterus of females; worms in kidney pelvis, ureters or in the urinary bladder\_\_\_\_\_Trichosomoidinae, p. 12.

## Subfamily TRICHINELLINAE Ransom, 1911a.

*Subfamily diagnosis.*—Trichinellidae (p. 9): Male without spicule. Female ovoviviparous; the spherical egg is surrounded with a delicate membrane and is without a true eggshell. Worms in the intestine of the host animal.

*Type-genus.*—*Trichinella* Railliet, 1895.

Genus TRICHINELLA Railliet, 1895.

*Generic diagnosis.*—Trichinellinae (p. 10): With the characters of the subfamily.

*Type-species.*—*Trichinella spiralis* (Owen, 1835) Railliet, 1895.

TRICHINELLA SPIRALIS (Owen, 1835) Railliet, 1895.

*Synonyms.*—*Trichina spiralis* Owen, 1835; *Trichina circumflexa* Polonio, 1860.

*Specific diagnosis.*—*Trichinella* (p. 10): Minute worms of nearly uniform diameter throughout, becoming somewhat thicker posteriorly. The small head has a round unarmed mouth which opens into a distinct tubular portion of the esophagus which in turn is followed by the chain of single cells characteristic of the superfamily. This is stated to be half of the length of the body, but is figured as quite a little more or less by various authors. It consists of a thin chitinous tube of triangular cross section, which is embedded in a string of vesicular cells, the individual cells thus surrounding the tube on all sides. These cells and the esophageal tube inclosed by them are surrounded by a common membrane. The cells may perhaps have the function of digestive glands. At the posterior end of the esophagus are two inconstant lateral appendages which have been taken for ceca, but which according to Leuckart are solid cell structures. Following the esophagus is the thin-walled intestine, flask-shaped at its origin. On the inner side flat cells are visible in places. The intestine terminates in the rectum, a muscular tube lined with chitin. In sexually mature males the rectum is

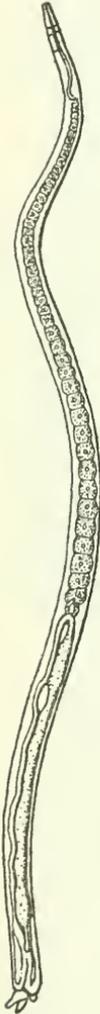


FIG. 5.—TRICHINELLA SPIRALIS. MALE. ENLARGED. AFTER LEUCKART, 1866.

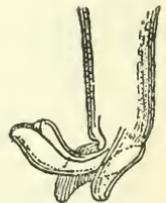


FIG. 6.—TRICHINELLA SPIRALIS. POSTERIOR EXTREMITY OF MALE, SHOWING EXTENDED CLOACA. ENLARGED. AFTER LEUCKART, 1866.

longer and its musculature thicker. The anus is terminal and in the form of a cleft.

*Male* (fig. 5) 1.4 to 1.6 mm. long by  $40\ \mu$  thick. The single testis originates in the posterior portion of the body and extends anteriorly to about the posterior end of the esophagus; here it turns back and becomes the vesicula seminalis, which terminates at the anal aperture to form a cloaca. This terminal portion of the vesicula and the cloaca can be protruded in copulation (fig. 6). Two conical projections (fig. 7),  $10\ \mu$  long, are situated one on each side of the cloaca. These are bent toward the ventral side and serve to hold the female in copula. Between these lie four papillae, the anterior pair hemispherical, the posterior pair conical.

*Female* (fig. 8) 3 to 4 mm. long by  $60\ \mu$  thick. The single ovary begins in the posterior end of the body, extends anteriorly for a short distance, and transforms into the uterus, which is clothed with a small-celled epithelium. The ovary and uterus appear to be separated by a constriction. The uterus transforms into the vagina near the posterior end of the esophagus, and as such extends forward to the vulva, which is on the ventral side near the middle of the esophagus and about one-fifth of the body length from the anterior end. The eggs are subspherical and are  $40$  by  $30\ \mu$  in diameter. There is a very delicate vitelline membrane, but no true eggshell. The embryos are developed in the uterus and escape from the surrounding membrane while there. The embryos are  $100$  to  $160\ \mu$  long by  $9\ \mu$  thick, the anterior end being the thicker and the worm decreasing in diameter toward the posterior end.

*Life history.*—The adult male and female trichinae copulate in the intestine of the host animal. The male then dies, while the female bores into the mucosa, in the glands of Lieberkühn, and attains the lymph spaces. Here the embryos are deposited, beginning about a week after the infection. The female lives five to six weeks longer

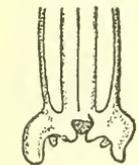


FIG. 7.—TRICHINELLA SPIRALIS. POSTERIOR EXTREMITY OF MALE, SHOWING CLASPING PROJECTIONS AND PAPILLAE. ENLARGED. AFTER LEUCKART, 1866.

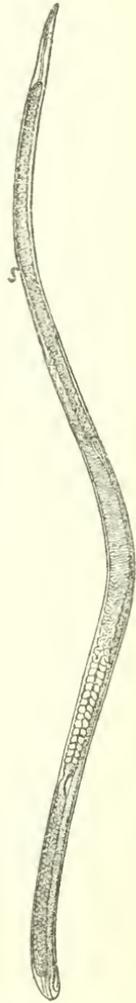


FIG. 8.—TRICHINELLA SPIRALIS. FEMALE. ENLARGED. AFTER LEUCKART, 1866.

and bears during this time 1,500 to 1,800 (Braun says 10,000) embryos. In part actively and in part passively, the embryos make their way by the lymphatic and blood channels throughout the entire body and finally come to rest in the voluntary muscles, where

they force their way from the intermusculature connective tissue into the sarcolemma. Here they show active movement and develop to the infective larval state. They attain a length of 800  $\mu$  to 1 mm. and a thickness of 30  $\mu$  and are found enrolled in a coil two to three weeks after the infection. The anterior portion of the larvae is now the thinner and more pointed, the posterior is thicker and rounded. The sex organs are rudimentary, but the two sexes can be differentiated. The larvae lie with the ventral surface toward the periphery of the cyst; in the female the primordium of the genitalia may be seen on the ventral side of the posterior portion of the esophagus; while in the male the genital primordium is on the dorsal surface. Farre's granules may also be seen in the female genitalia. These larvae are at first free inside the sarcolemma, later encapsuled and rolled in spirals, rings, or figures of eight. When the larval trichinae from the muscles are ingested by a suitable animal, the capsule is digested in the stomach and the larvae are set free. This may take place in 24 hours. These larvae enter the intestine and in one to five days become sexually mature. In three to four days after infection, the worms are found in copula. There are about 12 females to each male.

*Hosts.*—*Epimys norvegicus* (*Mus decumanus*), *Mus musculus*, *Mus albus*, *Oryctolagus cuniculus* (*Lepus cuniculus*), *Lepus europaeus* (*Lepus timidus*), *Cavia porcellus* (*Cavia cobaya*), *Cricetus cricetus* (*Cricetus frumentarius*), and numerous hosts in groups of mammals not covered in this paper.

*Location.*—Small intestine. Larvae in musculature.

*Locality.*—Cosmopolitan.

#### TRICHOSOMOIDINAE Hall, 1916, new subfamily.

*Subfamily diagnosis.*—Trichinellidae (p. 9): Males without spicule or sheath and parasitic in the vagina or uterus of females; eggs with opercular plug at each end and containing embryos when oviposited. In urinary bladder, ureters, and pelvis of kidney.

*Type-genus.*—*Trichosomoides* Railliet, 1895.

#### Genus TRICHOSOMOIDES Railliet, 1895.

*Synonyms.*—*Trichosoma* Rudolphi, 1819, of Bellingham, 1845, *Trichocephalus* Schrank, 1788, of Eberth, 1863; *Trichodes* von Linstow, 1874.

*Generic diagnosis.*—Trichosomoidinae (p. 12): With the characters of the subfamily.

*Type-species.*—*Trichosomoides crassicauda* (Bellingham, 1845) Railliet, 1895.

## TRICHOSOMOIDES CRASSICAUDA (Bellingham, 1845) Railliet, 1895.

*Synonyms.*—*Trichosoma crassicauda* Bellingham, 1845; *Trichosomum crassicauda* (Bellingham, 1845) Eberth, 1863; *Trichocephalus crassicauda* (Bellingham, 1845) Eberth, 1863; *Trichodes crassicauda* (Bellingham, 1845) von Linstow, 1874; *Trichosoma muris decumani* Bayer of Stossich, 1890.

*Specific diagnosis.*—*Trichosomoides* (p. 12): Male and female very dissimilar in size, the male commonly found parasitic in the vagina or uterus of the female. Anus terminal in both sexes.

*Male* 1.46 to 2.5 mm. long and 23 to 33  $\mu$  thick (figs. 9 and 10). Anterior terminal portion of esophagus devoid of cell body; according to von Linstow (1874), the portion of esophagus surrounded by the cell chain is equal in length to about half the total body length. The intestine has numerous fine refractive nuclei in its wall, these being especially prominent in somewhat macerated specimens. There is no spicule, bursa, or trace of copulatory organs of any sort, a lack correlated with the fact that the male lives in the vagina and uterus of the female. The single tubular testis originates in the anterior portion of the body and transforms into the vesicula seminalis which is filled with spermatozoa showing a small dark spherical nucleus.

*Female* 10.5 to 13 mm. long and attaining a maximum thickness in the posterior portion of the body of around 200  $\mu$  (figs. 10 and 11). Anterior 200 to 260  $\mu$  of esophagus devoid of a surrounding cell body, and followed by a short transitional portion where there is a gradually enlarging protoplasmic structure surrounding the chitinous central tube and continued by the cell body posteriorly.

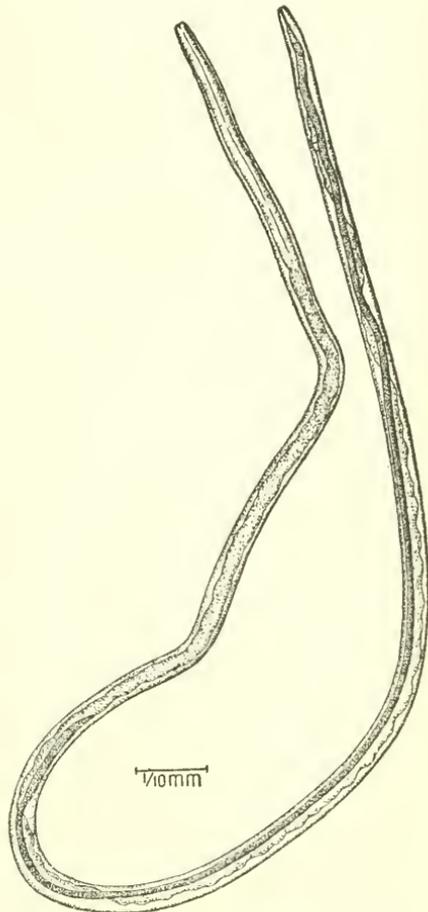


FIG. 9.—TRICHOSOMOIDES CRASSICAUDA. MALE.

The prevulvar portion of the body, or the esophageal portion, is equal in length to a little more than one-sixth of the entire body length. The head is rounded and is 20 to 22  $\mu$  in diameter. From the head the body enlarges gradually to the posterior end, which is rounded or bluntly conical. In mature females the cuticle is usually smooth for a short distance posterior of the head and is then transversely striated, the striations showing in profile as serrations in some cases, but usually presenting the appearance of hemispherical beading (figs. 10 and 13). The vulva (figs. 12 and 13) is ventral, just posterior of the posterior termination of the esophagus, and forms a transverse slit at the summit of a more or less prominent cone. The portion of the body following the vulva is marked for a distance of 3 to 4 mm. by a series of irregularly arranged, hemispherical to fungi-form cuticular elevations (figs. 14 and 15) in three or four rows along the ventral surface. These elevations are usually conspicuous; in the freshly collected worms they are clear and refractive hyaline structures, but in alcoholic material they

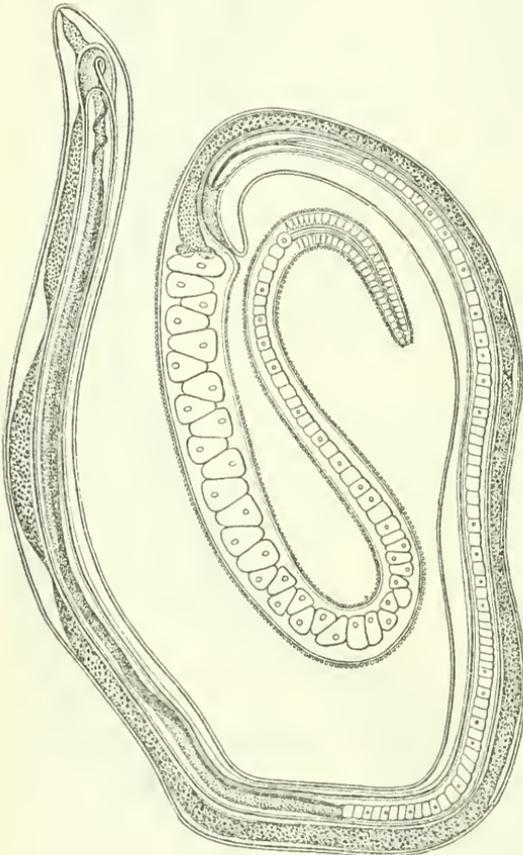


FIG. 10.—*TRICHOSOMOIDES CRASSICAUDA*. YOUNG FEMALE WITH MALE IN VAGINA. ENLARGED. AFTER VON LINSTOW, 1874.

are often dark and in one glycerin mount they are a reddish brown; they are round to oval in shape and 4 to 13  $\mu$  in diameter. Another row of smaller inconspicuous elevations, about 2  $\mu$  in diameter, may be seen in the vicinity of the vulva, extending for a short distance anteriorly and posteriorly (fig. 15). The uterus extends to the posterior end of the worm and then turns forward, the uterus and ovary forming a series of loops with the long axis parallel, in a general way, to that of the worm (fig. 16). The eggs (fig. 17) are strikingly variable,

especially along the short diameter, ranging from subspherical to cylindrical, and are 62 to 72  $\mu$  long and 25 to 56  $\mu$  wide; the opercular

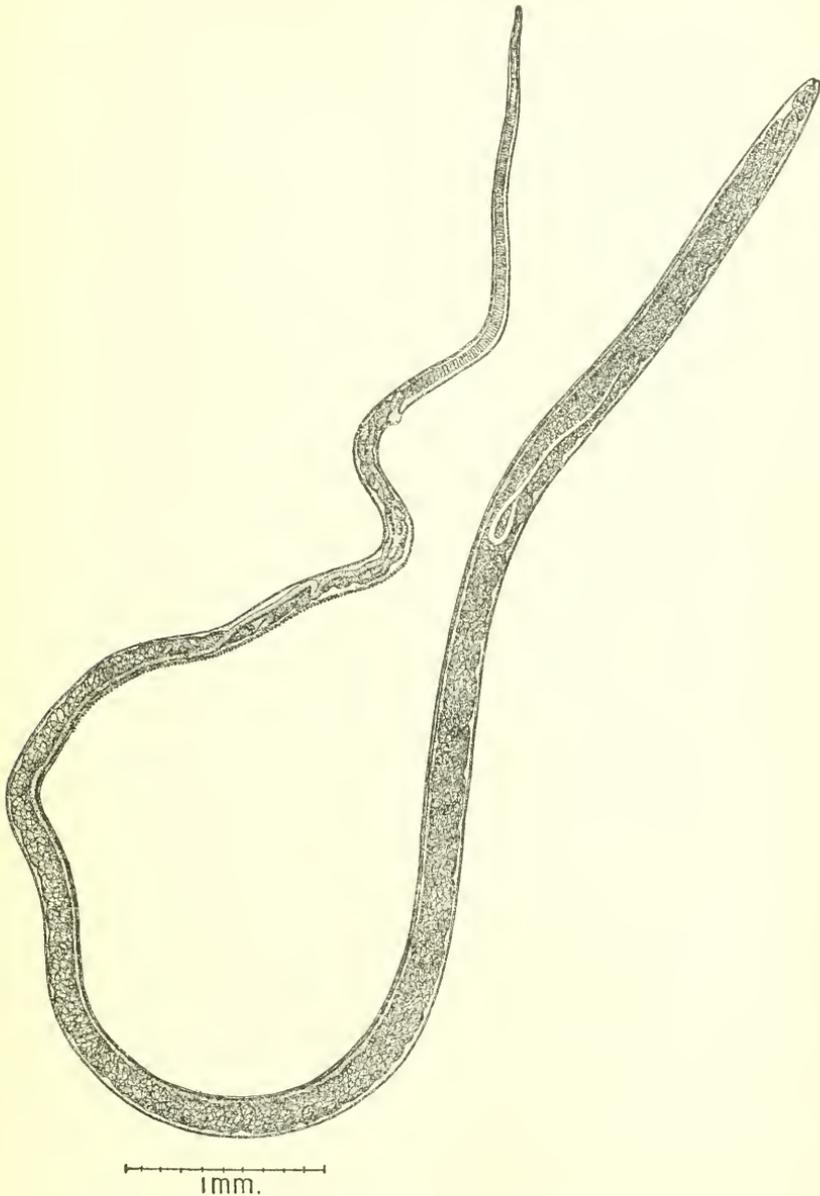


FIG. 11.—*TRICHOSOMOIDES CRASSICAUDA*. MATURE FEMALE WITH MALE IN UTERUS.

plugs are not prominent; the eggs become dark brown in the vagina and here also may be seen what is apparently extra shell material being passed out. Eggs contain embryos when oviposited.

*Life history.*—The eggs containing embryos are passed in the urine of infected animals and are apparently ingested by other rats in contaminated food or water. In the stomach of the new host the shell digests off and the embryos escape. I have seen embryos escape from the shell in the vagina of the female after the worm had been in normal salt solution a short time, and I judge from this fact and from the fact that such embryos seemed to live only a short time that infection must take

place in a rather short period as a rule, or else the embryo perishes. The embryo has a body of almost uniform thickness, terminating in bluntly rounded ends, so far as my observation goes (fig. 18), but provided with a single lancetlike process anteriorly, according to von Linstow (fig. 19). Von Linstow suggests that the embryos may bore into the wall of the digestive tract and make their way to the pelvis of the kidney, possibly by way of the blood stream and the renal artery particularly. Sexually undeveloped individuals, the males but little smaller than the females, are found in the pelvis of the kidney and copulation



FIG. 12.—TRICHOSOMOIDES CRASSICAUDA. VULVA REGION OF FEMALE. ENLARGED.

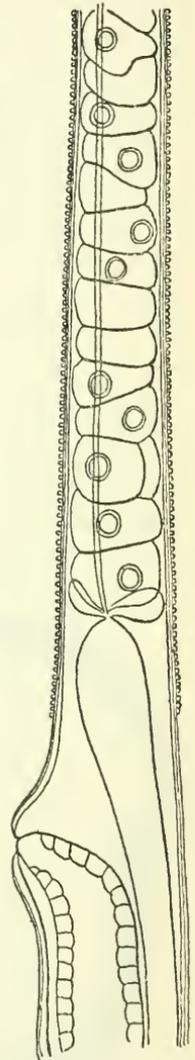
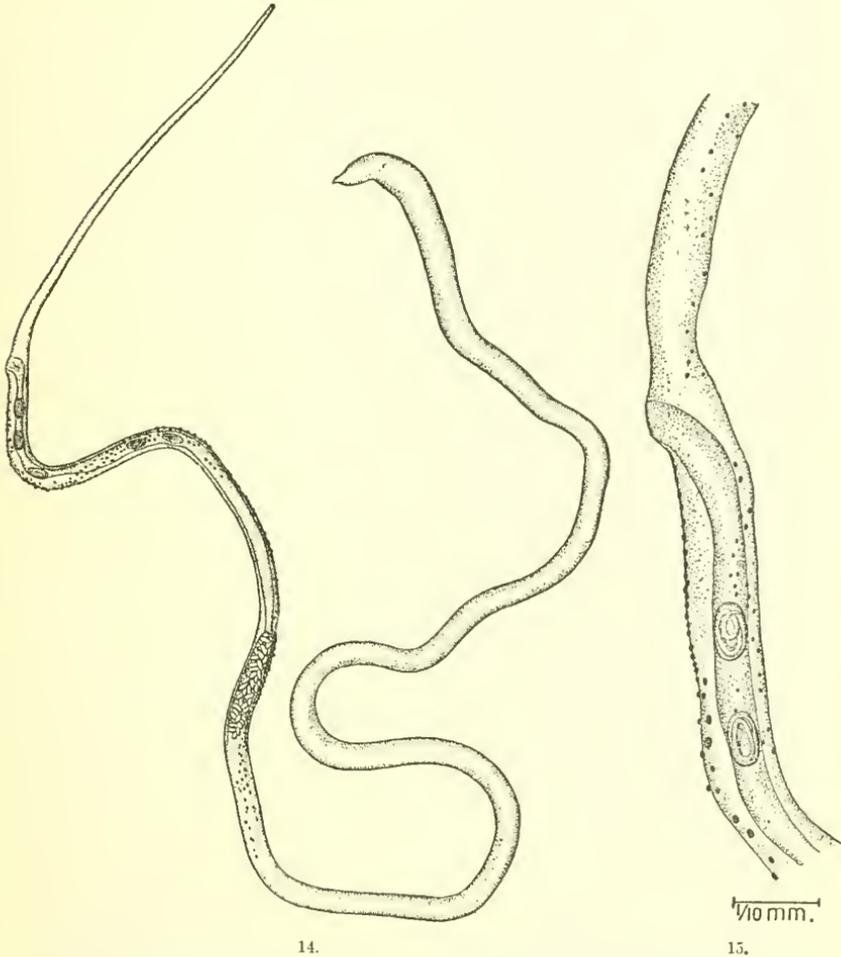


FIG. 13.—TRICHOSOMOIDES CRASSICAUDA. VULVA REGION OF FEMALE. ENLARGED. AFTER EBERTH, 1863.

takes place in the ureters, the females becoming larger and the males entering the vagina. The first male turns about after entrance and, according to von Linstow, is always found with its head toward the vulva. The fertilized females pass to the urinary bladder and grow

considerably, the esophagus taking little part in this growth, and the male coming to lie in the mass of eggs in the uterus. I have commonly found only one male in a female; von Linstow states that there may be three or four and occasionally as many as six.



FIGS. 14, 15.—*TRICHOSOMOIDES CRASSICAUDA*. 14, FEMALE SHOWING EXTENT OF CUTICULAR MARKINGS, ENLARGED. 15, VULVA REGION OF FEMALE, SHOWING CUTICULAR MARKINGS.

*Hosts*.—*Epimys rattus* (*Mus rattus*), *Epimys norvegicus* (*Mus norvegicus*, *Mus decumanus*).

*Location*.—Pelvis of kidneys, ureters, and urinary bladder.

*Localities*.—Ireland, Germany (Offenbach), Austria (Trieste, Ratzeburg), France (Paris), Australia (Brisbane), United States

(Washington, District of Columbia; Lincoln, Nebraska; San Francisco, California).

The *Trichosoma muris decumani* Bayer referred to by Stossich (1890) is probably a reference to this worm in a paper by Rayer (1843).

Von Linstow (1874) has made a study of this worm, and made it the type of his new genus *Trichodes*. Unfortunately this generic name was already preoccupied by *Trichodes* Herbst, 1792, coleopteron, hence the change by Railliet, 1895, to *Trichosomoides*. Von Linstow has noted in the esophageal cell chain that in many places there were alternately darker cells with large nuclei and lighter cells filled with quite small punctiform nuclei which showed a lively molecular movement. The cell content of the latter must therefore have been fluid. I find the esophageal cell body actively contractile and the cells full of large, clear granules.

Eberth (1863) and von Linstow (1874) have both described dorsal, ventral, and lateral bacillary bands. They also agree in a general way that the prevulvar portion of the body is covered with small hyaline hemispherical elevations at regular intervals. My observation is to the effect that there is a dorsal and ventral band of cuticular elevations, of which the one regarded here as ventral is the more conspicuous, but these bands are apparently rather different in

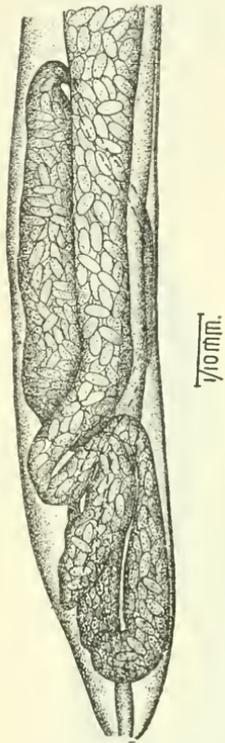


FIG. 16.—TRICHOSOMOIDES CRASSICAUDA. POSTERIOR EXTREMITY OF FEMALE.

structure from the usual bacillary band, although their presence in this family would indicate that they were to be homologized with

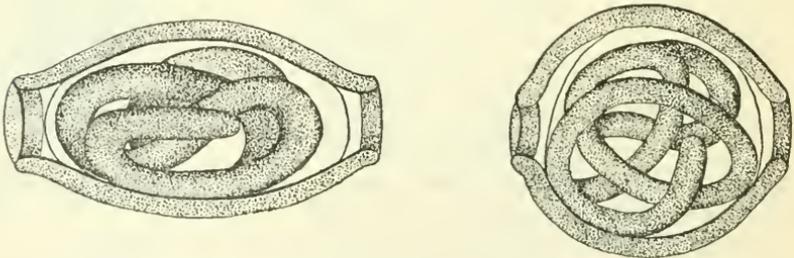


FIG. 17.—TRICHOSOMOIDES CRASSICAUDA. EGGS CONTAINING EMBRYOS, SHOWING VARIATIONS IN SHAPE. ENLARGED. AFTER VON LINSTOW, 1874.

the customary bacillary band. The hemispherical elevations noted in the prevulvar portion of the body are apparently to be seen only in profile and are due to deep cuticular annulations.

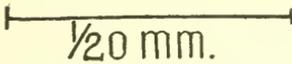
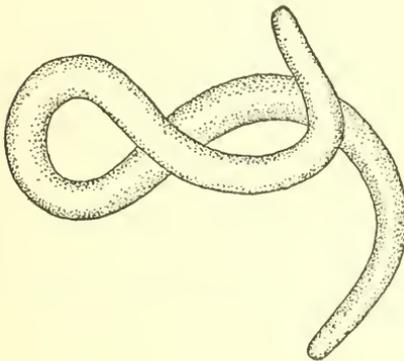


FIG. 18.—TRICHOSOMOIDES CRASSICAUDA. EMBRYO.

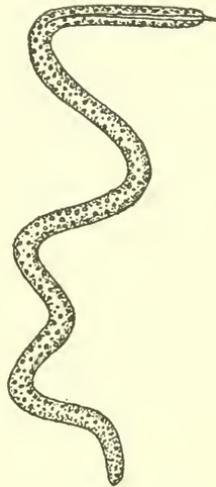


FIG. 19.—TRICHOSOMOIDES CRASSICAUDA. EMBRYO. AFTER VON LINSTOW, 1882.

Subfamily TRICHURINAE Ransom, 1911a.

*Synonym.*—Capillariinae Railliet, 1915, in part.

*Subfamily diagnosis.*—Trichinellidae (p. 9): Male with one spicule, or, exceptionally, with only a copulatory sheath. Eggs lemon-shaped, the apertures at each end closed with opercular plugs. Development, so far as known, direct and without intermediate host. Egg development often slow. Eggs with thick shell; do not hatch until swallowed by a suitable host.

*Type-genus.*—*Trichuris* Roederer, 1761.

ANALYTICAL KEY TO GENERA OF TRICHURINAE.

1. Anterior esophageal region of body very slender and longer than the posterior portion, which is much thicker and contains the reproductive organs.....*Trichuris*, p. 20.
- Anterior esophageal portion of body shorter than, rarely equal to, the posterior portion, which is only slightly thicker..... 2.
2. Worms with spicule; in digestive tract or urinary bladder, ducts, etc.....*Capillaria*, p. 33.
- Worms without spicule; in liver.....*Hepaticola*, p. 30.

## Genus TRICHURIS Roederer, 1761.

*Synonyms.*—*Trichocephalos* Goeze, 1782; *Trichocephalus* Schrank, 1788; *Mastigodes* Zeder, 1800; *Tricocephalos* Lamarck, 1801; *Trichuris* Roederer and Wagler, 1761, of Stiles and Hassall, 1905.

*Generic diagnosis.*—Trichurinae (p. 19): Anterior esophageal portion of body very slender and longer than the posterior portion, which is much thicker and contains the reproductive organs. Posterior extremity of body blunt and rounded. Anus terminal or subterminal. On the ventral surface of the anterior esophageal portion of the body is a longitudinal bacillary band, terminating near the union of the anterior and posterior portions of the body, and formed of punctiform projections which are the ends of small rodlike structures originating in subcuticular cells and penetrating the cuticle. The cuticle has transverse striations forming annuli, which have the posterior edges projecting slightly in such a way as to give the body a finely serrate appearance in profile. This striation is absent from the ventral surface covered by the bacillary band.

*Male.*—Posterior portion of body rolled dorsally in a spiral. Spicule surrounded by a prepuce-like sheath, which evaginates when the spicule is protruded. The sheath is a soft structure of variable shape and size. External surface of the evaginated sheath smooth or covered with spines.

*Female.*—Posterior portion of body may be slightly curved, but not rolled into a spiral. Vulva near the union of the anterior slender portion and the posterior thick portion of the body. Eggshell thick, usually brown, and with the opening at each end of the shell closed with an opercular plug, giving the egg the characteristic lemon shape.

*Type-species.*—*Trichuris trichiura* (Linnaeus, 1767) Stiles, 1901.

## ANALYTICAL KEY TO SPECIES OF TRICHURIS.

1. No description whatever.....*Trichocephalus castoris*, p. 21.  
Described species..... 2.
2. Anterior and posterior portions of body of almost equal length.  
*Trichuris gracilis*, p. 23.  
Anterior portion of body longer than posterior..... 3.
3. Ratio of length of anterior portion of body to length of posterior portion 2 : 1  
or 3 : 1, minimum length around 50 mm.....*Trichuris ovis*, p. 28.  
Ratios smaller than the above, or minimum length less..... 4.
4. Female contorted, not straight or curved.....*Trichuris contorta*, p. 21.  
Female straight or curved, not contorted..... 5.
5. Maximum length of spicule 7 mm.....*Trichuris leporis*, p. 24.  
Maximum length of spicule not over 2 mm..... 6.
6. Worms 44.6 to 52.1 mm. long.....*Trichuris infundibulus*, p. 23.  
Worms not over 35 mm. long..... 7.
7. Spicule less than 1 mm. long; ratio of anterior to posterior body lengths 5 : 3  
in male and 7 : 4 in female.....*Trichuris muris*, p. 26.  
Spicule more than 1 mm. long..... 8.

8. Posterior body lengths only slightly smaller than anterior; spicule 1.7 mm. long-----*Trichuris fossor*, p. 21.  
 Posterior body lengths about half of anterior; spicule 2 mm. long.  
*Trichuris opaca*, p. 27.

The data on described species of *Trichuris* are so scarce that the above key, based on the limited and little diagnostic features described, may prove of little value in actual practice.

TRICHOCEPHALUS CASTORIS Rudolphi, 1819.

*Specific diagnosis.*—*Trichuris* (p. 20): Characters of the genus. No description.

*Host.*—*Castor fiber*.

*Location.*—Large intestine.

*Locality.*—Not given.

Rudolphi (1819) lists this under *Species dubiae* and states that there is a female specimen in the Vienna Museum. He does not describe it, and von Linstow (1909a) states that the species is not described. The name is therefore a *nomen nudum* and I have not made the combination with the specific name and the valid generic name *Trichuris* in order to avoid adding useless synonyms to the literature.

TRICHURIS CONTORTA (Rudolphi, 1819) Hall, 1916.

*Synonyms.*—*Trichocephalus contortus* Rudolphi, 1819.

*Specific diagnosis.*—*Trichuris* (p. 20): Characters of the genus. strongly contorted, the considerable folding giving a transient verucous appearance. Ratio of length of anterior esophageal portion of body to length of posterior portion 12:10.

*Male* 40 mm. long. The flesh-colored body convolute, but not spiral. Posterior portion of body terminates very bluntly. The cloaca is ventral and subterminal. The spicule sheath is short, broad, and truncate. The spicule is narrow and curved.

*Female* 50 mm. long. Body contorted, not, as is usually the case, straight or curved. Tail rather pointed. Oviduct black. Eggs elliptical with the usual opercular plugs.

*Hosts.*—*Georychus capensis* (*Georhynchus capensis*, *Mus capensis*, "*Georhynchus illigeri*").

*Location.*—Cecum.

*Locality.*—Cape of Good Hope, Africa.

TRICHURIS FOSSOR Hall, 1916, new species.

*Synonym.*—*Trichuris* species Hall, 1912.

*Specific diagnosis.*—*Trichuris* (p. 20): Head conical, about 40  $\mu$  in diameter where the sides of the cone tend to flatten into the neck

portion. Mouth simple. Diameter of bacillary band in anterior esophageal region about one-third that of esophageal portion. The esophageal cell chain consists of elongate cells with prominent nuclei. A few of the more anterior cells are of simple outline, but the others have numerous constrictions along their length, giving the appearance of numerous small discoidal cells with occasional nuclei. These nuclei are actually near the middle of the cells. The piriform glands at the posterior end of the esophagus are small.

*Male* 17.5 to 20 mm. long, with a maximum thickness of 516  $\mu$ . Anterior esophageal portion of body 10.8 to 10.9 mm. long; posterior

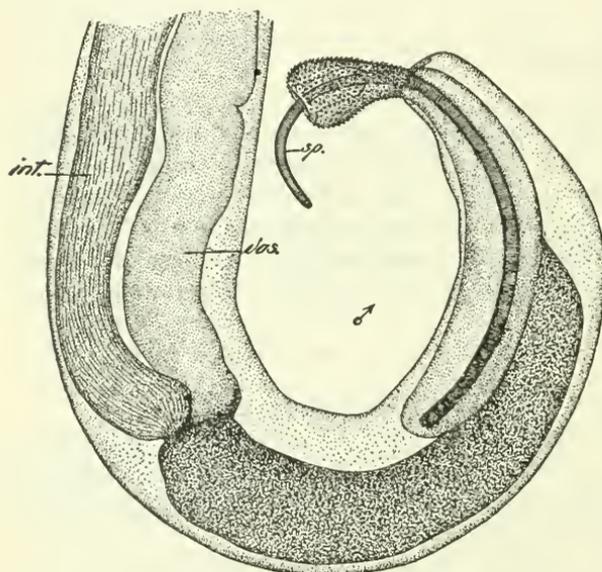


FIG. 20.—TRICHURIS FOSSOR. POSTERIOR EXTREMITY OF MALE. ENLARGED. *int.*, INTESTINE; *sp.*, SPICULE; *vas.*, VESICULA SEMINALIS.

portion of body 6.6 to 9.2 mm. long. The anterior portion of the esophageal tube from the mouth to the beginning of the esophageal cell chain is 400 to 670  $\mu$  long. The body ends posteriorly in a bifurcation formed by two rounded lobes (fig. 20), with the cloacal aperture on the posterior ventral surface between them. Spicule 1.7 mm.

long with a diameter of 26  $\mu$  at the distal end, gradually thickening to a diameter of 52  $\mu$  at the proximal end. The campanulate sheath evaginates to a distance of at least 300  $\mu$  and is studded with small conical projections.

*Female* 24 mm. long, with a maximum diameter of 380  $\mu$ . (Probably becomes larger, judging from male diameter.) Anterior esophageal portion of body 12.4 mm. long; posterior portion of body 11.6 mm. long. The anterior portion of the esophageal tube from the mouth to the beginning of the esophageal cell chain is 560  $\mu$ . The anus is subterminal on the ventral surface. The vulva is situated just back of the posterior end of the esophagus. Eggs not observed. Two specimens, apparently immature females of this species, were collected from the same host. On first sight they appear to be species of *Capillaria*, but the ratios of the anterior and posterior body parts

argue against this. One specimen is 10.5 mm. long, of which the anterior esophageal portion is 6.88 mm., while the other specimen is 8.6 mm. long, of which the anterior esophageal portion is 6 mm.

*Host*.—*Thomomys fessor*.

*Location*.—Cecum.

*Locality*.—Crested Buttes, Colorado, and Livermore, Colorado.

*Type material*.—Cat. No. 16179, U.S.N.M. (Bureau of Animal Industry helminthological collection).

These specimens were collected by the writer from alcoholic material collected by Mr. E. R. Warren, of Colorado Springs, and were reported by the writer in 1912 in a list of parasites from Colorado.

TRICHURIS GRACILIS (Rudolphi, 1819) Hall, 1916.

*Synonym*.—*Trichocephalus gracilis* Rudolphi, 1819.

*Specific diagnosis*.—*Trichuris* (p. 20): Whitish, capillary portion darkening anteriorly. Head acute. Anterior esophageal portion of body scarcely longer than posterior portion.

*Male* unknown.

*Female* 47 to 54 mm. long. Posterior portion of body relatively slender, slightly curved, blunt posteriorly.

*Host*.—*Dasyprocta aguti* (*Cavia agouti*).

*Location*.—Cecum.

*Locality*.—Brazil.

TRICHURIS INFUNDIBULUS (von Linstow, 1906) Hall, 1916.

*Synonym*.—*Trichocephalus infundibulus* von Linstow, 1906.

*Specific diagnosis*.—*Trichuris* (p. 20): Diameter of bacillary band equals two-thirds of the diameter of body.

*Male* 44.6 mm. long with a maximum thickness of 790  $\mu$ . Ratio of length of anterior esophageal portion of body to length of posterior portion is 7:6. Spicule 1.94 mm. long and 26  $\mu$  thick, gradually thinning to a point posteriorly. The sheath has transverse folds at its base and widens in a funnel opening posteriorly (fig. 21). (These folds may be transient rather than constant.) It is studded with little shining cones of equal size, set close together and directed posteriorly. The posterior body is in two parts. (This last

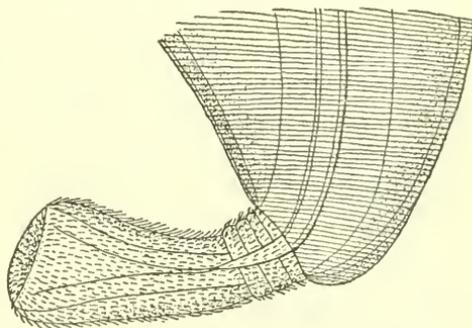


FIG. 21.—TRICHURIS INFUNDIBULUS. POSTERIOREXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1906.

(This last

statement would lead one to suppose that the body terminated in two lobes as in *Tr. fossor*, but von Linstow's figure does not bear out this idea.)

*Female* 52.1 mm. long with a maximum thickness of 1.03 mm. Ratio of length of anterior esophageal portion of body to length of posterior portion is 10:6. Eggs 62  $\mu$  long and 25  $\mu$  wide.

*Host.*—*Hystrix cristata*.

*Location.*—Intestine.

*Locality.*—Not given.

This species was described by von Linstow from the Zoological Museum at Koenigsberg. Diesing lists *Trichuris ovis* from this same host, *Hystrix cristata*, and von Linstow notes that such a record does not seem plausible.

**TRICHURIS LEPORIS (Froelich, 1789) Hall, 1916.**

*Synonyms.*—*Trichocephalus leporis* Froelich, 1789; *Mastigodes leporis* (Froelich, 1789) Zeder, 1803; *Trichocephalus unguiculatus* Rudolphi, 1809.

*Specific diagnosis.*—*Trichuris* (p. 20): Bacillary band (fig. 22) about four-fifths of body diameter and extending to below the vagina. Head 17 to 20  $\mu$  diameter. Transverse striations of cuticle at intervals of about 4 to 5  $\mu$ . On each side of bacillary band an area of delicate cuticular plaques (fig. 23).

*Male* 29 to 32 mm. long, with a maximum diameter of about 430  $\mu$ . Body white. Ratio of length of anterior esophageal portion of body to length of posterior portion of body is 3:2. Length of esophageal tube from mouth to anterior end of esophageal cell chain about 825  $\mu$ . Esophageal cell chain begins as two or three simple long cells, with not very prominent nuclei, and continues posteriorly as long cells with numerous constrictions along their length, giving the appearance of numerous small discoidal cells with occasional nuclei. Spicule of variable length, 1.87 to 7 mm. long, and with a diameter of about 80

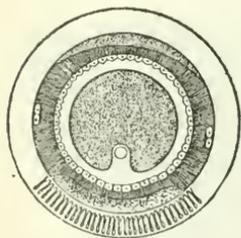


FIG. 22.—TRICHURIS LEPORIS. CROSS-SECTION OF THE ESOPHAGEAL PORTION OF THE BODY, SHOWING THE PROMINENT VENTRAL BACILLARY BAND AND THE RELATION OF THE ESOPHAGEAL TUBE TO THE CELL BODY. ENLARGED. AFTER EBERTH, 1863.



FIG. 23.—TRICHURIS LEPORIS. ANTERIOR EXTREMITY OF BODY, SHOWING CUTICULAR PLAQUES. ENLARGED. AFTER SCHNEIDER, 1866.

$\mu$  near the proximal end, thinning to about 8  $\mu$  near the distal end. The sheath (fig. 24) is very narrow and diaphanous, attaining a

length of 1.55 mm. and a breadth of about  $52\ \mu$  near the distal end; proximally it has a diameter for the most part but slightly in excess

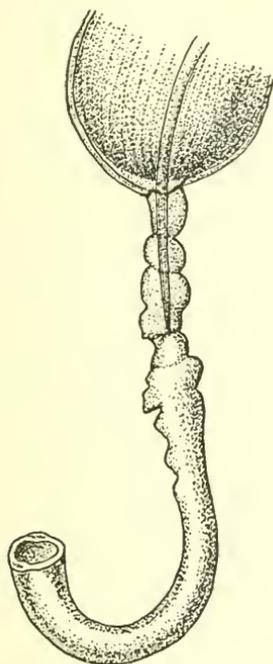


FIG. 24.—TRICHURIS LEPORIS. POSTERIOR EXTREMITY OF MALE, SHOWING SHEATH AND SPICULE. ENLARGED. AFTER SCHNEIDER, 1866.

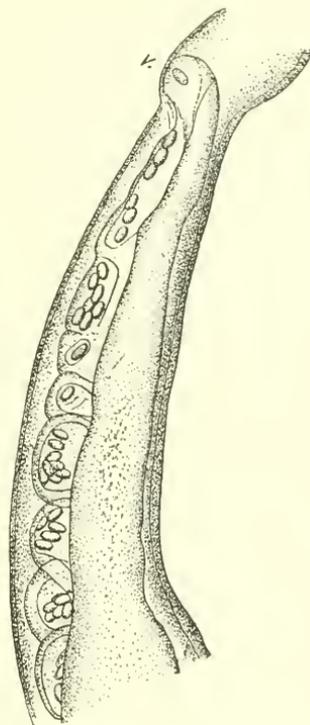


FIG. 25.—TRICHURIS LEPORIS. VULVA (v) REGION OF FEMALE, SHOWING POCKETING IN VAGINA. ENLARGED.

of the surrounded spicule. Toward the distal extremity the sheath is covered with delicate colorless punctations.

*Female* 32 to 24.5 mm. long, with a maximum diameter of about 1.12 mm. Anterior esophageal (prevulvar) portion of body white; posterior (postvulvar) portion brownish. Ratio of length of anterior portion to posterior portion 2:1. The vagina appears to comprise a series of pouches or pockets (fig. 25). Eggs  $56\ \mu$  long, including the opercular plugs;  $52\ \mu$  long, excluding the opercular plugs. The external surface of the shell is delicately punctate (fig. 26).

*Hosts*.—*Oryctolagus cuniculus* (*Lepus cuniculus domesticus*, *L. c. ferus*), *Lepus europaeus* (*Lepus timidus*), *Lepus timidus* (*Lepus variabilis*), *Sylvilagus floridanus*, *Sylvilagus floridanus mallurus*, *Citellus citellus* (*Arctomys citillus*, *Spermophilus citillus*).

*Location*.—Large intestine.



FIG. 26.—TRICHURIS LEPORIS. EGG. ENLARGED. AFTER STOSSICH, 1896.

*Localities.*—Germany, France, Switzerland, Austria, Italy, United States.

The amount of variation in the reported spicule lengths suggests the possibility of error in measurement or confusion of species.

TRICHURIS MURIS (Schrank, 1788) Hall, 1916.

*Synonyms.*—*Trichocephalus muris* Schrank, 1788; *Mastigodes muris* (Schrank, 1788) Zeder, 1803; *Trichocephalus nodosus* Rudolphi, 1809.

*Specific diagnosis.*—*Trichuris* (p. 20): Diameter of the bacillary band equals three-fourths of the diameter of the body. Bacillary band ends in front of the vulva. Band is bordered with large marginal rods which are larger than the others and are capable of swelling by endosmosis. Simple weak lateral lines. Granular dorsal



FIG. 27.—TRICHURIS MURIS. ANTERIOR EXTREMITY OF BODY, SHOWING CUTICULAR VESICLES. ENLARGED. AFTER GOEZE, 1782.

line disappearing near vulva. Maximum head diameter 18  $\mu$ . Transverse striations of body at 4 to 5  $\mu$  intervals. There are three nodules on the head, according to Goeze (1782) and Rudolphi (1809). There are also seven or eight delicate cuticular vesicles (fig. 27) along the (?ventral) side of the worms, according to Goeze (1782) and Eberth (1863). The esophageal tube extends a third of the length of the anterior esophageal portion of the body before being surrounded by the esophageal cell chain.

*Male* 14 to 20 mm. long with a maximum thickness of 300  $\mu$ . Anterior esophageal portion of body 12.5 mm. long; posterior portion of body 7.5 mm. long. Ratio of lengths of two portions 5:3. Spicule 760  $\mu$  long and 15  $\mu$  wide, bent in a semicircle (fig. 28). The sheath is 170  $\mu$  long and presents various shapes, vesicular, tubular, funnel-shaped or terminating in a large turbanlike swelling 100  $\mu$  in diameter. Except at its aperture, this sheath is covered with pointed conical projections. A blunt papilliform projection on each side of the cloacal aperture.

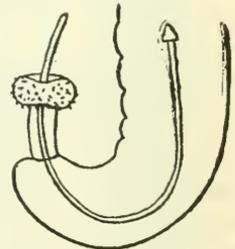


FIG. 28.—TRICHURIS MURIS. POSTERIOR EXTREMITY OF MALE, SHOWING SPICULE AND SHEATH. ENLARGED. AFTER VON LINSTOW, 1909.

*Female* 23 to 31 mm., with a maximum thickness of 400  $\mu$ . Anterior esophageal portion of body 14 to 20 mm. long; posterior portion of body 8 to 11 mm. long. Ratio of lengths of two portions 7:4. Tail obtuse, terminating in a rounded point. The vulva round, lo-

cated at the union of the esophagus and the intestine. Eggs lemon-shaped, 57 to 62  $\mu$  long.

*Hosts.*—*Mus musculus*, *Epimys rattus* (*Mus rattus*), *Arvicola amphibius* (*Mus amphibius*), *Apodemus sylvaticus* (*Mus sylvaticus*), *Epimys ugandae* (*Mus ugandae*), *Microtus arvalis* (*Arvicola arvalis*, *Mus arvalis*), *Thrichomys apercoides* (*Echinomys anticola*), *Holochilus physodes* (*Hesperomys physodes*), *Holochilus brasiliensis* (*Holochilomys brasiliensis*), *Arricanthis abyssinicus*, *Isothria bistrata* (*Loncheres bistrata*), *Georychus capensis* (*Georhynchus capensis*).

*Location.*—Cecum.

*Localities.*—France (Paris), Germany, Africa (Toro, Fort Portal).

TRICHURIS OPACA Barker and Noyes, 1915.

*Specific diagnosis.*—*Trichuris* (p. 20): Body cylindrical, stiff, opaque; anus a little subterminal.

*Male* 22 to 28 mm. long; esophageal region 13 to 19 mm. long and 60 to 80  $\mu$  thick; body region 7 to 9 mm. long and 140 to 160  $\mu$  thick (fig. 29). Posterior end rolled into a spiral (fig. 30). Spicule 2 mm. long and 17  $\mu$  thick, surrounded by a sheath covered with minute blunt projections; sheath, when evaginated, 180  $\mu$  long and 70  $\mu$  in diameter.

*Female* 22

to 30 mm. long; esophageal region 18 to 19 mm. long and 60 to 70  $\mu$  thick; body region 10 to 11.1 mm. long and 230 to 250  $\mu$  thick (fig. 31). Posterior portion slightly

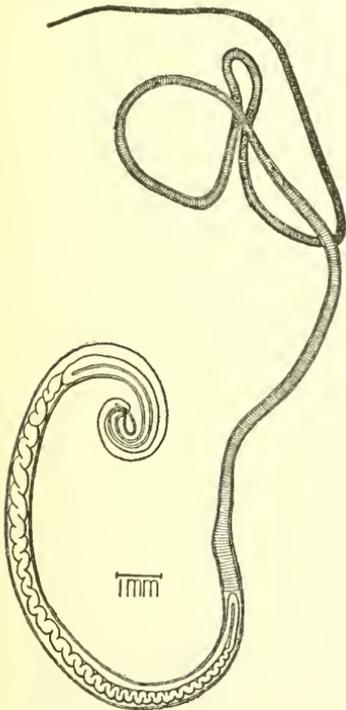


FIG. 29.—TRICHURIS OPACA. MALE. AFTER BARKER, 1915.

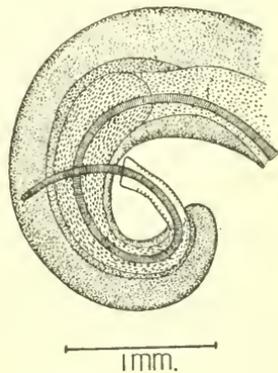


FIG. 30.—TRICHURIS OPACA. POSTERIOR EXTREMITY OF MALE. AFTER BARKER, 1915.

curved. Vulva between first and second anterior elevenths of body region. Anus nearly terminal.

*Host.*—*Ondatra zibethica* (*Fiber zibethicus*).

*Location*.—Duodenum.

*Locality*.—United States (Nebraska).

This parasite, described in a paper by Barker (1915), is reported, as noted, from the duodenum, a most unusual location for a worm of this genus. His indicated magnifications do not agree with the text.

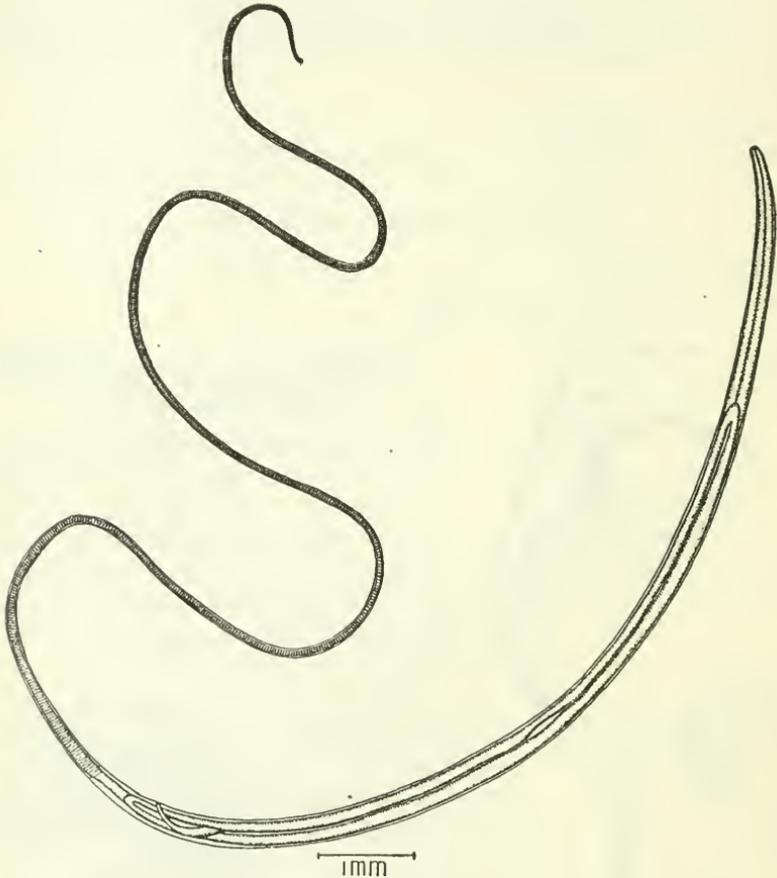


FIG. 31.—TRICHOURIS OPACA. FEMALE. AFTER BARKER, 1915.

**TRICHOURIS OVIS** (Abildgaard, 1795) Smith, 1908.

*Synonyms*.—*Trichocephalus ovis* Abildgaard, 1795; *Trichocephalus affinis* Rudolphi, 1802; *Mastigodes affinis* (Rudolphi, 1802) Zeder, 1803.

*Specific diagnosis*.—*Trichouris* (p. 20): Head 10 to 22  $\mu$  in diameter, according to place of measurement, and sometimes provided with two lateral vesicular swellings. Bacillary band originates about 80  $\mu$  posterior of the anterior end and is about 140  $\mu$  wide near the union of the two parts of the body. The marginal rods of the bacillary

band are larger than the others. Body transversely striate at intervals of 9 to 34  $\mu$ . Esophageal tube from mouth to esophageal cell chain 70  $\mu$ . long. Piriform glands almost spherical, 57 to 72  $\mu$ . in diameter.

*Male* 50 to 80 mm. long with a maximum diameter of about 500  $\mu$ . Ratio of length of anterior esophageal portion of body to length of posterior portion of body is 2 or 3:1 (fig. 32). Testis begins about 3 mm.

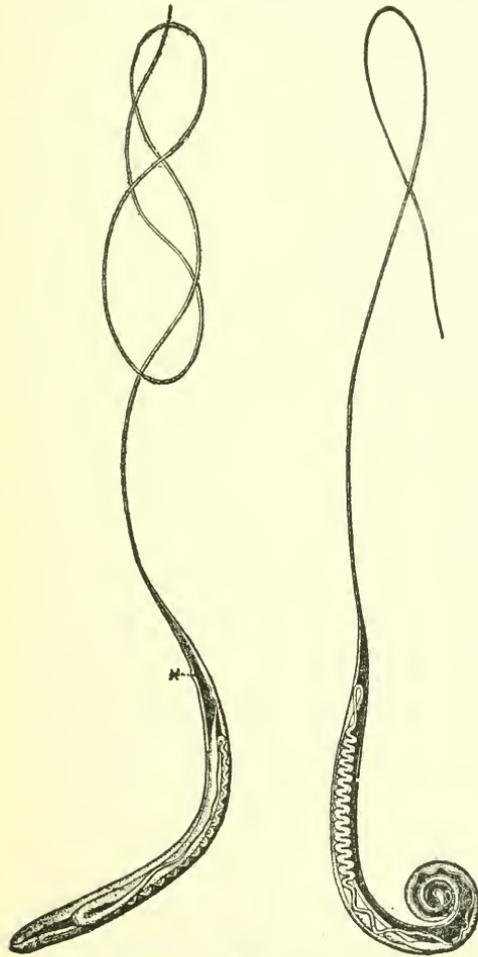


FIG. 32.—TRICHURIS OVIS. MALE AT RIGHT, FEMALE AT LEFT. \*VULVA,  $\times 5$ . FROM RANSOM, 1911, AFTER CURTICE, 1890.

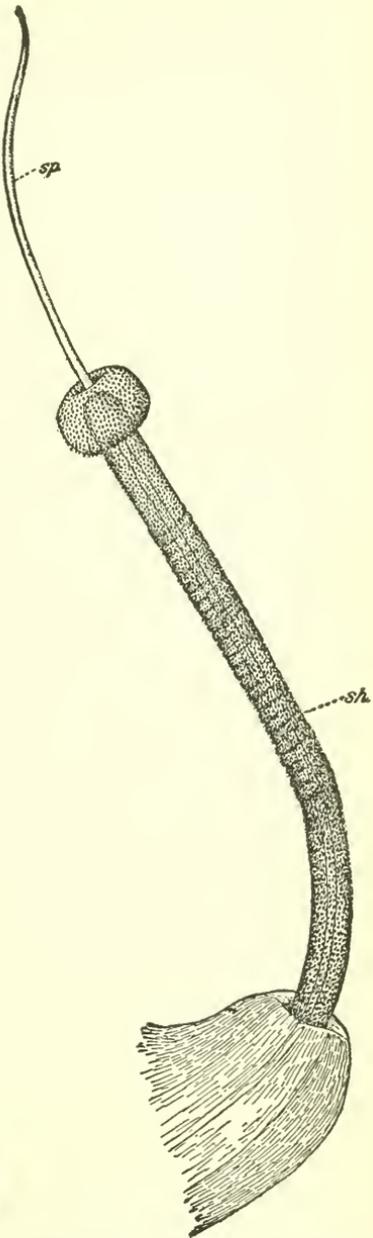


FIG. 33.—TRICHURIS OVIS. POSTERIOR END OF MALE, SHOWING SHEATH (sh.) AND SPICULE (sp.). ENLARGED. FROM RANSOM, 1911, AFTER CURTICE, 1890.

from the posterior end of the body, extends forward to near the vulva region and turns back as the ductus seminalis, transforms to

the vesicula seminalis, which terminates in a constriction followed by the ductus ejaculatorius, which opens into the cloaca. The spicule (fig. 33) originates bluntly or with a slight knob, and is slightly attenuated from the anterior end posteriorly, terminating in a sharp point; it is 5 to 7 mm. long and with a fairly uniform diameter of about  $25\ \mu$ . The spicule sheath has a maximum external length of about 1.55 mm. and a width of about  $90\ \mu$ . The sheath has a bulbous enlargement at the end when evaginated and is covered with little spines about  $5\ \mu$  long. The cloacal aperture is located between two short lobelike projections at the posterior end of the body.

*Female* 50 to 70 mm. long with a maximum diameter of about 1 mm. Ratio of length of anterior esophageal portion of body to length of posterior portion varies from 2:1 to 3:1 (fig. 32). From the vulva the vagina extends back about half the length of the posterior portion of the body, continues as the uterus to the posterior end of the body, turns forward as the oviduct and extends to the vulva region again, turning back here as the ovary and extending to its termination in the posterior end of the body. The vulva is covered with little spines. Terminal end of the body obtuse. Eggs (fig. 34) dark brown, lemon-shaped, 70 to  $80\ \mu$  long including the opercular plugs, 55 to  $65\ \mu$  long excluding the opercular plugs, and 30 to  $35\ \mu$  wide.

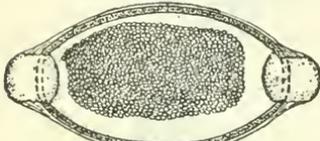


FIG. 34.—TRICHURIS OVIS. Egg.  $\times 600$ .  
FROM RANSOM, 1911.

including the opercular plugs, 55 to  $65\ \mu$  long excluding the opercular plugs, and 30 to  $35\ \mu$  wide.

*Hosts*.—*Hystrix cristata*. Usually found in ruminants and common in quite a number of these.

*Location*.—Large intestine.

*Locality*.—Not specified for *Hystrix cristata*. Cosmopolitan for other hosts.

This species is recorded from *Hystrix cristata* by Diesing (1851) from the Vienna Museum. Von Linstow (1906), in describing *Trichuris infundibulus* from the same host, has noted it as unlikely that such a record should be correct, but although there is a possibility of error or misidentification in this record, it must be provisionally accepted in the absence of further data.

#### HEPATICOLA Hall, 1916, new genus.

*Generic diagnosis*.—Trichurinae (p. 19): Anterior esophageal portion of body shorter than the posterior portion, which is only slightly thicker. No spicule. Bacillary band apparently not present.

*Type-species*.—*Hepaticola hepatica* (Bancroft, 1893) Hall, 1916.

## HEPATICOLA HEPATICA (Bancroft, 1893) Hall, 1916.

*Synonyms.*—*Trichocephalus hepaticus* Bancroft, 1893; *Trichosoma hepaticum* (Bancroft, 1893) Railliet, 1898; *Trichosomum* ? *tenuissimum* Leidy, 1891, not *Trichosoma tenuissimum* Diesing, 1851.

*Specific diagnosis.*—*Hepaticola* (p. 30): Head 7 to 10  $\mu$  in diameter. Mouth minutely papillate. Cuticle delicately striate. Worms 4 to 5 (10 to 12) cm. long.

*Male* 28  $\mu$  thick at posterior end. Anterior esophageal portion of body about equal in length to posterior portion. A membranous sheath is prolonged from the posterior extremity. No spicule present.

*Female* 100 to 120  $\mu$  thick at the middle of the body, and 65  $\mu$  thick at the blunt tail. Anterior esophageal portion of body half as long as the posterior portion. Prominent swollen membranous vulva 6 or 7 mm. from the head. Tail very short, blunt, and conical. Eggs (fig. 35) lemon-shaped, 40 to 52  $\mu$  long and 30 to 35  $\mu$  thick, with the usual opercular plugs at each end. The outer shell is radially striate; the closely approximated inner shell appears homogenous.

*Life history.*—If the eggs containing embryos are fed to rats, the embryos escape from the shell and make their way to the liver. These embryos are 156  $\mu$  long and 7  $\mu$  thick, with one end blunter than the other. At a distance of 5  $\mu$  from the narrow head end the embryo is 3  $\mu$  thick; at the same distance from the other it is 5  $\mu$  thick. Two days after feeding such eggs to rats Bancroft was unable to find embryos in the intestine of the rat, and no trace of the worms was found in the liver for two weeks, at the end of which time immature worms were found in the liver. Railliet (1892) found embryos in the intestine and liver at the end of five days. In the liver the worms mature and copulate. The subsequent fate of the male is not known. It has only been found by Bancroft in feeding experiments, and it seems likely that it dies and disintegrates or passes out. The female deposits large numbers of eggs in the liver and finally dies, in the course of two to three weeks, according to Bancroft, the body serving as the container for the eggs not yet passed out. According to Perugia (1893) the worms are in the biliary canaliculi, but inasmuch as these long worms are found coiled up in the liver, it appears that they extend through the parenchyma largely without reference to the canaliculi (pl. 1). According to Bancroft the eggs do not pass through the bile duct and into the intestine; Railliet says he has found the eggs in the feces. The presence of so many eggs in the liver, associated with the death of the female, suggests that the propagation of the worm depends on can-

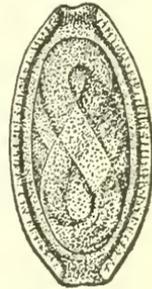


FIG. 35.—HEPATICOLA HEPATICA. EGG. ENLARGED. AFTER BANCROFT, 1893.

nibalism. The development of the embryo in the egg is very slow. Bancroft found that the egg did not begin segmentation before the end of three months; Railliet found that segmentation began in the fourth month. Bancroft found the embryos formed in five months; Railliet found the embryos formed in the fifth and sixth months. The embryos in the eggs have been found alive as much as two years and five months after embryo formation, the eggs being kept in water. Galli-Valerio (1903) has developed embryos in two months in 2 per cent formalin.

The worms cause irregular white or yellowish spots on the liver as a result of egg deposition, the spots suggesting coccidiosis. Section shows a localized cirrhosis of the liver, the liver cells being atrophied and supplanted by connective tissue elements. In severe artificial infestations Bancroft found that three weeks after feeding the rats showed signs of dyspnea, diarrhea, and emaciation, and died in the course of three to four weeks. Animals less heavily infested exhibit an atrophy of the liver which after the death of the worms goes on to recovery, leaving only the localized cirrhosis.

*Hosts.*—*Epimys norvegicus* (*Mus decumanus*), *Epimys alexandrinus* (*Mus alexandrinus*), (?) *Lepus europaeus*.

*Location.*—Liver.

*Localities.*—France, Italy, Australia, (?) England, United States (?Philadelphia, Pennsylvania; Washington, District of Columbia; Providence, Rhode Island; San Francisco, California).

This parasite was first observed by Chaussat (1850). Other records are those of Colin (1862), Davaine (1877), Leidy (1891), McCoy (1908), Mink (1909), and Robinson (1913). Generali (1878) notes the finding of encysted filiform nematodes in the liver of a rabbit, causing nodules resembling those of coccidiosis and associated with coccidiosis. Nicoll (1911) has recorded the finding of fragments of a trichosome together with trichosome eggs in the liver of *Lepus europaeus* in England, and I have tentatively referred his record to *Hepaticola hepatica* on the grounds that if the worm were a species proper to and common in a food animal like the rabbit it would be found oftener, as the lesions are almost sure to be observed. To be sure, they might easily be regarded as coccidiosis, but the numerous studies on coccidiosis of rabbits in turn should have insured finding it. However, there are certain discrepancies between Nicoll's description and that of *H. hepatica*. His measurements of eggs in utero are slightly in excess of the maximum, 52  $\mu$ , found by me, while the eggs found by him in the vagina attain a size of 70 to 78  $\mu$  by 40 to 45  $\mu$ . He also finds the egg (fig. 36) to consist of a radially striate outer shell, a concentrically striate inner shell, both incomplete at the poles, and an inner complete discrete membrane surrounding the embryonic mass. I do not find a condition approxi-

mating his figure of this. He also finds the female to be 140 to 230  $\mu$  thick, which figures are considerably in excess of those given for *H. hepatica*. In spite of these discrepancies I have tentatively referred this species to *H. hepatica* on the ground that further study of live material may reconcile the discrepancies, and present data are insufficient to warrant a new species. Eggs from a worm possibly belonging to *H. hepatica* were reported by Peroncito (1878) from the liver of a dog.

Genus CAPILLARIA Zeder, 1800.

*Synonyms*.—*Trichosoma* Rudolphi, 1819; *Trichosomum* Creplin, 1839; *Calodium* Dujardin, 1845.

*Generic diagnosis*.—Trichurinae (p. 19): Body very slender, capillary; anterior esophageal portion of body shorter than or rarely equal to the posterior portion of body. Bacillary band dorsal, ventral or lateral, or absent. Esophagus long and slender, gradually increasing in size posteriorly. Spicule long and slender, surrounded by a sheath which may present a smooth outer surface when evaginated or a surface armed with spines. Tail of male may or may not be provided with membranous wings and a membranous bursalike structure, these being usually inconspicuous when present. Vulva located near the base of the esophagus. Eggs lemon-shaped, with the usual opercular plugs.

*Type-species*.—*Capillaria tumida* Zeder, 1803=*Trichosoma brevicolle* Rudolphi, 1819.

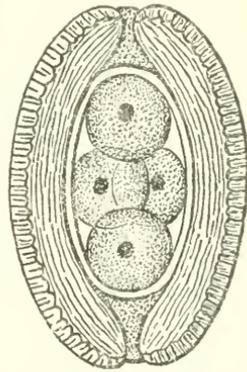


FIG. 36.—?HEPATICOLA HEPATICA. EGG OF TRICHOSOME FROM LIVER OF LEPUS EUROPAEUS. ENLARGED. AFTER NICOLL, 1911.

ANALYTICAL KEY TO SPECIES OF CAPILLARIA.

1. Recognizable species ..... 2.
- Inadequately described or undescribed species ..... 5.
2. Dorsal and ventral bacillary band present.....*Capillaria bacillata*, p. 34.
- No bacillary bands present, or, at least, none described..... 3.
3. Spicules less than 1 mm. long; worms in intestine...*Capillaria annulosa*, p. 35.
- Spicules more than 1 mm. long..... 4.
4. Worms in urinary bladder.....*Capillaria schmidti*, p 37.
- Worms in intestine.....*Capillaria ransomia*, p. 34.
5. Females described..... 6.
- No description; nomina nuda..... 8.
6. In urinary bladder.....*Capillaria papillosa*, p. 37.
- In digestive tract (apparently)..... 7.
7. In *Apodemus sylvaticus* (*Mus sylvaticus*)...*Trichosoma muris-sylvatici*, p. 36.
- In *Elionymys quercinus* (*Myoxus nitella*)...*Trichosomum myoxi-nitellae*, p. 36.
8. In *Mus musculus*.....*Trichosoma muris-musculi*, p. 37.
- In *Arvicola amphibius* (*Lemmus amphibius*).....*Trichosomum lemni*, p. 37.

## CAPILLARIA RANSOMIA Barker and Noyes, 1915.

*Specific diagnosis.*—*Capillaria* (p. 33): Anal aperture subterminal. *Male* 19.6 mm. long with a body diameter of  $10\ \mu$  just behind the

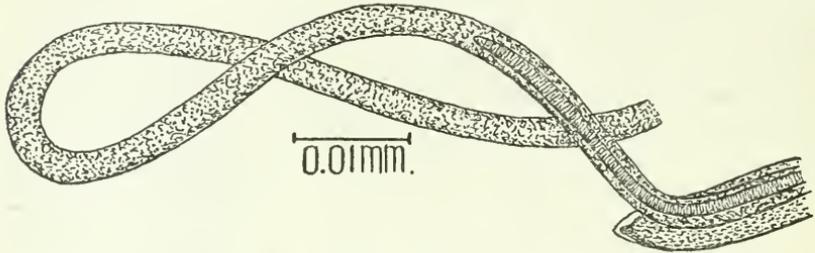


FIG. 37.—CAPILLARIA RANSOMIA. POSTERIOR EXTREMITY OF MALE. AFTER BARKER, 1915.

head and of  $32\ \mu$  in the posterior portion. Posterior end slightly curved and provided with a small bursa with two lateral lobes (fig. 37); spicule 1.36 mm. long and  $7\ \mu$  thick; the sheath of the spicule  $10\ \mu$  in diameter.

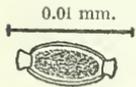


FIG. 38.—CAPILLARIA RANSOMIA. EGG. AFTER BARKER, 1915.

*Female* 19 mm. long with a body diameter of  $22\ \mu$  just behind the head and  $65\ \mu$  in the posterior portion. Vulva in anterior fourth of the body, 5 mm. from the anterior end. Eggs 50 by  $20\ \mu$  in diameter and with prominent plugs (fig. 38).

*Host.*—*Ondatra zibethica* (*Fiber zibethicus*).

*Location.*—Duodenum.

*Locality.*—United States (Nebraska).

This worm is described in a paper by Barker (1915). His indicated magnifications do not agree with text.

## CAPILLARIA BACILLATA (Eberth, 1863) Hall, 1916.

*Synonym.*—*Trichosomum bacillatum* Eberth, 1863.



FIG. 39.—CAPILLARIA BACILLATA. CROSS-SECTION OF POSTERIOR (POSTVULVAR) PART OF BODY, SHOWING DORSAL AND VENTRAL BACILLARY BANDS. DIAGRAMMATIC. ENLARGED. AFTER EBERTH, 1863.

*Specific diagnosis.*—*Capillaria* (p. 33): Dorsal bacillary band three-fourths of body diameter and ventral bacillary band one-third of body diameter (fig. 39). The rods are thicker in the dorsal band. The lateral bands are small and simple. Mouth aperture surrounded by three small papillae.

*Male* 15 mm. long with a maximum thickness of  $80\ \mu$ .

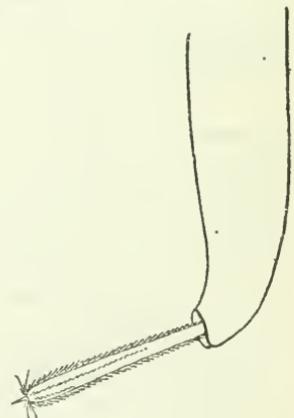


FIG. 40.—CAPILLARIA BACILLATA. POSTERIOR EXTREMITY OF MALE, SHOWING SHEATH. ENLARGED. AFTER EBERTH, 1863.

Posterior end of body slightly bent toward the ventral surface (fig. 40). A bursa, consisting of two lateral flaps, is present. Cloacal

aperture is terminal. Penis sheath is provided with fine bristly spines.

*Female* length (?), thickness (?). Body thickens only moderately posteriorly, and diminishes in size toward the terminal anal aperture. Posterior end obliquely truncate. The round, inconspicuous vulva (fig. 41) is situated laterally and posterior of the union of the esophagus and intestine. The thick-shelled eggs are barrel-shaped, with the usual opercular plugs, and are 48  $\mu$  long and 19  $\mu$  thick.

*Host.*—*Mus musculus*.

*Location.*—Esophagus.

*Locality.*—Not given.

The location given is quite unusual.

**CAPILLARIA ANNULOSA** (Dujardin, 1845) Hall, 1916.

*Synonyms.*—*Calodium annulosum* Dujardin, 1845; *Trichosomum annulosum* Dujardin, 1845; *Trichosoma muris-decumani* Bellingham, 1845, of Molin, 1861b; *Trichosomum (Calodium) annulosum* Diesing, 1851; *Trichosoma annulosum* Dujardin of Stossich, 1890.

*Specific diagnosis.*—*Capillaria* (p. 33): Body distinctly annulate, especially in the posterior portion. Head very narrow, about 8  $\mu$  in diameter. Cuticle distinctly striate transversely; striations at intervals of 2 to 5  $\mu$ , the narrower intervals in the anterior portion. No bacillary bands.

*Male* 14 mm. long by 40  $\mu$  thick. Body somewhat bent posteriorly. Tail bilobed, with two slightly prominent membranous (?) alae. Spicule 950  $\mu$  long; sheath of equal length, smooth and with regular transverse folds on the interior.

*Female* 21 mm. long by 58  $\mu$  thick. Tail obtuse. Anal aperture subterminal. Vulva (fig. 42) a transverse cleft without appendix, 4 mm. from the anterior extremity, and posterior of the union of the esophagus and intestine. Eggs 51 to 57  $\mu$  long. Body slightly thicker posteriorly than anteriorly.

*Host.*—*Epimys norvegicus (Mus decumanus)*, *Epimys rattus (Mus rattus)*.

*Location.*—Intestine.

*Localities.*—France (Rennes); Ireland.

The writer has followed Dujardin, who proposed this species, in stating that there are no bacillary bands in this species. It must be noted, however, that Eberth (1863), presumably on the study of material which he believed to be Dujardin's species, states that this form has lateral bacillary bands equal to a third of the body diameter

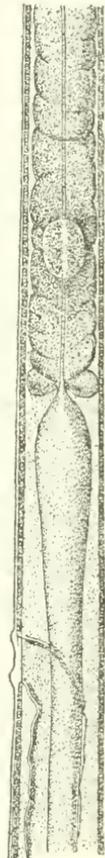


FIG. 41.—CAPILLARIA BACILLATA. FEMALE IN REGION OF VULVA. ENLARGED. AFTER EBERTH. 1863.

and that he finds similar ventral and dorsal lines consisting of small nuclei. In the face of Dujardin's statement that the absence of bacillary bands is a specific characteristic, I have left the diagnosis in this form. It is possible that Eberth had another species, distinct from *C. annulosa* or that Dujardin did not find the typical bacillary structure and that Eberth uses the term "bacillary band" to refer to structures which are not really bacillary (i. e. composed of rods). See also *C. schmidti*.

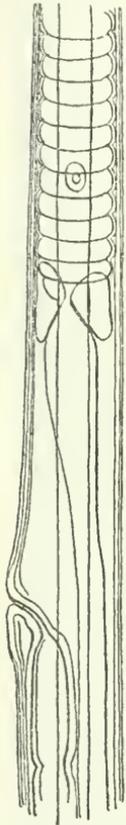


FIG. 42.—CAPILLARIA ANNULOSA. FEMALE IN REGION OF VULVA. ENLARGED. AFTER EBERTH, 1863.

TRICHOSOMA MURIS-SYLVATICI Diesing, 1851.

*Synonym.*—*Trichosoma muris sylvatici* Dujardin, 1845, of Diesing, 1851.

*Specific diagnosis.*—*Capillaria* (p. 33):

*Male* unknown.

*Female* 12 to 22 mm. long and 70 to 80  $\mu$  thick. Head 9 to 13  $\mu$  in diameter. Tail transversely truncate. Cuticle transversely striate, with striations at intervals of 2  $\mu$ . Vulva 5.6 mm. from the anterior extremity and without appendix. Eggs 55 to 60  $\mu$  long; opercular plugs large.

*Host.*—*Apodemus sylvaticus* (*Mus sylvaticus*).

*Location.*—(?) Intestine. Dujardin does not give the location.

*Locality.*—France (Rennes).

Dujardin did not apply any name to this species and the name credited to Dujardin by Diesing must be credited to Diesing. I have regarded this name as binomial in intent and have placed the hyphen in the specific name accordingly. In the absence of adequate data regarding this form I have left the generic name as it stands.

TRICHOSOMUM MYOXI-NITELAE Diesing, 1851.

*Synonym.*—*Trichosomum myoxi nitelae* Dujardin of Diesing, 1851.

*Specific diagnosis.*—*Capillaria* (p. 33):

*Male* unknown.

*Female* length (?), 71  $\mu$  thick. Tail 44  $\mu$  thick, slightly thinned, obtuse. Anal aperture situated laterally in front of the posterior extremity. Eggs lemon-shaped, 58  $\mu$  long, longitudinally striate, and with the usual opercular plugs.

*Host.*—*Eliomys quercinus* (*Myoxus nitella*).

*Location.*—Intestine.

*Locality.*—France (Rennes).

This species was not named by Dujardin, who described it, and the name credited to him by Diesing must be credited to Diesing. This

name, like the preceding, I have regarded as binomial in intent, but in the absence of further data regarding the worm I see no reason for making the correct generic and specific combination.

TRICHOSOMA MURIS-MUSCULI Creplin, 1849.

*Specific diagnosis.*—*Capillaria* (p. 33):

*Host.*—*Mus musculus*.

*Location.*—Large intestine.

*Locality.*—Not known.

There is no description of this species and the name must be regarded as a *nomen nudum*. It might have been *Capillaria bacillata*.

TRICHOSOMUM LEMMI Diesing, 1851.

*Synonyms.*—*Trichosoma* Retzius, 1841; *Trichosomum lemmi* Retzius of Diesing, 1851.

*Specific diagnosis.*—*Capillaria* (?) (p. 33):

*Host.*—*Arvicola amphibius* (*Lemmus amphibius*).

*Location.*—Stomach.

*Locality.*—Not known.

Retzius refers to this worm merely as *Trichosoma*, and the name credited by Diesing to Retzius must be credited to Diesing. In the location in which this undescribed worm was found, it is quite possible that the worm was one of the hairlike strongyles. The name used is a *nomen nudum*, and there is considerable likelihood that the record is entirely erroneous in regarding this as a trichosome.

CAPILLARIA PAPILLOSA (Polonio, 1860) Hall, 1916.

*Synonym.*—*Calodium papillosum* Polonio, 1860.

*Specific diagnosis.*—*Capillaria* (p. 33):

*Male* unknown.

*Female* 15 (?) mm. long. Body attenuate anteriorly and rounded posteriorly. Vulva in anterior portion of body. Anal aperture at the caudal extremity with 4 papillae in that vicinity.

*Host.*—*Epimys rattus* (*Mus rattus*).

*Location.*—Urinary bladder.

*Locality.*—Italy (Padua).

Note the comment on the following species.

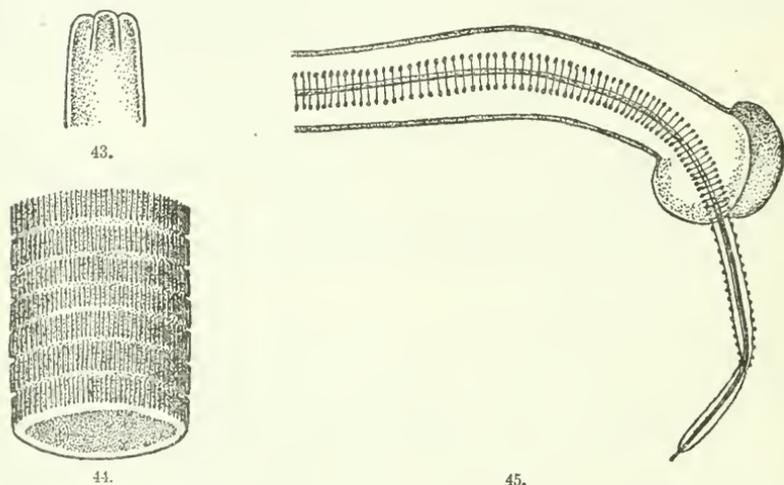
CAPILLARIA SCHMIDTI Hall, 1916, emend.

*Synonym.*—*Trichosoma schmidtii* von Linstow, 1874.

*Specific diagnosis.*—*Capillaria* (p. 33): Head (fig. 43) ends bluntly with three small projections. No bacillary bands present. The

cuticle (fig. 44) is finely striate longitudinally, the striations being interrupted at short intervals by annular spaces free of striations, these spaces being especially distinct in the posterior portion of the body.

*Male* 17.1 to 21 mm. long. Body thickest in the middle, 30 to 52  $\mu$  thick, the head end 10 to 16  $\mu$  thick and the tail end 20 to 33  $\mu$  thick. Anterior esophageal portion of body 4.8 to 7.2 mm. long. The cells of the esophageal cell chain are about eight times as long as wide. The bent, unciform spicule (fig. 45) is 1.2 to 1.4 mm. long. It is 6  $\mu$  thick at the proximal end and terminates in a fine point distally.



FIGS. 43-45.—CAPILLARIA SCHMIDTI. 43, HEAD OF MALE. ENLARGED. AFTER VON LINSTOW, 1874. 44, CUTICLE SHOWING ANNULAR INTERRUPTIONS OF LONGITUDINAL STRIATIONS. ENLARGED. AFTER VON LINSTOW, 1874. 45, POSTERIOR EXTREMITY OF MALE, SHOWING SPICULE. ENLARGED. AFTER VON LINSTOW, 1874.

The sheath is smooth and transversely striated and may be evaginated to a distance of 0.9 mm. The posterior extremity of the body terminates in two distinct lobes of greater diameter than the preceding portion of the body.

*Female* unknown.

*Host*.—*Epimys norvegicus* (*Mus decumanus*).

*Location*.—Urinary bladder.

*Locality*.—Germany.

It is quite possible that this species and the foregoing, *Capillaria papillosa*, are identical, since they are both trichosomes and found in the urinary bladder of closely related species of rats, which are cosmopolitan animals, and in areas so comparatively close to one another as Germany and Italy. However, since one species is based on the male and the other on the female, it is perhaps better to keep the species distinct for the present and merely call attention to the likelihood of their being identical. *C. schmidti* might be *C. annulosa*.

### Superfamily ASCAROIDEA Railliet and Henry, 1915.

*Synonym.*—Ascaridea Diesing, 1861, of Travassos, 1914a.

*Superfamily diagnosis.*—Nematoda (p. 4): Mouth commonly provided with two or three prominent or inconspicuous lips which are often supplied with papillae, but the mouth may be of variable shape and without lips. When three lips are present one is median and dorsal, the others are submedian and are approximated in the ventral line. Buccal capsule is not present. Males are provided with one or two spicules, rarely with none. Female with two ovaries, oviparous, rarely, as in *Oxyuris vivipara*, viviparous. As a rule development is direct and without intermediate host; exceptionally (as in ascarids of fish) there is an intermediate host.

*Type-family.*—Ascaridae Cobbold, 1864.

Travassos (1914a) proposes the name Ascaridea as a superfamily. This name was used as a family name by Diesing (1861), but it is not in the form of either the family or superfamily name.

#### ANALYTICAL KEY TO FAMILIES OF ASCAROIDEA.

1. Meromyarian. Males with 1 spicule, at times reduced, imperfectly chitinized or absent.....*Oxyuridae*, p. 65.  
Polymyarian; or meromyarian with 2 spicules..... 2.
2. Meromyarian with 2 spicules.....*Family uncertain*, p. 105.  
Polymyarian ..... 3.
3. Lips 3 or 6 in number and very prominent. No anal sucker in male.  
*Ascaridae*, p. 39.  
Lips 2 or 3 or none present, mouth variable in shape. Anal sucker in male or rarely (*Seuratum*) absent.....*Heterakidae*, p. 44.

#### Family ASCARIDAE Cobbold, 1864.

*Family diagnosis.*—Ascaroidea (p. 39): Polymyarian, mouth with three prominent lips supplied with papillae, the dorsal lip being median and the two others submedian and approximated in the ventral line, or with three main lips and three relatively prominent or inconspicuous intermediate lips (interlabia). Male usually with two spicules. Caudal extremity of female terminates conically and fairly abruptly.

*Type-genus.*—*Ascaris* Linnaeus, 1758.

#### Subfamily ASCARINAE Travassos, 1913.

*Subfamily diagnosis.*—Ascaridae (p. 39): Characters of the family.

*Type-genus.*—*Ascaris* Linnaeus, 1758.

#### ANALYTICAL KEY TO GENERA OF ASCARINAE.

1. Lips without fringes or tentacles.....*Ascaris*, p. 40.
- Lips with fringes or tentacles.....*Crossophorus*, p. 42.

## Genus ASCARIS Linnaeus, 1758.

*Synonyms*.—*Stomachida* Pereboom, 1780; *Fusaria* Zeder, 1800; *Lombricoïdes* Mérat, 1821.

*Generic diagnosis*.—Ascarinae (p. 39): Mouth with three well-developed lips. Male with two equal spicules, and with numerous papillae on the ventral surface of the body in front of and behind the anus. Vulva near middle of body or anterior of this point. Shell of egg thick, with numerous mamillate projections on its outer albuminous layer.

*Type-species*.—*Ascaris lumbricoïdes* Linnaeus, 1758.

## ANALYTICAL KEY TO SPECIES OF ASCARIS.

1. No description.....*Ascaris* species, p. 40.  
Described species..... 2.
2. Intermediate lips absent.....*Ascaris castoris*, p. 40.  
Intermediate lips present (?)..... 3.
3. Female 9 cm. long; male unknown.....*Ascaris laevis*, p. 41.  
Female 11 cm. long; male described.....*Ascaris pigmentata*, p. 41.

## ASCARIS species Parona, 1909.

*Specific diagnosis*.—*Ascaris* (p. 40). No description.

*Host*.—*Mus minutoïdes* (*Leggada minutoïdes*).

*Location*.—Stomach.

*Locality*.—Fort Portal, Africa.

Parona mentions finding one female specimen, which he calls *Ascaris* species. It seems likely to the writer that this does not belong in the genus *Ascaris* or even in the Ascaroidea, but rather in the superfamily Filarioidea and possibly in the genus *Protospirura*, of which I have a large species, superficially resembling an ascarid, from the stomach of a rodent. See comment on *Ascaris pigmentata*. However, in the absence of adequate data and in view of the fact that it is not a named species, there is nothing to gain by changing the name used by Parona.

## ASCARIS CASTORIS Rudolphi, 1809.

*Specific diagnosis*.—*Ascaris* (p. 40): Long cylindrical worms, 10.8 to 21.7 cm. long.

*Male* not described.

*Female* not described.

*Host*.—*Castor fiber*.

*Location*.—Intestine.

*Locality*.—Not stated.

Perrault, Charras, and Dodart, in their memoir on mammals, mention these worms, and state that they are comparable to earthworms. Rudolphi regarded them as ascarids. Such a supposition is quite

reasonable, though the writer is of the opinion that these and other ascarids from rodents probably belong in some related genus rather than in the restricted genus *Ascaris*.

**ASCARIS LAEVIS** Leidy, 1856.

*Synonym*.—*Ascaris levis* Leidy, 1904.

*Specific diagnosis*.—*Ascaris* (p. 40):

*Male* unknown.

*Female* 9 cm. long by 3 mm. thick. Lips prominent. Tail conical, mucronate.

*Host*.—*Marmota monax* (*Arctomys monax*).

*Location*.—Intestine.

*Locality*.—Not stated.

The above description from Leidy is rather inadequate, but in view of the size of the worm, the determination as *Ascaris*, and the presence in *Marmota marmota* (*Arctomys marmota*) of a large similar worm, the standing of this worm may be considered in connection with this latter worm, *Ascaris pigmentata*.

**ASCARIS PIGMENTATA** von Linstow, 1897.

*Specific diagnosis*.—*Ascaris* (p. 40): Characterized by a dark pigment occurring throughout the cuticle and the walls of the intestine and esophagus. The lips (fig. 46) have dental ridges and there are inferior intermediate lips. The dorsal lip is 320  $\mu$ . broad and 260  $\mu$  long. The lip pulp toward the external aspect of the worm is rounded; that toward the internal aspect divides into two parts. The lip bears two double papillae. There is a gross cuticular annulation at intervals of 30  $\mu$  and a finer one at intervals of 5  $\mu$ . The esophagus is 1/10.6 of the entire length.

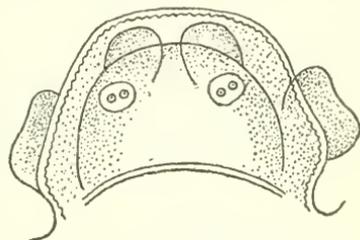


FIG. 46.—*ASCARIS PIGMENTATA*. LATERAL VIEW OF HEAD. ENLARGED. AFTER VON LINSTOW, 1897.

*Male* 7.5 cm. long and 950  $\mu$  thick. The length of the tail is 1/227 of the entire length. The spicules are lancet-shaped and are 1.38 mm. long. On each side of the tail end there are 5 postanal and about 22 to 25 preanal papillae.

*Female* 11.4 cm. long by 1.26 mm. thick. The tail end is rounded and measures 1/286 of the entire length. Eggs not developed.

*Host*.—*Marmota marmota* (*Arctomys marmota*).

*Location*.—Not given; presumably intestine.

*Locality*.—Königsberg Zoological Gardens, Königsberg, Germany.

The presence of intermediate lips must be taken as sufficient to remove this worm from the genus *Ascaris*. Leiper and Atkinson (1914) have very properly created the new genus *Kathleena* for

ascarids with interlabia, such as the well-known forms from seals. However, I am disinclined to put this species in the genus *Kathleena*. There is no reason to think that the esophageal appendage and intestinal ceca are present and the host animals are from widely separated groups. On the other hand, I was surprised to find that a parasite I had regarded on first sight and after some examination as a species of *Ascaris*, perhaps close to *Ascaris pigmentata*, was a species of *Protospirura*. The gross appearance of the animal, the size and other external characteristics spoke for its ascarid nature, but it was, nevertheless, not even in the same superfamily as the ascarids. In view of this fact, I have left Leidy's and von Linstow's species in the genus *Ascaris*, not on the grounds that they belong there, but for fear they may prove to be separated more than generically from that genus.

Genus **CROSSOPHORUS** Hemprich and Ehrenberg, 1828.

*Synonym.*—*Ascaris* of Schneider, 1866, in part.

*Generic diagnosis.*—Ascarinae (p. 39): Head with three lips hollowed on the inside and provided with papillae or fringed. Intestine with two ceca directed anteriorly. Male with a simple spicule. Female uterus with two branches.

*Type-species.*—*Crossophorus collaris* Hemprich and Ehrenberg, 1828.

ANALYTICAL KEY TO SPECIES OF CROSSOPHORUS.

1. Head separated from body by pronounced strangulation and surrounded by a collar of bifurcated fimbriae.....*Crossophorus collaris*, p. 42.
- Head not sharply separated from body and without collar of fimbriae; each lip provided with 3 long tentacles.....*Crossophorus tentaculatus*, p. 43.

**CROSSOPHORUS COLLARIS** Hemprich and Ehrenberg, 1828.

*Synonym.*—*Ascaris ferox* Schneider, 1866.

*Specific diagnosis.*—*Crossophorus* (p. 42): Lips (figs. 47 and 48) very similar, semicircular with scalloped edge. The dental ridge is interrupted, forming on the outer edge of the lip on each side five combs of spines, the number of spines figured as two to eight to a comb. An uninterrupted row of spines encircles the lips, proceeding in a bow to the inner surface of the base of each lip, bending about

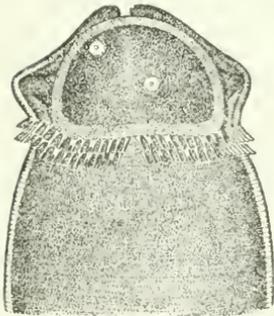


FIG. 47.—*CROSSOPHORUS COLLARIS*.  
LATERAL VIEW OF HEAD.  $\times 90$ .  
AFTER SCHNEIDER, 1866.

and crossing the outer basis of the lip, going back to the body cuticle parallel to the posterior edge of the lip, and proceeding again to the

middle of the outer base of the adjoining lip. These spines are flat. The transition from one to another at their bases is in the form of a bow, and anteriorly they usually branch dichotomously. The intestine has two ceca projecting toward the esophagus.

*Male* 46 mm. long. The simple bare spicule projects forward from a very short tail. This tail (fig. 49) bears a double row of papillae on each side. Schneider figures 9 preanal and 10 to 12 postanal.

*Female* 90 mm. long. Uterus with two branches.

*Hosts.*—*Procapra capensis* (*Hyrax capensis*), *Procapra syriaca* (*Hyrax syriacus*).

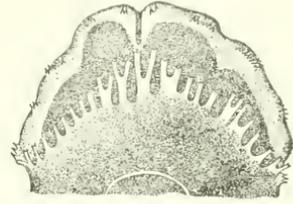


FIG. 48.—*CROSSOPHORUS COLLARIS*.  
MEDIAN VIEW OF THE DORSAL LIP.  
× 90. AFTER SCHNEIDER, 1866.

*Location.*—Cecum.

*Locality.*—Shores of the Red Sea.

Schneider (1866) used the name *Ascaris ferox*, crediting it to Hemprich and Ehrenberg, and at the same time noting *Crossophorus collaris* of Hemprich and Ehrenberg as a synonym. Hemprich and Ehrenberg do not use the term *Ascaris ferox* and, so far as can be determined, it is a deliberate renaming.

In his description, Schneider says the male tail bears a double row of papillae and

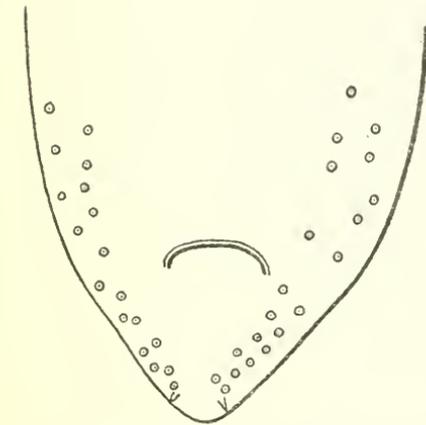


FIG. 49.—*CROSSOPHORUS COLLARIS*. POSTERIOR  
EXTREMITY OF MALE; VENTRAL VIEW. × 130.  
AFTER SCHNEIDER, 1866.

adds "1 steht ganz seitlich." It is not clear whether this means that one row, the outer on each side, is entirely lateral or that one papilla is entirely lateral, and his figures do not definitely affirm either idea, though leaving a presumption in favor of the first.

*CROSSOPHORUS TENTACULATUS* Hemprich and Ehrenberg, 1828.

*Synonym.*—*Ascaris tentaculatus* Ehrenberg of Nassonov (1897).

*Specific diagnosis.*—*Crossophorus* (p. 42): Head not distinctly separated from the body. Mouth provided with papillae and each lip bearing three very long tentacles. Worms 2 to 3 inches (about 5 to 7.5 cm.) long.

*Male* not specifically described.

*Female* not specifically described.

*Host.*—*Procapra capensis* (*Hyrax capensis*).

*Location*.—Cecum.

*Locality*.—Shores of Red Sea.

Hemprich and Ehrenberg state that this species is rarer than *Crossophorus collaris*. The descriptions suggest that the two species do not belong in the same genus, but in the absence of an adequate diagnosis of *Crossophorus tentaculatus* no satisfactory separation is possible, and there is the possibility that further study might show them to be congeneric.

The name *Ascaris tentaculatus*, credited by Nassonov to Ehrenberg, must be credited to Nassonov as *Ascaris tentaculatus* (Hemprich and Ehrenberg, 1828) Nassonov, 1897.

#### Family HETERAKIDAE Railliet and Henry, 1914.

*Synonym*.—Heteracidae Railliet and Henry, 1914.

*Family diagnosis*.—Ascaroidea (p. 39): Polymyarian. Mouth provided with two or three lips or without lips and of variable shape. Esophagus cylindrical or club-shaped, often followed by a distinct bulb. Males with a preanal sucker, which may be limited by a chitinous ring or a delicate cuticular membrane, or formed by a simple longitudinal depression; this sucker not present in *Seuratium*. Two spicules, one or both of which may tend to atrophy or show imperfect chitinization, and with accessory piece present or absent. Vulva near middle of body.

*Type-genus*.—*Heterakis* Dujardin, 1845.

##### ANALYTICAL KEY TO SUBFAMILIES OF HETERAKIDAE.

1. Mouth with 2 lips, anal sucker absent in male.....Seuratinae, p. 62.  
Mouth with 3 lips or with lips inconspicuous or wanting..... 2.
2. Mouth with 3 well-defined lips; preanal sucker nearly circular and limited by a chitinous ring.....Heterakinae, p. 44.  
Mouth with lips inconspicuous or wanting, rarely with 3 lips; preanal sucker fusiform and without a chitinous ring.....Subulurinae, p. 51.

#### Subfamily HETERAKINAE Railliet and Henry, 1912b.

*Subfamily diagnosis*.—Heterakidae (p. 44): Mouth with three well-defined lips; esophageal bulb present or absent; preanal sucker nearly circular and limited by a chitinous ring; spicules equal or unequal; gubernaculum present or absent.

*Type-genus*.—*Heterakis* Dujardin, 1845.

Lane (1914) proposes the subfamily Heterakinae in a strict sense as "sub-fam. nov." The name of the subfamily must, of course, date from the person proposing it, not from the person restricting it or rewriting its diagnosis.

##### ANALYTICAL KEY TO GENERA OF HETERAKINAE.

1. Bursa well developed; no gubernaculum.....*Heterakis*, p. 45.  
Bursa not developed; gubernaculum present.....*Paraspidodera*, p. 49.

## Genus HETERAKIS Dujardin, 1845.

*Synonym.*—*Heterakis* Molin, 1858c; *Ganguleterakis* Lane, 1914.

*Generic diagnosis.*—Heterakinae (p. 44): Mouth with three lips. Esophagus subcylindrical, progressively swollen toward its posterior extremity and with a distinct bulb. Two lateral membranes present or absent. Males with caudal alae well developed to form a bursa sustained by papillae of raylike appearance. Spicules generally unequal, at times equal or subequal, without accessory piece. Preanal sucker with a distinct chitinous ring. Females with vulva toward the middle of the body, the uterine branches passing in opposite directions. The eggs have a thick shell.

*Type-species.*—*Heterakis vesicularis* (Froelich, 1791) Dujardin, 1845.

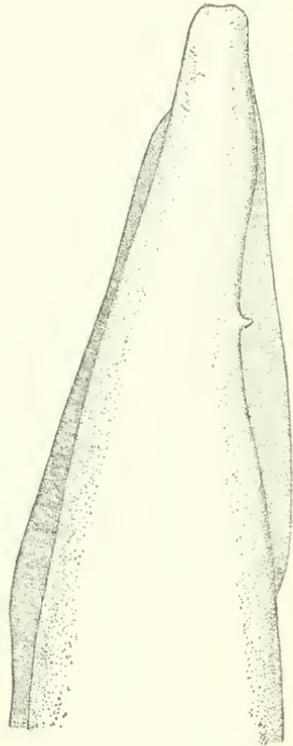
## HETERAKIS SPUMOSA Schneider, 1866.

*Synonyms.*—*Heterakis dahomensis* Gendre, 1911; *Ganguleterakis gangula* Lane, 1914.

*Specific diagnosis.*—*Heterakis* (p. 45): Head 70 to 80  $\mu$  in diameter. Mouth with three distinct subequal lips; each lip with two lateral papillae and apparently one median.

The small mouth cavity is followed immediately by the esophagus. About 65 to 75  $\mu$  from the head end the esophagus lumen dilates transversely and abruptly narrows to its original diameter. Exclusive of the bulb, the esophagus is 625 to 685  $\mu$  long and 60 to 70  $\mu$  in diameter; the bulb is 250 to 300  $\mu$  long and 125 to 170  $\mu$  in diameter.

The cavity of the bulb is dilated posteriorly and lined with a chitinous investment, the shape of the cavity varying with the contraction of the bulb. The lining of the esophagus proper shows a delicate transverse marking. The cuticle shows a fine longitudinal and transverse striation. A short distance back of the head a lateral membrane (fig. 50) originates and rapidly attains its maximum development, gradually diminishing posteriorly and continuing to the posterior end of the body. The two cervical papillae are about 225 to 250  $\mu$  from the anterior end of the body. The excretory pore is about 440  $\mu$  from the head end.



1/10 mm.

FIG. 50.—HETERAKIS SPUMOSA. ANTERIOR EXTREMITY OF FEMALE.

*Male* 6.4 to 9.85 mm. long and with a maximum thickness of about 260  $\mu$ . There is a well-developed bursa (figs. 51 and 52) which originates anterior of the preanal sucker. It is sustained in the anal region by three pairs of papillae and is notched at the distal termination of the third of these. The bursal lobe originating at this notch is a small one, the bursa abruptly diminishing in diameter just behind this pair and being continued as the terminal portion accompanying the tail proper. This last portion is sustained by three pairs of papillae and extends to the tip of the acutely pointed

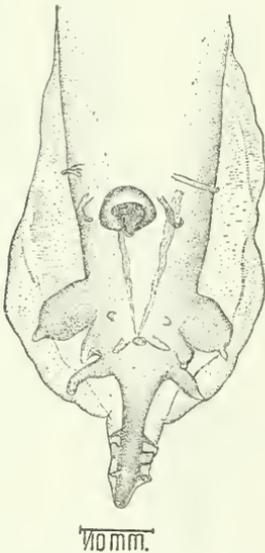


FIG. 51.—*HETERAKIS SPUMOSA*.  
POSTERIOR EXTREMITY OF  
MALE; VENTRAL VIEW.

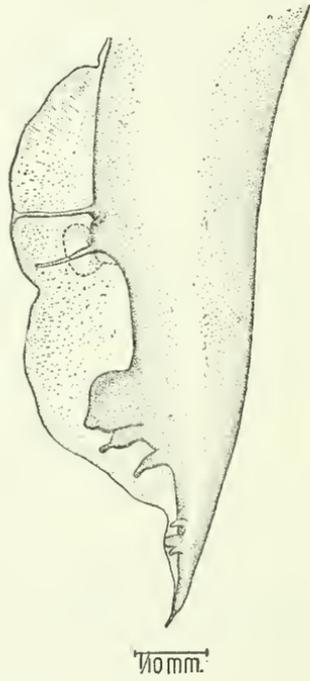


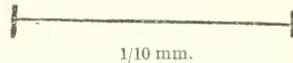
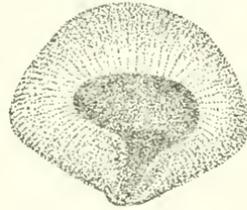
FIG. 52.—*HETERAKIS SPUMOSA*. POS-  
TERIOR EXTREMITY OF MALE; LAT-  
ERAL VIEW.

tail. Of the three pairs of papillae sustaining the bursa in the anal region the anterior pair is much the largest. The proximal portion appears to be thick and granular, the diminished distal portion is thin and clear. The next pair of papillae behind this is shorter and has the same structure, a granular proximal portion and a clear distal portion. The next pair of papillae, that in relation with the bursal notch, does not show this same structure; it is longer than the preceding pair. Of the three pairs of papillae sustaining the bursa along the tail proper the anterior pair is the thinnest, the middle the thickest, and the posterior pair is intermediate in thickness. These are all of about the same length. It is sometimes diffi-

cult to see more than two pairs of papillae on one or both sides of the tail membrane, possibly due to doubling or crumpling. In addition to the six pairs of papillae which sustain the bursa, there are four other pairs. Of these, two stalked pairs are in the region of the sucker, the apparent relation to the sucker being rather variable. The other two pairs are sessile and are in the vicinity of the cloacal aperture; they are rather difficult to observe accurately. The cloacal aperture is variable in shape or presents variations due to point of view or distortion. The sucker (fig. 53) is a powerful pedunculate structure, with a strong chitinous investment interrupted on the posterior border by a papilliform elevation. The sucker is elliptical, with a transverse diameter of about  $86 \mu$  and a longitudinal diameter of  $65$  to  $82 \mu$ . There are well-developed muscular strands from the base of the sucker to the opposite body wall. The spicules are subequal,  $200$  to (?)  $400 \mu$  in length, flattened, and have a pronounced longitudinal striation. They are thickest at the proximal end and taper gradually to a point. They are very flexible, and commonly show signs of curving, twisting, and bending in mounting. The proximal end terminates in a short open hook bending laterally. The distance from the posterior margin of the sucker to the tip of the tail is  $435$  to  $500 \mu$ ; the distance from the cloacal aperture to the tip of the tail is  $250$  to  $300 \mu$ .

*Female* 7 to 13 mm. long with a diameter of  $300$  to  $520 \mu$ . The anus is from  $680$  to  $740 \mu$  from the posterior end of the body. The vulva (fig. 54) is slightly posterior of the middle of the body. It has two prominent transverse lips with one or two cuticular prominences before and behind it in the midventral line. Each lip of the vulva bears two papillae. The vagina appears to be surrounded by a spiral band for some distance back from the region near the vulva. From the vulva the vagina turns forward for a short distance and then turns and extends posteriorly for a short distance. Apparently it then forks to form the anterior and posterior uterine branches. These extend forward and backward, respectively, and then turn back, transform into the ovaries, and as such make their way in numerous transverse loops through the anterior and posterior ends of the body. The egg has a mamillated shell about  $4 \mu$  thick and is  $55$  to  $60$  by  $40$  to  $55 \mu$  in diameter. Eggs segmenting when oviposited.

*Hosts.*—*Epimys norvegicus* (*Mus decumanus*), *Epimys rattus* (*Mus rattus*), *Cricetomys gambianus*.

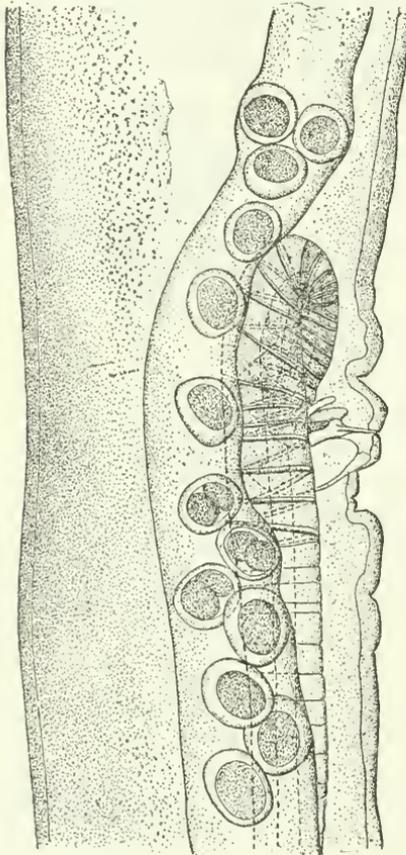


1/10 mm.

FIG. 53.—*HETERAKIS SPUMOSA*.  
CAUDAL SUCKER OF MALE; VENTRAL VIEW.

*Location.*—Cecum.

*Localities.*—Cosmopolitan: Germany, Austria (Trieste), South America (Rio Janeiro), Australia (Brisbane), Africa (Abomey, Dahomey), India, United States (Washington, District of Columbia; Bowie and Bethesda, Maryland; Massachusetts; Wooster, Ohio; Kearney, Nebraska; Detroit, Michigan; Idabel, Oklahoma).



10mm.

FIG. 54.—*HETERAKIS SPUMOSA*. VULVA REGION OF FEMALE.

The above calls for some comment. In the first place, I have regarded *Heterakis dahomensis* Gendre, 1911, as a synonym of *Heterakis spumosa*. Gendre's figures and description seem to warrant this in spite of the fact that there are some discrepancies between his description and that commonly given or given in the above notes. His specimens measure a little larger than is usual, but still within the reasonable limit of variation. He only figures two papillae on the tail proper, but that may easily be due to errors of observation or even anomalies. The spicule measurement given by him (400  $\mu$ ) is longer than I find it. I find the connection between the vagina and the uteri rather difficult to ascertain; but the point of union appears to be just a little posterior of the vulva. This is approximately where Cobb (1896) states that the vagina and uteri meet in the type species, *H. vesicularis*, but I have found on dissection that the vagina and ovijector in

that species make up a much larger affair extending far posterior of the vulva. Cobb's figuring would make the distance from the vulva to the utero-vaginal union about 340 or 350  $\mu$ . In a dissected specimen I find the actual distance to be 4.472 mm. and something of the same sort may be true of *H. spumosa*.

I have also made *Ganguleterakis gangula* Lane, 1914, a synonym of *Heterakis spumosa*. Lane's species was collected from *Epimys nor-*

*vegicus* in India, and his description and figures leave no doubt that this is *Heterakis spumosa*. He quotes Schneider's (1866) description of *H. spumosa* and then states: "I have been unable to obtain any specimens of *H. spumosa* from Europe. The difference in length makes it reasonable to conclude that this is a different species from that now described." It appeals to the present writer as unsafe to make a new species on a slight difference in size where a described species is known to exist in the same host and in the same location, as animals of all sorts have a more or less definite range of size but not a fixed size. As a matter of fact, my own measurements for *H. spumosa* vary beyond those given by Lane for his species and those given by Schneider for *H. spumosa*.

Genus PARASPIDODERA Travassos, 1914a.

*Generic diagnosis*.—Heterakinae (p. 44): Mouth with three large conspicuous lips. Esophageal bulb present. Males without caudal bursa. Spicules equal or subequal. Gubernaculum present. Vulva anterior to the middle of the body.

*Type-species*.—*Paraspidodera uncinata* Travassos, 1914a.

PARASPIDODERA UNCINATA Travassos, 1914a.

*Synonyms*.—*Ascaris uncinata* Rudolphi, 1819, of Travassos, 1914a; *Heterakis uncinata* Schneider, 1866, of Travassos, 1914a.

*Specific diagnosis*.—*Paraspidodera* (p. 49): Mouth with three large equal lips (fig. 55). Esophagus 1.098 to 1.169 mm. long. Excretory pore 540  $\mu$  from the anterior end.

*Male* 11 mm. long by 300  $\mu$  thick. No caudal bursa. Preanal sucker (figs. 56 and 57) round, about 68  $\mu$  wide, and with a chitinous ring bearing a papilliform node on the posterior margin. Seven pairs of preanal, 1 pair adanal, and 13 pairs of postanal papillae. Of the preanal papillae, one pair is somewhat anterior of the sucker, another is adjacent to the anterior margin of the sucker, another at the side of the sucker, another at the posterior border of the sucker, and three pairs nearer the anus. Of the postanal papillae, the two most anterior pairs are near the median line, the third pair is remote from the median line, and the remaining 10 pairs are arranged in two longitudinal lines on each side of the tail, the lines most remote from the median line presenting in profile on viewing the ventral surface

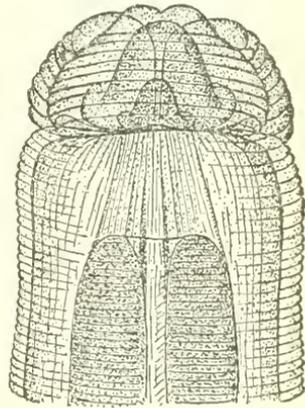


FIG. 55.—PARASPIDODERA UNCINATA. LATERAL VIEW OF HEAD. ENLARGED. AFTER TRAVASSOS, 1914.

of the worm. The spicules are nearly equal,  $470\ \mu$  long. The gubernaculum is  $136\ \mu$  long. The cloacal aperture is  $279\ \mu$  from the posterior end.

*Female* 16 mm. long by  $400\ \mu$  thick. The vulva is anterior to the middle of the body. Eggs ellipsoidal, 43 by  $31\ \mu$  in diameter, not

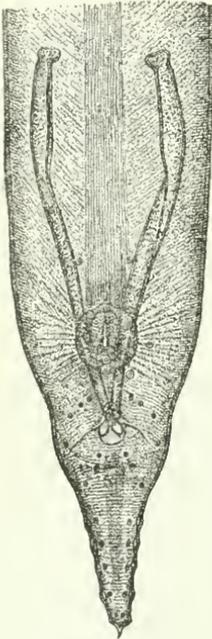


FIG. 56.—PARASPIDODERA UNCINATA. POSTERIOR EXTREMITY OF MALE; VENTRAL VIEW. ENLARGED. AFTER TRAVASSOS, 1914.

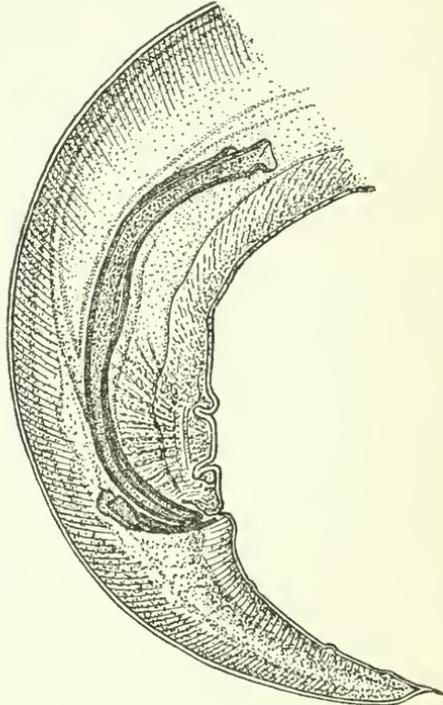


FIG. 57.—PARASPIDODERA UNCINATA. POSTERIOR EXTREMITY OF MALE; LATERAL VIEW. ENLARGED. AFTER TRAVASSOS, 1914.

segmenting when oviposited. Anus 1.198 mm. from the posterior end of the body.

*Host*.—*Cavia porcellus*.

*Location*.—Cecum and colon.

*Locality*.—Brazil.

The species described here, according to Travassos (1914*a*), "are considered to belong to *H. uncinata* Rudolphi, as they are of the same size, besides having also a long sidecrest." On comparing Travassos's figures and description with those for *Heterakis uncinata* given by Schneider (1866), I am unable to agree with this finding. It is true that the worms are of about the same size and that they both have lateral alae. It is also true that Schneider states that he had only a few poorly preserved specimens and that his description was consequently incomplete. But Schneider figures a long, fusi-

form sucker, apparently without a limiting chitinous ring and its accompanying papilliform node, and Travassos describes and figures a circular sucker with a prominent chitinous ring bearing on its posterior margin a papilliform node. Even in poorly preserved material the heavy chitinous sucker can be depended on to remain in evidence. Schneider figures a worm in which the distance from the sucker to the cloacal aperture is more than twice the distance from the tip of the tail to the cloacal aperture, whereas Travassos figures a worm in which the distance from the tip of the tail to the cloacal aperture is more than five times the distance from the sucker to the cloacal aperture. Schneider figures a total of 11 pairs of papillae, while Travassos describes and figures a total of 21 pairs of papillae. We must therefore conclude that Schneider gave a most inaccurate account of the important features of his specimens or that Travassos had described a new species. Without feeling that a final verdict is possible, I still believe it is better to keep two apparently different species separate rather than to suppress Schneider's description. I have therefore accepted Travassos's species as a new one, and accepted the name as a new one, regarding this species as type of the new genus. The specific name is to be regarded as valid and based on a misdetermination. There is some question as to the proper action in a case of this sort, but as this action makes no change in the name I have preferred it.

Subfamily SUBULURINAE Travassos, 1914a.

*Synonym.*—Kathlaniinae Lane, 1914.

*Subfamily diagnosis.*—Heterakidae (p. 44): Mouth with lips inconspicuous or lacking, rarely with three lips, followed by a vestibule; esophageal bulb present; preanal sucker fusiform and not limited by a chitinous ring; spicules unequal, one or both occasionally lacking or imperfectly chitinized; gubernaculum usually present, rarely lacking.

*Type-genus.*—*Subulura* Molin, 1860b.

The present writer is unable to determine whether Subulurinae Travassos, 1914a, or Kathlaniinae Lane, 1914, is the earlier name, as Travassos's paper bears no date of publication and the date of receipt of available copies indicates nothing as to whether it preceded or followed Lane's paper. As matters stand, the name Subulurinae has been used because it is based on a better known genus from commoner and better known hosts. Lane's subfamily is based on a new genus and species of worm from the turtle in India, and a casual examination of the descriptions of the two included species suggests that certain features may in time warrant restricting his forms to a subfamily Kathlaniinae and divorcing it from the genera which may better be included under the Subulurinae.

## ANALYTICAL KEY TO GENERA OF SUBULURINAE.

1. Male with no spicules or accessory piece visible.....*Heteroxyzema*, p. 56.  
Male usually with 2 spicules; occasionally with 1..... 2.
2. Buccal cavity with very thick chitinous lining in anterior portion and with 3 small teeth, with a rounded free edge, limiting the esophageal aperture.....*Allodapa*, p. 60.  
Buccal cavity with a very thin lining and with 3 large teeth, with a sharp free edge, at its base.....*Subulura*, p. 52.

## Genus SUBULURA Molin, 1860b.

*Synonyms*.—*Heterakis* Dujardin, 1845, of authors; *Oxyzema* von Linstow, 1899, of Railliet and Henry, 1914, in part.

*Generic diagnosis*.—Subulurinae (p. 51): Mouth rarely with three lips, sometimes round, usually oval or hexagonal with the long axis dorso-ventral. Mouth followed by a vestibule with a very thin chitinous lining at the base of which are three large teeth, each with a sharp free edge, marking the beginning of the esophagus. Esophagus club-shaped, with a distinct terminal esophageal bulb. Six cephalic papillae usually quite distinct. Two lateral membranes often present. Males with caudal alae slightly developed or lacking. Spicules equal and provided with an accessory piece. Preanal sucker fusiform and without a chitinous ring. Female with the vulva near the middle of the body. Uterus probably similar to that of *Heterakis*. Eggs subglobular, almost always containing an embryo when oviposited.

*Type-species*.—*Subulura acutissima* Molin, 1860b.

Seurat (1915e) states that *Oxyzema* is a synonym of *Allodapa*, since *O. rectum* is identical with *Allodapa crassispiculum*. *Oxyzema* is not regarded, therefore, as a subgenus of *Subulura*.

## ANALYTICAL KEY TO SPECIES OF SUBULURA.

1. Head simple.....*Subulura andersoni*, p. 52.  
Head with 3 lips..... 2.
2. Male 13 mm. long; from *Cavia aperca*.....*Subulura uncinata*, p. 53.  
Male less than 12 mm. long; from *Euxerus erythropus*.....*Subulura boueti*, p. 54.

## SUBULURA ANDERSONI (Cobbold, 1876) Railliet and Henry, 1914.

*Synonym*.—*Ascaris andersoni* Cobbold, 1876.

*Specific diagnosis*.—*Subulura* (p. 52): Head simple and unarmed. Body finely drawn out in front and sharply pointed behind in both sexes.

*Male* attains a maximum length of 12.5 mm. Tail "furnished with a minute oval-shaped spine at the tip." Two long arcuate spicules slightly winged at the distal extremity (fig. 58).

*Female* attains a maximum length of 19 mm. and a thickness of 1 mm. Tail "with the terminal spine continuous and scarcely distinct" (fig. 58). Vulva not located. Ova nearly spherical, 50 to 63  $\mu$  in diameter, and containing coiled embryos when oviposited.

*Host*.—*Sciurus* species.

*Location*.—Cecum.

*Locality*.—Northeast India.

The presence of embryos in the egg when oviposited, as well as the site of infestation, indicate clearly that this is not a species of *Ascaris*, as Cobbold made it. Railliet and Henry have tentatively assigned it to the genus *Subulura*, and despite the fact that the evidence is quite incomplete in important respects, it still seems sufficiently likely to warrant placing it there rather than leaving it in a genus in which it obviously does not belong.

Cobbold's statement that the worm has a simple head has been used in the key to differentiate this species from the following, but Cobbold's study of his species was not adequate for proper description, and it can not be taken too seriously. The worm may or may not have lips.

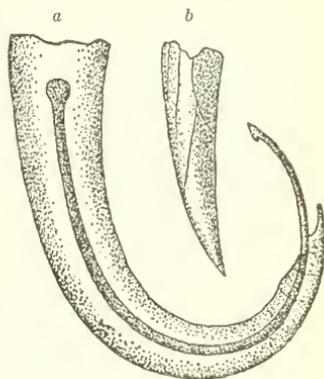


FIG. 58.—*SUBULURA ANDERSONI*. POSTERIOR EXTREMITY OF THE MALE (a) AND OF THE FEMALE (b). ENLARGED. AFTER COBBOLD, 1876.

*SUBULURA UNCINATA* (Rudolphi, 1819) Hall, 1916.

*Synonyms*.—*Ascaris uncinata* Rudolphi, 1819; *Heterakis uncinata* (Rudolphi, 1819) Schneider, 1866.

*Specific diagnosis*.—*Subulura* (p. 52): Mouth with three lips. Lateral membrane begins one-third of the length of the body from the head.

*Male* 13 mm. long. Tail ends in an attenuate unciniform apex (fig. 59). Bursa very little developed. There are five pairs of preanal papillae, of which one pair is adjacent to the sucker, three pairs close to the cloacal aperture, and one pair about halfway between the cloacal aperture and the sucker. There are six pairs of postanal papillae. One pair of preanal and one pair of postanal papillae are large and prominent. The sucker is fusiform and, judging from this shape and from Schneider's figure, is without a chitinous ring.

*Female*.—16 mm. long. Tail straight and sharp.

*Hosts*.—*Cavia aperia* (*Cavia aperia*), *Cuniculus paca* (*Agouti paca*).

*Location*.—Cecum.

*Locality*.—Brazil.

This is the species which Travassos has regarded as identical with his *Paraspidodera uncinata*. For reasons given in the discussion of that species, it seems safer to regard the two species as distinct. On the other hand, it seems quite likely, as far as the descriptions are concerned, that *Subulura boueti* and *S. uncinata* are identical, though they are kept separate here on account of the different hosts and localities and to await additional data. The only difference in size utilized in compiling the key is of no significance.

*SUBULURA BOUETI* (Gendre, 1911) Travassos, 1913.

*Synonyms*.—*Heterakis boueti* Gendre, 1911; *Subulura (Oxynema) boueti* (Gendre, 1911) Railliet and Henry, 1914.

*Specific diagnosis*.—*Subulura* (p. 52): Body is pale yellow and is attenuated, especially posteriorly, in both sexes. There are two small lateral alae. The cuticle is finely striate. The cephalic extremity is truncated and shows no trace of lips or sign of demarcation from the rest of the body. The head bears six fungiform papillae, almost equidistant in arrangement, four of them submedian and two lateral, disposed in a circle about the buccal orifice which is large, circular, and yawning. The mouth cavity is large and cylindrical, its base provided with three strong muscular teeth covered with chitin. The pharynx is short. The esophagus thickens gradually to its posterior extremity where it presents a slight swelling. The esophageal bulb is rounded. The intestine, which at its origin is larger than the esophageal bulb, follows a straight line without notable variation to the anus. The excretory pore occurs on the ventral surface at the union of the anterior and middle third of the length of the esophagus.

FIG. 59.—*SUBULURA UNCINATA*. POSTERIOR EXTREMITY OF MALE; VENTRAL VIEW. ENLARGED. AFTER SCHNEIDER, 1866.

*Male* 9.55 to 11.10 mm. long and 440 to 480  $\mu$  thick. Esophagus 1/5.5 to 1/6 and tail 1/28 to 1/31.7 of total length of body. The posterior region (figs. 60 and 61) is always curved toward the ventral surface and terminates in a conical pointed tail, followed by a small mucronate appendix. It is provided with a bursa, of which the alae extended from the region of the sucker to the base of the caudal appendix. The sucker is oval and is not delimited by a chitinous ring. There are five pairs of preanal and six pairs of postanal papillae. The first pair of preanal is submedian and is even with the middle of

the sucker; the second pair is submedian and almost equidistant between the sucker and the cloacal aperture; the third pair is submedian and is just anterior of the cloacal aperture; the fourth and fifth pairs are close together and lateral, the fifth being farthest from the median line and sustaining the bursal membrane. The first and second pairs

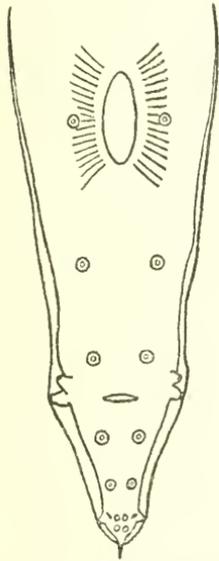


FIG. 60.—SUBULURA BOUETI. POSTERIOR EXTREMITY OF MALE; VENTRAL VIEW. ENLARGED. AFTER GENDRE, 1911.

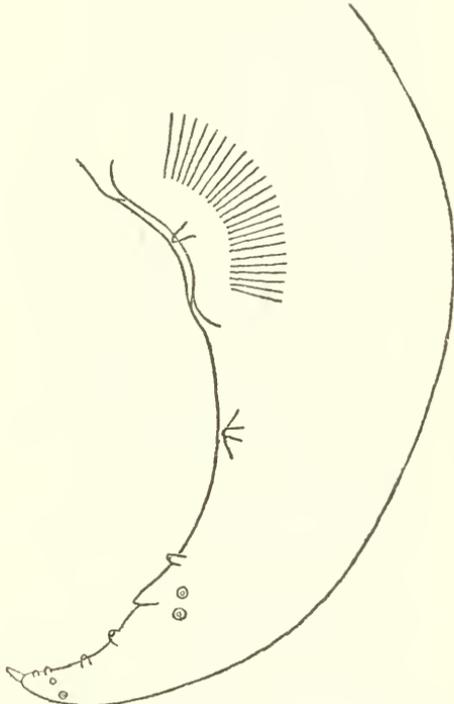
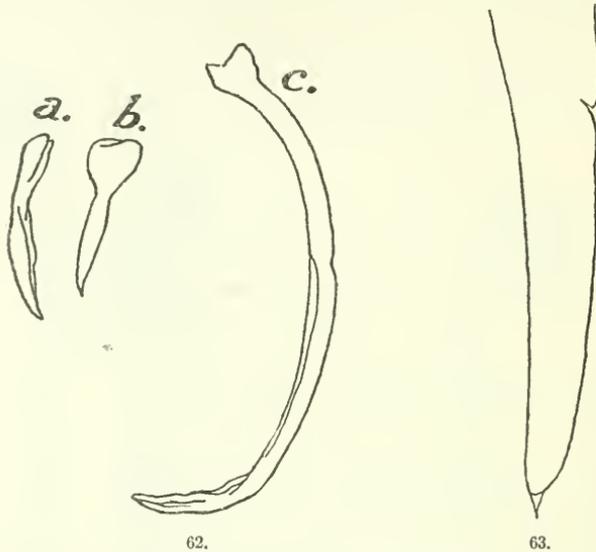


FIG. 61.—SUBULURA BOUETI. POSTERIOR EXTREMITY OF MALE; LATERAL VIEW. ENLARGED. AFTER GENDRE, 1911.

of postanal papillae are large and submedian; the fifth and sixth pairs are also submedian, but much smaller; the third and fourth pairs are lateral, the third pair sustaining the lateral membrane and the fourth pair being the smallest of all the papillae. There is a single spicule, the right, and an accessory piece (fig. 62). The spicule is strong, curved, and finely striate transversely. It is 980  $\mu$  long and is composed of two distinct parts; the short proximal part is cylindrical and terminates in a funnel-shaped head, while the longer distal part terminates in a point and is provided with two lateral alae. The accessory piece is awl-shaped and abruptly enlarged at the base. On its ventral face is a groove, along which the spicule slides, formed by a simple depression on the side of the base and by two small, flexible, membranous folds on the side of the point.

*Female* 15.52 to 18.78 mm. long and 600 to 640  $\mu$  thick. Esophagus is 1/7.6 to 1/8.4 and tail 1/11.9 to 1/13.8 of the total body length.

The tail (fig. 63) is straight and conical and terminates in a small point comparable to that of the male. The vulva is very prominent and visible to the naked eye. It opens transversely on the ventral surface in the anterior portion of the body about  $1/2.5$  of the total



FIGS. 62, 63.—SUBULURA BOUETI. 62, ACCESSORY PIECE IN ANTERIOR, *a*, AND POSTERIOR, *b*, VIEW, AND THE SPICULE, *c*. AFTER GENDRE, 1911. 63, POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER GENDRE, 1911.

body length from the head. The genital apparatus is double. The eggs have thin shells and are rounded in shape. They average  $62 \mu$  long and  $52 \mu$  wide. They contain an embryo, always rolled up like a snail, in a uniform fashion, when oviposited.

*Host*.—*Euxerus erythropus* (*Xerus erythropus*).

*Location*.—Intestine.

*Locality*.—Agouagon, Dahomey.

As noted in the discussion of *S. uncinata*, there seem to be no morphological differences between that species and *S. boueti*.

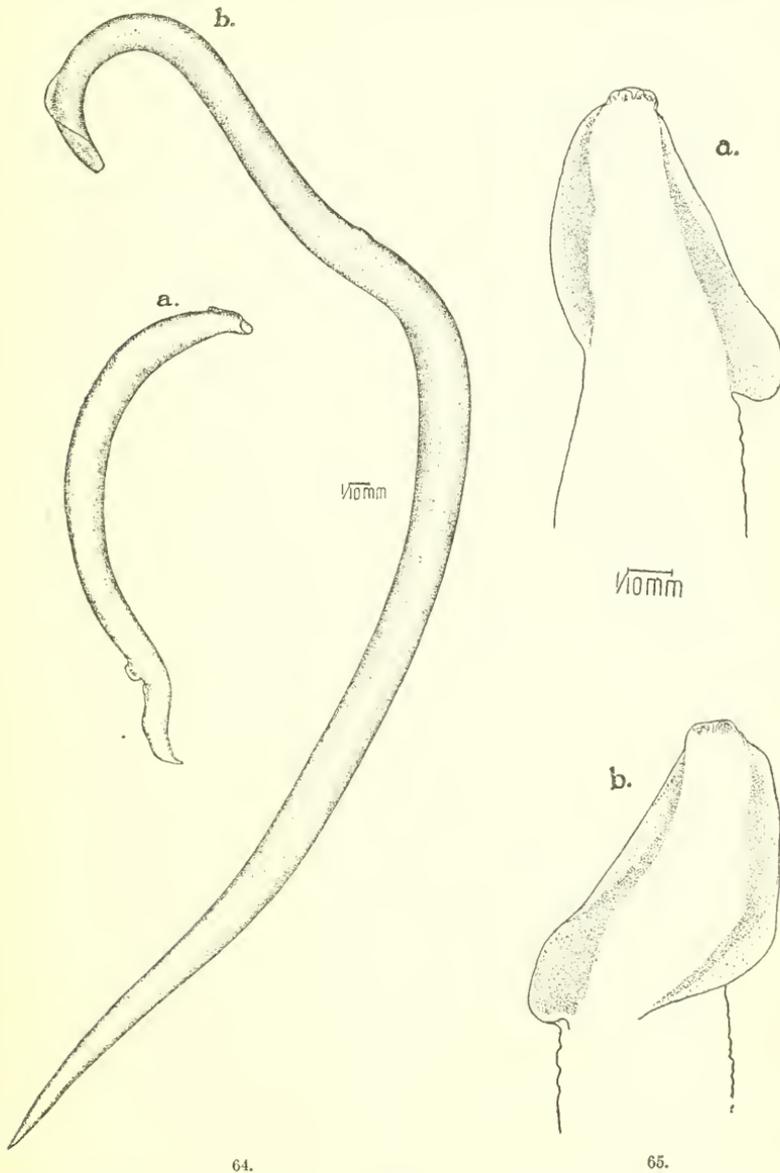
#### HETEROXYNEMA Hall, 1916, new genus.

*Generic diagnosis*.—Subulurinae (p. 51): Mouth with three lips; teeth feebly, if at all, developed at the base of the mouth. Two cervical alae present. No spicules or gubernaculum visible. Pre-anal sucker fusiform and without a chitinous margin, the margin consisting of a delicate cuticular membrane, which is apparently lacking in the median line anteriorly and posteriorly, so that the sucker has two lateral cuticular membranes. The vulva is near the union of the anterior and middle thirds of the body. The eggs are bluntly pointed, somewhat similar to those of *Oxyuris*.

*Type-species*.—*Heteroxy nema cucullatum* Hall, 1916.

## HETEROXYNEMA CUCULLATUM Hall, 1916, new species.

*Specific diagnosis.*—*Heteroxyinema* (p. 56): Males approximately half as long or less than half as long as females (fig. 64). The



FIGS. 64, 65.—HETEROXYNEMA CUCULLATUM. 64, MALE, *a*, AND FEMALE, *b*. 65, HEAD: *a*, DORSAL VIEW; *b*, VENTRAL VIEW.

cuticle has a transverse striation. There are three simple lips, one dorsal and two latero-ventral, each bearing a median papilla apparently double and with a papilla between the adjacent lips. The

buccal cavity is simple and shallow. The esophagus is club-shaped, gradually thickening posteriorly and terminating in a bulb. The bulb is often deeply set in the dilated enfolding anterior end of the intestine. The prominent cervical alae start at the base of the lips and swing around toward the ventral surface (fig. 65).

*Male* 2.786 to 4.47 mm. long and 140 to 170  $\mu$ . thick in front of sucker. Head diameter about 65  $\mu$ . The esophagus, exclusive of the bulb, is about 355 to 515  $\mu$  long and 50 to 70  $\mu$ . thick. The bulb is 136 to 172  $\mu$  long and 112 to 145  $\mu$ . thick. Nerve ring 130  $\mu$ . from head end in one specimen. The bursal membrane is very slightly developed. Most of the caudal papillae (fig. 66) are clustered about the cloacal aperture, a single pair

holding an isolated position 85 to 112  $\mu$  from the tip of the tail. The cloacal aperture is about 235  $\mu$  from the end of the tail. Here is a line of 6 adanal papillae, two outer larger ones and two smaller ones just median of each of these. Just posterior of these papillae is a pair in the submedian position, followed directly by an

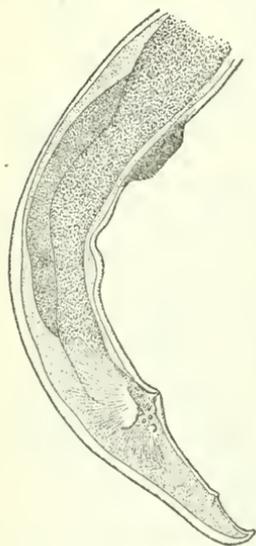


FIG. 66.—HETEROXYNEMA CUCULLATUM. POSTERIOR EXTREMITY OF MALE.

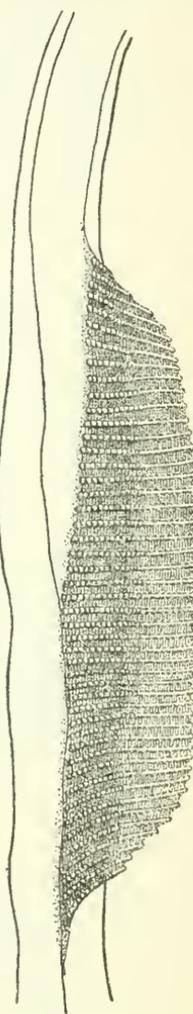


FIG. 67.—HETEROXYNEMA CUCULLATUM. ANAL SUCKER OF MALE.

unpaired papilla in the median line. No preanal papillae have been observed, the total number of papillae present being 11. There are no spicules present. The sucker (fig. 67) has a delicate longitudinal and transverse sculpturing which gives the effect of fenestration.

It is fusiform, 112 to 130  $\mu$  long and of variable width owing to contraction and folding of the flexible edges. These cuticular membranes are on the lateral margins of the sucker, but are apparently lacking in the median line anteriorly and posteriorly. The posterior border of the sucker is about 515 to 600  $\mu$  from the tip of the tail.

*Female* 7.39 to 7.9 mm. long and 345 to 415  $\mu$  thick in the region of the vulva. The posterior end of the body terminates in a blunt point. The esophagus, exclusive of the bulb, is about 430 to 535  $\mu$  long and 56 to 70  $\mu$  thick. The bulb is 198 to 240  $\mu$  long and 130 to 185  $\mu$  thick. Nerve ring 170  $\mu$  from head in one specimen. The anus is about 1.65 mm. from the tip of the tail. The vulva is at the union of the anterior and middle thirds of the body, 1.8 to 3.265 mm. from the head. The vagina has its walls wound with a close spiral similar to that of *Heterakis spumosa*, and ex-

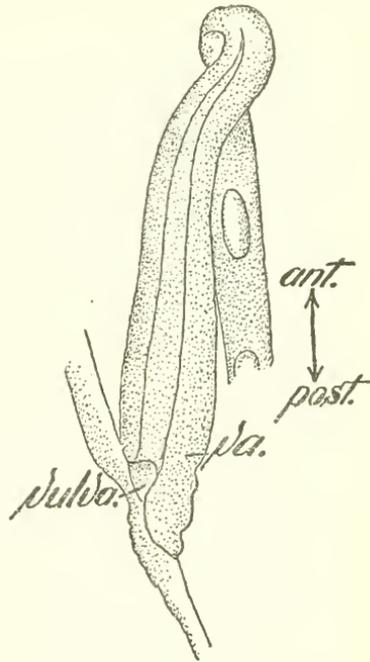


FIG. 68.—*HETEROXYNEMA CUCULLATUM*. VULVA REGION OF FEMALE, SHOWING POSITION OF VAGINA.  $\times 92.5$ .

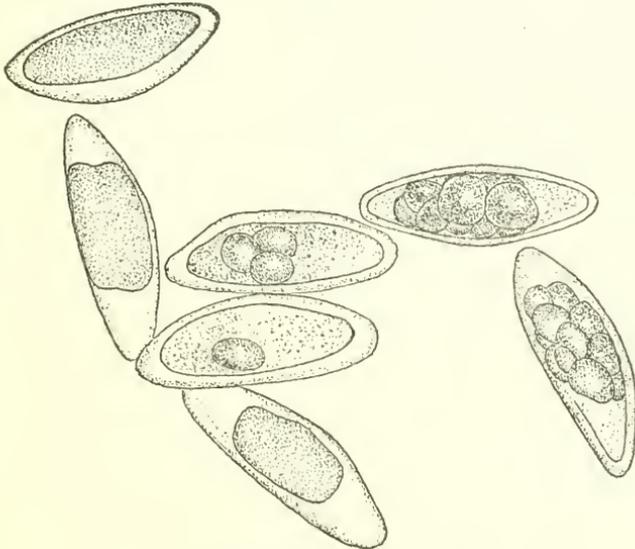


FIG. 69.—*HETEROXYNEMA CUCULLATUM*. EGGS.  $\times 340$ .

tends forward from the vulva toward the head and then turns back toward the tail (fig. 68). The posterior portion of the body is densely

filled with uterine convolutions distended with eggs. Apparently two uterine branches. The eggs (fig. 69) are of the same type as those of *Oxyuris*, elongated, flattened on one side and the ends terminating in rounded points. They are 98 to 100  $\mu$  long and 35  $\mu$  thick.

*Host*.—*Eutamias amoenus operarius*.

*Location*.—Cecum and large intestine.

*Locality*.—San Acacio, Costilla County, Colorado.

*Type material*.—No. 16637, U.S.N.M. (Bureau of Animal Industry helminthological collection).

It seems probable that the males in the writer's possession are sufficiently mature to have the spicules developed, as the eggs in the females show various segmentation stages.

#### Genus ALLODAPA Diesing, 1861.

*Synonym*.—Not *Allodapa* Brunn, 1878, orthopteron; *Oxyinema* von Linstow, 1899.

*Generic diagnosis*.—Subulurinae (p. 51): Body reddish in color, thick, attenuated posteriorly, and with two lateral cervical alae. Mouth elongated dorso-ventrally and surrounded by six papillae. The buccal cavity with a thick chitinous lining in its anterior portion; at its base three small teeth, with a rounded free edge, limiting the entrance to the esophagus. The esophagus is club-shaped posteriorly, and there is a distinct esophageal bulb. The nerve ring surrounds the anterior portion of the esophagus and the ventral excretory pore is posterior of the nerve ring. The vulva is anterior of the middle of the body and is not prominent. The ovjector is directed anteriorly and is characterized by a very long sphincter, presenting at one point a globular secreting portion where the egg remains some time before oviposition. The male has straight caudal alae. There are two spicules, terminating in fine points, and a triangular gubernaculum. The sucker is some distance from the cloacal aperture, devoid of a chitinous ring and shows radiating muscular fibers.

*Type-species*.—*Allodapa allodapa* (Creplin, 1853) Seurat, 1914a.

Seurat (1915e) states that the type of *Oxyinema*, *O. rectum*, is identical with *Allodapa crassispiculum*.

#### ALLODAPA ELONGATA Seurat, 1914c.

*Specific diagnosis*.—*Allodapa* (p. 60): Long, slender worms, with straight cervical alae which are finely striate transversely and do not extend posterior of the middle of the esophagus. Mouth surrounded with six papillae. The buccal cavity (fig. 70) divided into two parts, the anterior portion with a thick chitinous lining, the posterior portion with a separate thick chitinous lining and with three cuneiform, sharp-pointed, slightly bent teeth.

*Male* 20.5 mm. long. Esophagus very short, the total length, including the bulb, equal to one-fourteenth of the body length. The tail (fig. 71) is short; the distance from the cloacal aperture to the tip of the tail is  $230\ \mu$ . The sucker is feebly developed, elongated and without chitinous ring. The caudal alae are straight. There are 10 pairs of caudal papillae, of which 5 are preanal and 5 postanal. The most anterior pair of preanal is asymmetrically disposed in the region of the sucker; the second pair asymmetrically disposed in the region near the origin of the caudal alae; the third pair is asymmetrically disposed in the region of the gubernaculum; the fourth and fifth pairs are close together and slightly asymmetrical in the region just anterior of the cloacal aperture, the fifth pair supporting the caudal alae. The first and second pairs of postanal papillae are sessile and are symmetrically disposed; the third pair supports the caudal alae; the fourth pair is sessile and symmetrical; the fifth pair is quite asymmetrical and supports the caudal alae. The caudal glands

open on the ventral surface between the third and fourth postanal papillae. The spicules are short and equal,  $250\ \mu$  long. The gubernaculum is shaped like an arrowhead and is  $120\ \mu$  long.

*Female* 36 mm. long, with a

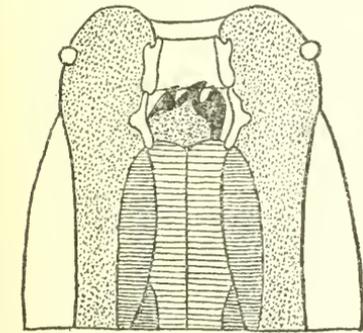


FIG. 70.—ALLODAPA ELONGATA. LATERAL VIEW OF OPTICAL SECTION OF THE HEAD.  $\times 120$ . AFTER SEURAT, 1914.

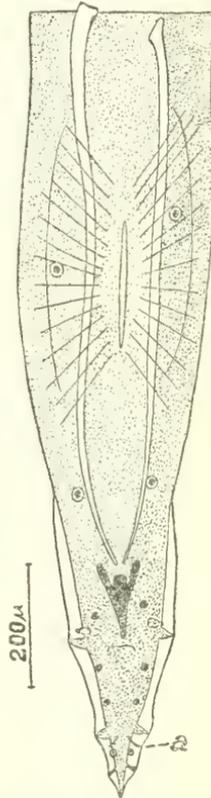


FIG. 71.—ALLODAPA ELONGATA. POSTERIOR EXTREMITY OF MALE; VENTRAL VIEW. a, ORIFICE OF CAUDAL GLAND. AFTER SEURAT, 1914.

maximum thickness of  $650\ \mu$ . The esophagus is very short; its length, including the bulb, is one-seventeenth of the total length of the worm. The short tail (fig. 72) is conical and  $915\ \mu$  long; the caudal glands open in its posterior fourth. The inconspicuous vulva is anterior of the middle of the body and divides the body in the ratio of 5:8. The ovijector is directed posteriorly (?), the very elongated tube attaining a length of 8 mm. The posterior uterus extends to the origin of the rectum and the anterior uterus extends within a millimeter of the

esophageal bulb, the ovaries being side by side in the prevulvar region. Eggs numerous, containing an embryo when oviposited, and 70 to 77  $\mu$  long by 63 to 65  $\mu$  thick.

*Host*.—*Dipodillus campestris* (*Dipodilla campestris*).

*Location*.—Cecum.

*Locality*.—Bou-Saâda, Algeria.

In a previous paper Seurat (1914*a*) has noted that *Allodapa* has the ovijector directed anteriorly. I have queried in the foregoing his statement that *A. elongata* has the ovijector directed posteriorly.

SEURATINAE Hall, 1916, new subfamily.

*Subfamily diagnosis*.—Heterakidae (p. 44): Transitional forms in which the male is without an anal sucker. Mouth with two lips. No esophageal bulb present. Male with short, equal, or subequal spicules, and with a gubernaculum. Vulva near middle of body. Uteri divergent.

*Type-genus*.—*Seuratum* Hall, 1916.

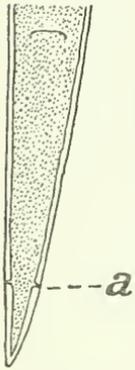


FIG. 72.—*ALLODAPA ELONGATA*. POSTERIOR EXTREMITY OF FEMALE; VENTRAL VIEW. *a*, ORIFICE OF CAUDAL GLAND. ENLARGED. AFTER SEURAT, 1914.

SEURATUM Hall, 1916, new genus.

*Synonym*.—*Ophiostomum* Creplin, 1839, of Seurat, 1915*a*.

*Generic diagnosis*.—Seuratinae (p. 62): Characters of the subfamily.

*Type-species*.—*Seuratum tacapense* (Seurat, 1915*a*) Hall, 1916.

This genus is named after Seurat, in recognition of his considerable contributions to nematology, especially in regard to the structure and importance of the female genitalia.

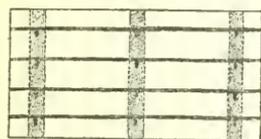
SEURATUM TACAPENSE (Seurat, 1915*a*) Hall, 1916.

*Synonym*.—*Ophiostomum tacapense* Seurat, 1915*a*.

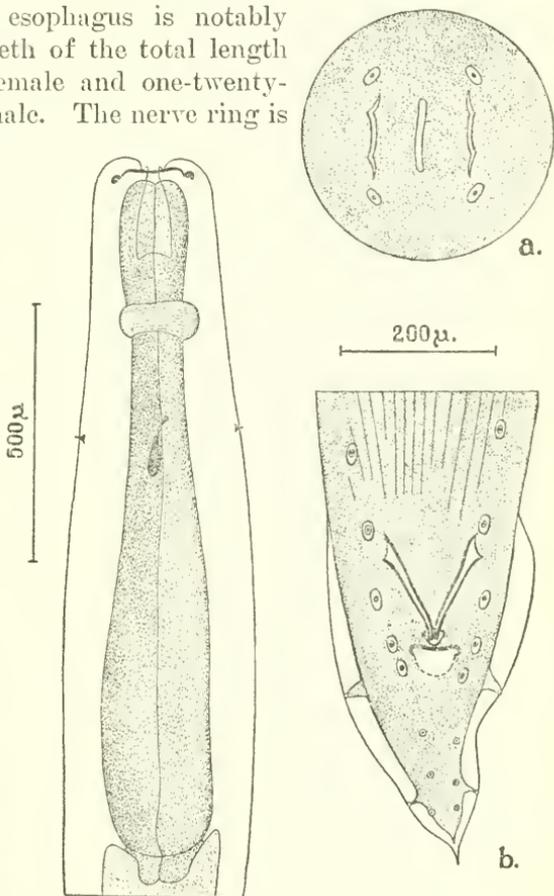
*Specific diagnosis*.—*Seuratum* (p. 62): Slender worms, attenuate at both extremities, the posterior extremity terminating in a small mucronation. Cuticle with fine transverse striations at intervals of 10  $\mu$ , and with 64 longitudinal bands, very straight, dark, and presenting in the median line of each band a dentiform thickening of the transverse striations, the point of this dentiform structure being directed posteriorly (fig. 73). The straight lateral lines are 60  $\mu$  wide. No lateral alae present. There are numerous long straight muscle cells. There are two not very prominent cervical papillae, situated about two-fifths of the length of the esophagus from its anterior extremity. The excretory pore is very small and opens

in the mid-ventral line posterior of the nerve ring and a little anterior of the level of the cervical papillae (fig. 74). The mouth (fig. 75) is elongated dorso-ventrally and bounded by two lateral lips with a thick internal border; each lip bears two large papillae. The mouth opens into a very short buccal cavity with a thick lining. The esophagus is notably short; it is one-twentieth of the total length of the body of the female and one-twenty-second of that of the male. The nerve ring is situated one-fifth of the length of the esophagus from the anterior extremity. There is no division into muscular and glandular portions. The posterior extremity at the union with the intestine has a valvular structure.

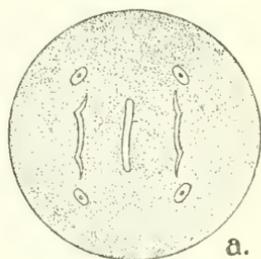
*Male* 18.5 to 22.5 mm. long and with a maximum thickness of 480  $\mu$ . The short, conical tail terminates in a small mucronation. The



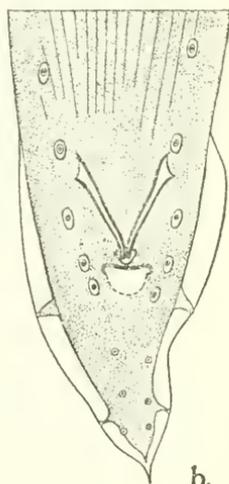
73.



74.



a.



b.

75.

FIGS. 73-75.—*SEURATUM TACAPENSE*. 73, A FRAGMENT OF CUTICLE. MAGNIFIED. AFTER SEURAT, 1915. 74, ANTERIOR EXTREMITY OF BODY. AFTER SEURAT, 1915. 75, a, HEAD VIEWED FROM THE FRONT; b, POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. AFTER SEURAT, 1915.

distance from the cloacal aperture to the posterior extremity of the tail is 250  $\mu$ . There are two straight symmetrical bursal alae (fig. 75). From a distance anterior of the cloacal aperture the ventral region of the body is covered with about 20 longitudinal rows of cuticular shields which become confluent a short distance anterior of the cloacal aperture; the circumcloacal region and the bursal alae are entirely covered with these shields, with a resultant verrucous appearance; only the inferior lip of the cloacal aperture

forms a smooth semicircular area. The transverse striation terminates on the ventral surface 300  $\mu$  anterior of the cloacal aperture. The cloacal aperture is bounded by a very distinct anterior border. There are four pairs of large sessile preanal papillae, the first pair being situated anterior of the origin of the bursal alae. There are six pairs of postanal papillae, of which the second and fifth pairs posterior of the cloacal aperture are pedunculated. The short spicules are equal or subequal, 140  $\mu$  long, and slightly curved. They are only in contact at their distal extremities, forming a V inside the gubernaculum; the very small gubernaculum is triangular.

*Female* 45 mm. long with a maximum thickness of 900  $\mu$ . The cervical papillae are 600  $\mu$  from the anterior extremity, and the excretory pore is 450  $\mu$  from the anterior extremity. The short tail is 710  $\mu$  long and terminates in a small mucronation. The vulva is hard to locate. It opens 2 mm. anterior of the middle of the body and is a transverse slit 45  $\mu$  long, communicating with a short vagina, which is continued as a tubular ovijector which extends anteriorly and then turns and continues posteriorly. The uteri are divergent. The relatively large subspherical eggs are 52 by 42  $\mu$  in diameter and contain an embryo when oviposited.

*Host*.—*Ctenodactylus gundi*.

*Location*.—Small intestine.

*Locality*.—Matmata, South Tunis.

Seurat states that this species is very close to *Ophiostomum mucronatum* Rudolphi from the bat, differing in its larger size, the more posterior position of the vulva, and in the dimension of the eggs. He adds that this brings up the number of species in this genus to two, since the other nematodes described for this genus belong to other genera. Unfortunately, the type of the genus *Ophiostomum* Creplin, 1839, emendation of *Ophiostoma* Rudolphi, 1801, is also the type of the genus *Cystidicola* Fischer, 1798, thus eliminating *Ophiostomum* entirely as a generic name. He states that it is related in some ways to those members of the Heterakidae with two lips and with *Dichylene* in the Acuariidae.

The site of infestation, the small intestine, makes it entirely unlikely that this form should have a very close relationship with the Acuariidae, a family of the Filarioidea, as no members of the Filarioidea are known to be parasitic in the small intestine. On the other hand, the relationship to the Heterakidae is so marked that I have felt it necessary to include this form in that family in spite of the fact that there appears to be no anal sucker in the male. Its nearest generic affinities are perhaps with *Dacnitis*, which also lacks an esophageal bulb, has a mouth with two lips, and has the vulva in the middle of the body, two equal spicules and a gubernaculum in the male, but differs in the possession of a sucker, though the sucker,

it should be noted, is one without a chitinous margin, and therefore of relatively weak development.

Family OXYURIDAE Cobbold, 1864.

*Family diagnosis.*—Ascaroidea (p. 39): Meromyarian. Mouth with simple, usually inconspicuous lips. Male usually with one spicule, at times reduced, imperfectly chitinized or absent. Caudal extremity of female much elongated and subulate. Vulva anterior. Eggs characteristically flattened on one side.

*Type-genus.*—*Oxyuris* Rudolphi, 1803.

Seurat (1915*b*) states that the Oxyuridae, although considered by most authors as belonging with the Ascaridae, are very distinct and should be considered as a special group having the same origin as the Heterakidae, but having evolved independent of the latter. The Ascaridae, on the contrary, he would consider as the extreme type of one ramification of what he calls the phylum Heterakidae.

OXYURINÆ Hall, 1916, new subfamily.

*Subfamily diagnosis.*—Oxyuridae (p. 65): Males with one spicule, at times lacking or imperfectly chitinized.

*Type-genus.*—*Oxyuris* Rudolphi, 1803.

ANALYTICAL KEY TO GENERA OF OXYURINÆ.

1. Males with a longitudinal row of transverse comblike cuticular structures on the ventral surface.....*Dermatoxys*, p. 99.
- Males without such structure.....*Oxyuris*, p. 65.

Genus OXYURIS Rudolphi, 1803.

*Synonyms.*—*Oxyurus* Lamarck, 1816; *Lepturis* Schlotthauber, 1860; *Dermatoxys* Schneider, 1866; *Oxiurus* Sonsino, 1878; *Oxyurus* Rudolphi, 1803, of Brumpt, 1910; *Syphacia* Seurat, 1916; *Fusarella* Seurat, 1916.

*Generic diagnosis.*—Oxyurinae (p. 65): Mouth naked or surrounded by slightly salient lips. Esophagus long, followed by a bulb, usually quite distinct. Males small and of relatively rare occurrence; provided with one spicule, which may be imperfectly chitinized or not developed. One or more pairs of papillae in the vicinity of the cloacal aperture. Females have the caudal extremity greatly elongated and subulate. There are two ovaries. The vulva is located in the anterior portion of the body as a rule. The eggs are elongated, thin shelled, asymmetrical, flattened on one side and ending in rounded points. Embryo may or may not be formed at oviposition: In *O. vivipara* some females are oviparous and some viviparous.

*Type-species.*—*Oxyuris equi* (Schrank, 1788) Blanchard, 1849.

The genus *Oxyuris* includes about 100 species, but a study of over a dozen species shows the general characteristics quite constant and the variable features not readily capable of a group arrangement.

## ANALYTICAL KEY TO SPECIES OF OXYURIS.

*Females.*

1. Description inadequate; in *Procavia syriaca* (*Hyrax syriacus*).  
*Oxyuris pugio*, p. 83.  
Description recognizable ----- 2.
2. Vagina normally everted externally through vulva ----- 15.  
Vagina not normally prolapsed ----- 3.
3. Over 2 cm. long, the tail approximately equal to the rest of body.  
*Oxyuris obesa*, p. 80.  
Less than 2 cm. long, or if more, tail not approximately equal to rest of  
body ----- 4.
4. Mouth with six hooklike lips bent outward ----- *Oxyuris hamata*, p. 79.  
Mouth not provided with hooklike lips ----- 5.
5. Tail ornamented with 35 to 48 prominent cuticular annuli.  
*Oxyuris ambigua*, p. 68.  
Tail not ornamented with cuticular annuli ----- 6.
6. Head strongly inflated; cervical alae terminate posteriorly in recurved  
margins ----- *Oxyuris tetraptera*, p. 86.  
Head not strongly inflated ----- 7.
7. Posterior half of esophagus conspicuously pigmented brown.  
*Oxyuris polyoon*, p. 98.  
Posterior half of esophagus not differentially pigmented ----- 8.
8. Over 20 mm. long ----- *Oxyuris flagellum*, p. 77.  
Less than 20 mm. long ----- 9.
9. Over 15 mm. long ----- *Oxyuris seiuri*, p. 84.  
Less than 15 mm. long ----- 10.
10. Over 10 mm. long ----- *Oxyuris stossichi*, p. 84.  
Less than 10 mm. long ----- 11.
11. Over 8 mm. long ----- *Oxyuris acutissima*, p. 67.  
Less than 8 mm. long ----- 12.
12. Cervical alae present ----- *Oxyuris ungula*, p. 94.  
Cervical alae absent or inconspicuous ----- 13.
13. Mouth with four double and two single papillae ----- *Oxyuris stroma*, p. 85.  
Mouth with single papillae ----- 14.
14. Vulva transversely elongate and followed posteriorly by bulla.  
*Oxyuris triradiata*, p. 90.  
Vulva on a more or less prominent cone, not followed by bulla.  
*Oxyuris obrvclata*, p. 81.
15. Not over 3 mm. long; lateral alae in median region of body.  
*Oxyuris pallaryi*, p. 95.  
More than 5 mm. long; no lateral alae in median region of body ----- 16.
16. Maximum length 18 mm. ----- *Oxyuris evoluta*, p. 70.  
Maximum length 12.7 mm. ----- *Oxyuris hilgerti*, p. 74.

*Males.*

1. Males unknown ----- *Oxyuris acutissima* (p. 67), *O. flagellum* (p. 77), *O. hamata*  
(p. 79), *O. obesa* (p. 80), *O. seiuri* (p. 84), *O. pugio* (p. 83).  
Males known ----- 2.

2. Not over 2 mm. long; tail with preanal bulla and 3 large preanal cuticular bolsters.....*Oxyuris stroma*, p. 85.  
Not over 2 mm. long and with only 2 preanal cuticular bosses; or more than 2 mm. long and no preanal bulla or bolsters present..... 3.
3. Not over 2 mm. long and with 2 preanal cuticular bosses.  
*Oxyuris pallaryi*, p. 95.  
More than 2 mm. long and no preanal bosses present..... 4.
4. Tail hoof-shaped in lateral view and with two cuticular projections on each side.....*Oxyuris ungula*, p. 94.  
Tail not hoof-shaped..... 5.
5. Prominent bursa supported by a large dorsal and 2 large lateral rays.  
*Oxyuris triradiata*, p. 90.  
No such bursa formation..... 6.
6. Posterior half of esophagus conspicuously pigmented brown.  
*Oxyuris polyoon*, p. 98.  
Posterior half of esophagus not differentially pigmented..... 7.
7. No lateral alae other than small cuticular ridges on each side of lateral lines.....*Oxyuris ambigua*, p. 68.  
Lateral alae present in cervical region..... 8.
8. Prominent conical raylike postanal papillae.....*Oxyuris evoluta*, p. 70.  
Postanal papillae not raylike..... 9.
9. From 5 to 8 mm. long.....*Oxyuris stossichi*, p. 84.  
Not over 6.2 mm. long..... 10.
10. From 3.8 to 6.2 mm. long.....*Oxyuris hilgerti*, p. 74.  
Not over 3 mm. long..... 11.
11. Head strongly inflated; cervical alae terminating posteriorly in recurved margins.....*Oxyuris tetraptera*, p. 86.
12. Head not strongly inflated; no cervical alae present.....*Oxyuris obvelata*, p. 81.

OXYURIS ACUTISSIMA (Zeder, 1800) Hall, 1916.

*Synonyms*.—*Fusaria acutissima* Zeder, 1800; *Ascaris acutissima* (Zeder, 1800) Rudolphi, 1809.

*Specific diagnosis*.—*Oxyuris* (p. 65): Body thinned at both ends, the anterior end thicker. Head pointed, with three lips. Two lateral alae extending to the caudal extremity. Esophagus at first narrow, then considerably dilated, and separated by a constriction from the much dilated origin of the intestine.

*Male* unknown.

*Female* 8.4 mm. long. Tail almost trihedral, subulate, diaphanous, and comprising almost a third of the entire length of the worm. The vulva has prominent lips and is situated at the thickest part of the body.

*Host*.—*Sciurus vulgaris*.

*Location*.—Cecum.

*Locality*.—Vienna, Austria.

Dujardin (1845) states that he has not been able to find this parasite, but from the description of Zeder, the only one who has seen the worm, he judges it be an *Oxyuris*. There appears to be little question but that this should be transferred to the genus *Oxyuris*.

## OXYURIS AMBIGUA Rudolphi, 1819.

*Synonyms.*—*Oxyurus ambigua* (Rudolphi, 1819) Bellingham, 1844; *Passalurus ambiguus* (Rudolphi, 1819), Dujardin, 1845.

*Specific diagnosis.*—*Oxyuris* (p. 65): The usual *Oxyuris* shape, that of a spindle greatly prolonged and attenuated posteriorly. The mouth is simple and is surrounded by four symmetrically arranged papillae. The pharynx is armed with a tripartite, chitinized dental structure. The esophagus is club-shaped, increasing in size posteriorly, and is separated from the spherical esophageal bulb by a deep constriction. The bulb contains a chitinized apparatus for the comminution of food. The esophageal bulb is separated from the anterior portion of the intestine by a deep constriction. The intestine is a straight thin-walled tube of almost uniform diameter, which is separated from the rectum by a pronounced constriction. The rectum is piriform and short in young specimens; it is elongated in older ones. Internally it presents a division into an anterior and posterior portion. There are a number of conspicuous cell structures, possibly glandular in nature, in connection with the rectum. There are no lateral alae, but there are sharp enticular ridges on each side of each lateral line which show as distinct parallel lines on each side of the body. There is a prominent transverse striation.

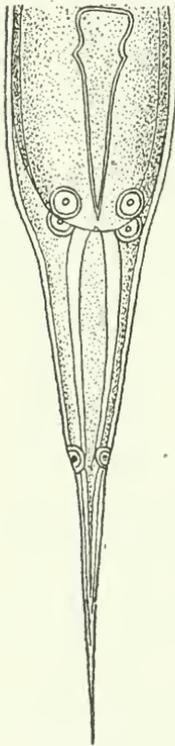


FIG. 76.—OXYURIS AMBIGUA. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1899.

*Male* 4.3 to 5 mm. long (von Linstow (1899) says 2.9 mm.) and 240 to 275  $\mu$  thick. Head diameter, 55 to 60  $\mu$ . Esophagus, exclusive of the bulb, 370 to 412  $\mu$  long and with a maximum thickness of 60 to 70  $\mu$ . Esophageal bulb almost spherical, 120 to 130  $\mu$  long by 112 to 125  $\mu$  thick. The nerve ring is 150 to 175  $\mu$  from the head end. The distance from the cloacal aperture to the posterior end of the body is 370 to 410  $\mu$ . There is a bursal membrane. There are five papillae in relation with the cloacal aperture (fig. 76). One pair of these, commonly regarded as pre-anal, is practically adanal. Another pair is postanal and very close to the cloacal aperture. The other papilla, unpaired, is directly behind the cloacal aperture. Another pair of papillae is located 130 to 150  $\mu$  posterior of the cloacal aperture at the point where the body of the worm suddenly narrows to form the long, thin tail, which is 225 to 260  $\mu$  long (fig. 77). The spicule is 90 to 120  $\mu$  long, simple in

shape, the first half of almost uniform diameter, with a gradual taper posteriorly and slightly curved.

*Female* 9 to 11 mm. long (von Linstow's measurements of 6.4 mm. must be regarded as those of rather small specimens) and attaining a maximum diameter behind the vulva of 515 to 590  $\mu$ . Head diameter, 50 to 70  $\mu$ . The posterior end of the body has a quite distinctive structure. Posterior of the anus is a long tail (fig. 78) which, with the exception of a thin terminal portion, shows in optical section, first the cuticle, externally, then the cellular walls of the prolonged body cavity, and finally the clear area indicative of the cavity itself, thus forming five parallel bands. For over half the length of this tail the proximal portion shows only a very fine transverse striation. The remaining distal portion shows a number of definite annular structures, usually 35 to 48 in number,

formed by the annular splitting of the cuticle, the part between the separated surfaces of cuticle containing a granular content (fig. 79). The proximal three or four of these annuli show an increasing size, the first being at times barely indicated, then there are a variable number of uniform size and finally a long series of annuli gradually diminishing in size. The

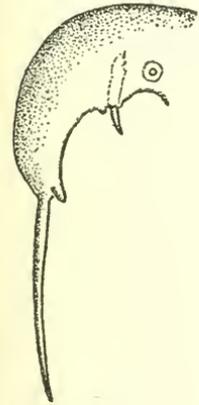


FIG. 77.—*OXYURIS AMBIGUA*. POSTERIOR EXTREMITY OF MALE, VIEWED FROM THE SIDE. ENLARGED. AFTER SCHNEIDER, 1866.

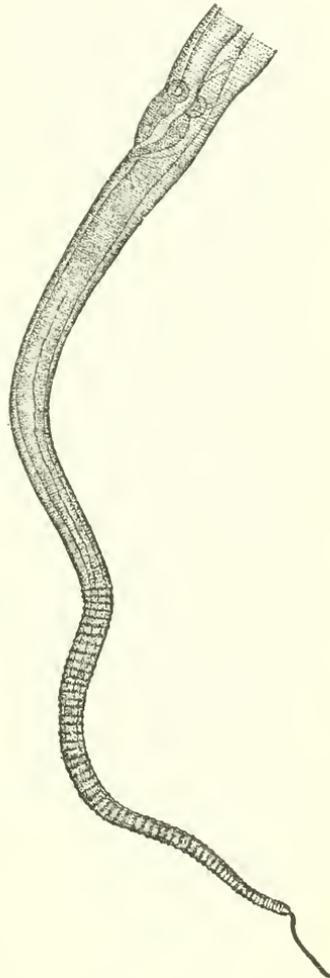


FIG. 78.—*OXYURIS AMBIGUA*. POSTERIOR EXTREMITY OF FEMALE. ENLARGED.

granular content gives the gross effect of dark bands and the microscopic effect of cuticular areolar markings. At the posterior end of this part of the tail there is a constant nucleus in the median field. The esophagus, exclusive of the esophageal bulb, is 495 to 535  $\mu$  long and 68 to 80  $\mu$  thick. The esophageal bulb is almost constantly spherical with a fairly uniform diameter in mature females of about

155  $\mu$ . The nerve ring is 190 to 215  $\mu$  behind the anterior end of the body. From the anus to the end of the tail is 2.34 to 4.51 mm., of which the thin, solid terminal portion is 190 to 210  $\mu$ . The vulva is 1.54 to 1.89 mm. from the anterior end. The vagina extends far posteriorly and then branches, sending two uteri forward. Eggs of typical *Oxyuris* shape, flattened on one side, 95 to 103  $\mu$  long by 43  $\mu$  thick in utero. (Von Linstow's measurements of 130 by 53  $\mu$  are probably for the eggs as oviposited.)

*Hosts.*—*Oryctolagus cuniculus* (*Lepus cuniculus*), *Lepus europaeus* (*Lepus timidus*), *Lepus arcticus* (*Lepus glacialis*), *Lepus* species, *Sylvilagus floridanus malurus*.

*Location.*—Cecum and large intestine. (Von Linstow (1899) lists it from "Cav. abdom.")

*Localities.*—Germany, Austria, United States (Washington, District of Columbia; Bethesda, Maryland; Nebraska; Detroit, Michigan).

*Life history.*—Probably direct and simple. Eggs oviposited in morula stage.

Schneider (1866) states that this species has a lateral membrane broadened on its free edge to form a T-shaped cross section. I am unable to verify this. So far as I can determine the only lateral membrane is that indicated by the cuticular ridges bounding the lateral lines. These might suggest a T-shaped cross section on focusing.

Dujardin (1845) makes this species type and only species of the genus *Passalurus*. The genus is apparently based on the mouth armature. I have retained it in *Oxyuris* on its general conformity. See Addendum, page 224.

*OXYURIS EVOLUTA* von Linstow, 1899.

*Synonym.*—*Oxyuris evaginata* Smith, 1908.

*Specific diagnosis.*—*Oxyuris* (p. 65): Body of typical *Oxyuris* shape, the female showing the prolonged posterior extremity. There are three large broad lips (fig. 80) and between them three other intermediate lip structures projecting nearer to the median longitudinal axis. Posterior and median of these and forming an anterior

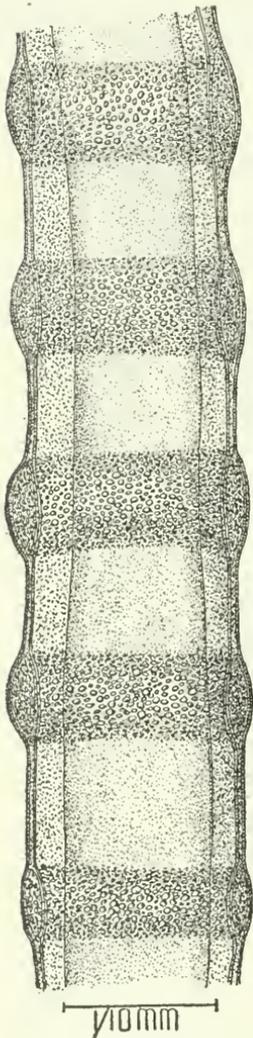


FIG. 79.—*OXYURIS AMBIGUA*.  
A PORTION OF THE POSTERIOR  
EXTREMITY OF THE FEMALE.

pharyngeal border is an incised cuticular plate with markings definitely related to the above-mentioned lips. There is a club-shaped esophagus which gradually increases in size posteriorly and finally terminates in a subspherical bulb which is separated by a deep constriction from the preceding portion of the esophagus. This bulb is supplied with a tripartite, chitinized dental apparatus. The intestine has at least one anterior and one posterior local dilatation, and finally terminates in a large ovoid dilatation, probably having the function of a colon, followed by a short narrow tube to the anus. There are two cervical alae, extending back less than half the length of the esophagus. There is a fine transverse striation, often obscure, and the usual fine longitudinally oblique striation due to the musculature. The nerve ring is far forward on the esophagus, unusually close to the head. The excretory canals unite just behind the esophageal bulb and the excretory pore opens just anterior of the vulva.

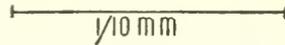
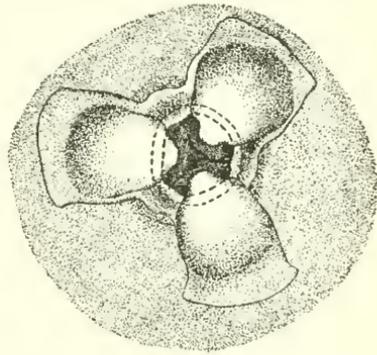


FIG. 80.—*OXYURIS EVOLUTA*. MOUTH VIEWED FROM THE FRONT. SLIGHTLY FLATTENED UNDER PRESSURE.

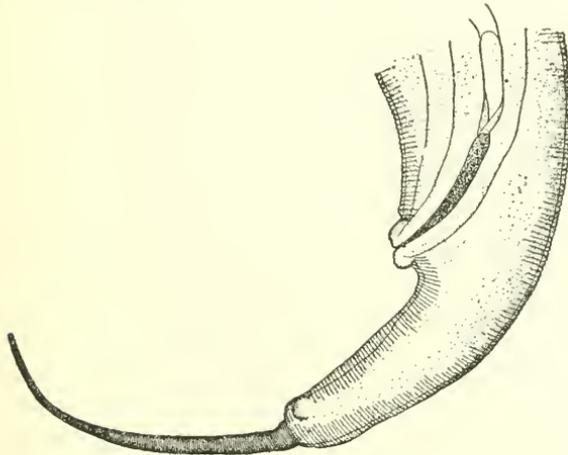


FIG. 81.—*OXYURIS EVOLUTA*. POSTERIOR EXTREMITY OF MALE. ENLARGED.

of the esophagus, exclusive of the bulb, is 500 to 660  $\mu$ . and its thickness is 70 to 105  $\mu$ . The bulb is subspherical, 145 to 175  $\mu$  long by 135 to 170  $\mu$  thick. The nerve ring is 85 to 105  $\mu$  behind the anterior end of the body. The bursa is only slightly developed, but there is one pair of postanal papillae which are highly developed in the form of elongate conical rays and show a close homology with similar rays in *O. triradiata* which function as supporters of a well-developed bursal

*Male* 4.6 to 6.53 mm. long, with a maximum thickness of about 350  $\mu$ . Head diameter is from 45 to 75  $\mu$ , but the contour of the head in this genus is such that there is no distinct place, as a rule, at which to take this measurement. The length

membrane. There is also a pair of well-developed conical adanal papillae. The tightly coiled posterior extremity of the male (fig. 81) in this species makes any study of the bursa quite difficult. Associated with this coiling habit is the presentation on the ventral surface, the inner side of the coil, of several series of short parallel longitudinal lines, commonly present, but apparently of a transient nature. The spicule is slightly curved and difficult to measure, owing to the gradual failure to complete chitinization in the proximal portion. Its apparent range in length is from 85 to 175  $\mu$ . The accessory piece is flask-shaped and is 30 to 40  $\mu$  long. The bursal membrane extends from the adanal papillae to the postanal, swinging in toward the body, and then forms a small membrane between the postanal papillae and the thin terminal portion of the body. The distance from the cloacal aperture to the posterior extremity of the body is 110 to 230  $\mu$ , of which the terminal portion posterior of the postanal papillae makes up 75 to 135  $\mu$  and the distance from the cloacal aperture to the postanal papillae makes up 85 to 100  $\mu$ .

*Female* 9 to 18 mm. long, with a maximum thickness slightly exceeding 1 mm. The body terminates in the prolongation usual in the female *Oxyuris*, and in favorable specimens this portion shows markings somewhat similar to those of *Oxyuris ambigua*. However, they are arranged in spirals and not in closed circles or annulations, the number of turns being 18 to 24 in adults and fewer in young specimens. The last spiral straightens out and extends on as a straight line to the end of the body. The spirals appear to involve the subcuticular epithelial structures primarily, and only involve the cuticle in that it is apparently grooved on its inner surface to receive this spiral. The head varies in diameter from 100 to 190  $\mu$ , due partly to the difficulty of finding a definite position at which to measure. The esophagus, exclusive of the esophageal bulb, measures 895  $\mu$  to 1.065 mm. long by 170 to 185  $\mu$  thick in mature specimens, and the subspherical bulb measures 225 to 275  $\mu$  long by 290 to 345  $\mu$  thick. The nerve ring is far forward on the esophagus, 95 to 155  $\mu$  from the anterior end of the body. The excretory pore opens just anterior of the vulva in the ventral line. The anus is a circular aperture 1.72 to 2.58 mm. from the tip of the tail in mature specimens. For a short distance back from the tail there are no distinctive features. The middle portion of the tail shows the spiral markings already mentioned, while the posterior portion of the tail terminates in a thin prolongation devoid of markings. The position of the vulva and vagina is distinctive of this and the following species (fig. 82). The distal portion of the vagina extends through a cuticular tube which projects out from the body of the worm, and the vulva is located on the distal extremity of this tube. The vagina is suspended in the tube by two mesenteries which extend along the

sides of the tube and which are apparently developed from the ventral line of the worm but not in the dorso-ventral line of the worm as might be expected.

The vulva, moreover, is located transversely and not longitudinally. This vulva is formed by a deep slit in the end of the tube, the slit forming two prominent lips. The origin of the tube is between a third and a fourth of the length of the worm from the head, or 4 to 5 mm. in mature specimens. The inclosing vaginal tube attains a maximum length of about 1.9 mm. and a maximum thickness of 225  $\mu$ . The vagina enters this tube as a thick-walled structure, but before attaining the distal end the walls thin to a membrane of epithelial nature. Shortly after its entrance into the body cavity proper (fig. 83), the posteriorly directed vagina transforms into a much dilated sac, apparently the receptaculum seminis, oval in form, the constricted posterior termination connecting by a short uterine tube with the long uterus. Near the anal region the uterus terminates and divides to form the oviducts which extend forward

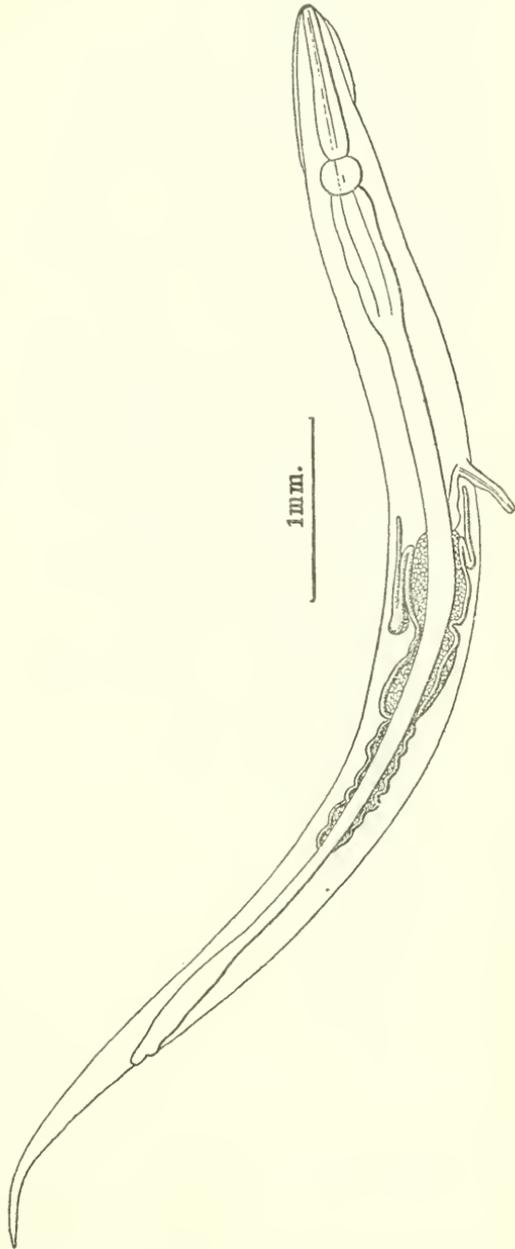


FIG. 82.—*OXYURIS EVOLUTA*. FEMALE. AFTER SMITH, 1908.

along the sides of the uterus and transform anteriorly into the looped ovaries. The eggs are of the typical *Oxyuris* shape, flattened on one side and measure in utero 55 to 65  $\mu$  long by about 25  $\mu$  thick.

*Hosts*.—*Acanthion brachyura* (*Hystriæ brachyura*), *Erethizon dorsatum*, *Erethizon epixanthum*.

*Location*.—Cecum and small intestine.

*Localities*.—Berlin (Zoological Collection); United States (Philadelphia, Pennsylvania (Zoological Garden); Washington, District of Columbia (Zoological Park); Wisconsin).

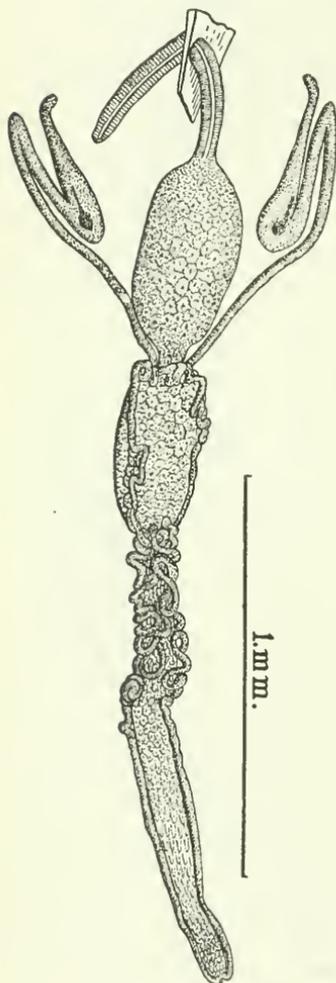


FIG. 83.—*OXYURIS EVOLUTA*. FEMALE GENITALIA. AFTER SMITH, 1908.

This species was first described by von Linstow (1899) and has since been noted only by Smith (1908). Both of these writers had only nongravid females which had attained only about half of the adult size. This accounts for the fact that the measurements given here are in excess of those given by von Linstow and by Smith. The writer is fortunate in having an abundance of material collected in 1896 by Dr. Albert Hassall from *Erethizon epixanthum*, together with some more material, in very bad shape, however, sent in from *Erethizon dorsatum* in Wisconsin in 1898. The material first noted contains numerous males.

For a similar species see the next species, *Oxyuris hilgerti*.

*OXYURIS HILGERTI* Seurat, 1914d.

*Specific diagnosis*.—*Oxyuris* (p. 65): Cuticle transversely striated at 14  $\mu$  intervals. No lateral alae. Muscle cells diamond-shaped and 800  $\mu$  long. Mouth with three lips (fig. 84), each provided with one papilla. Buccal cavity very short. Esophageal bulb with denticular apparatus. Intestine larger at its origin than the bulb. Two

prominent rectal glands. Nerve ring one-eighth of esophagus length from anterior extremity. Small excretory pore opens posterior of the esophageal bulb in the middle of a long clear area. Copulation occurs at an early stage while the males and females are nearly the same size, the females subsequently becoming mature and much larger than the males.

*Male* 3.8 to 6.2 mm. long and very slender. Posterior extremity commonly rolled in a spiral of two turns. Length of esophagus is

one-seventh of total body length. Tail (fig. 85) terminates in a dorsal point 200  $\mu$  long. There are two narrow bursal alae. There are three pairs of caudal papillae, one pair preanal and two postanal; the second pair of postanal papillae is pedunculated and sustains the bursal alae. The caudal glands apparently open between the two pairs of postanal papillae. The spicule is 300  $\mu$  long and is slightly enlarged at its free extremity. The gubernaculum is 70  $\mu$  long.

*Female* attains a maximum length of about 12.7 mm. and a thickness of about 600  $\mu$ . Tail long and narrow, one-fourth as long as the body (fig. 86). Esophagus one-sixth to one-twelfth of body length. Ovaries 5 mm. long, slightly looped, blackish from reserve granules. Vagina is everted to the exterior to a distance of 125  $\mu$  or more (fig. 87). In larvae in the fourth stage, 2.7 mm. long, and in some small and immature females, 7.2 to 9 mm. long, the vulva, which is about one-third of the length of the worm from the anterior extremity, presents a prominent anterior lip and opens into a vagina lined with a thick cuticle; at the

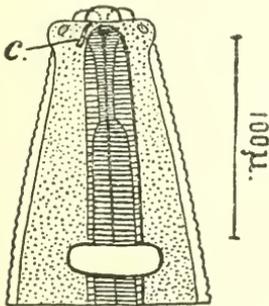


FIG. 84.—*OXYURIS HILGERTI*. ANTERIOR EXTREMITY, LATERAL VIEW. c, CEPHALIC GLAND. AFTER SEURAT, 1915.

[It is not clear from Seurat's figures whether this scale belongs with this figure or not.]

other end of the vagina is the ovijector. No spermatozoa are found in the receptaculum seminis. Immediately after the fourth molt, and long before sexual maturity is attained, the female, then usually about the same size as the male, 3 to 5 mm.

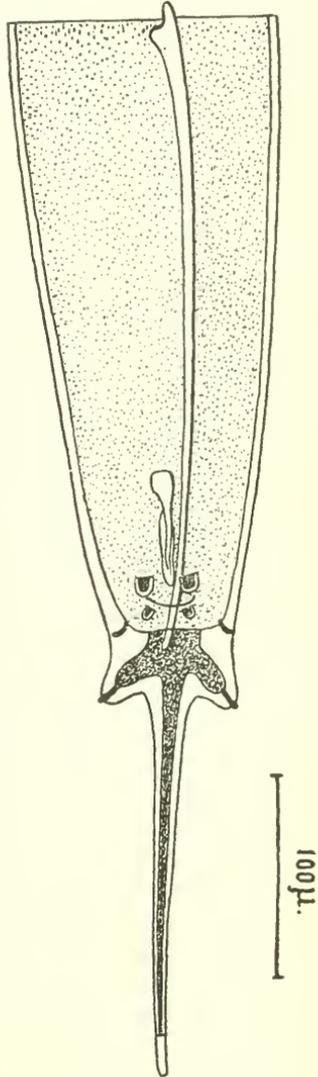


FIG. 85.—*OXYURIS HILGERTI*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. AFTER SEURAT, 1915.

long, is fertilized. Immediately after, the eversion of the vagina occurs, thereby automatically preventing further attempts at fertilization. Young females when fertilized show little development

of the genital glands; the ovaries and oviducts are represented by a narrow strand 1.4 mm. long, translucent and without reserve granules.

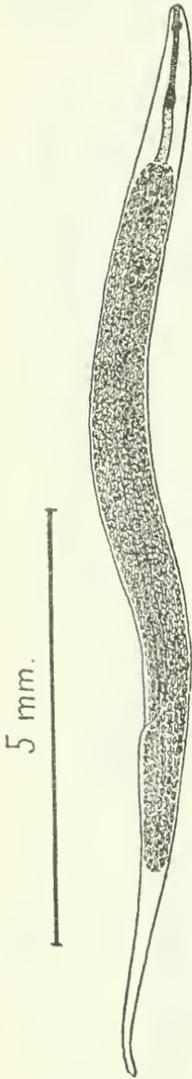


FIG. 86.—*OXYURIS HILGERTI*. FEMALE.  
AFTER SEURAT, 1915.

The two receptacula seminis are 150  $\mu$  long and 65  $\mu$  thick and are distended with spermatozoa. The two parallel uteri are 600  $\mu$  long and are empty. The musculo-epithelial first portion of the ovijector is 1 mm. long and unites the uterus and a vestibule with a thick internal cuticular lining; this portion of the ovijector and the vestibule have a remarkably large development of the external muscular layer. The vagina is prolapsed to a distance of 125  $\mu$ . The ovijector extends along the everted vagina to its distal extremity. In an exceptional female the vagina is not everted; it has the form of a truncated cone and the ovijector opens into it on the summit of a rounded nipple (fig. 88). When the female has attained its final size, the ovaries are completely developed but there are no eggs in the uterus. The fertilized eggs gradually make their way to the uteri; the latter elongate considerably, and in the female which is completely mature they are distended with eggs disposed in four or five rows and occupying almost all of the body cavity posterior of the esophageal bulb to the anal region. The eggs (fig. 89) are thick shelled, flattened on one side, 75 to 80  $\mu$  long and 20 to 30  $\mu$  thick, and are oviposited in the morula stage.

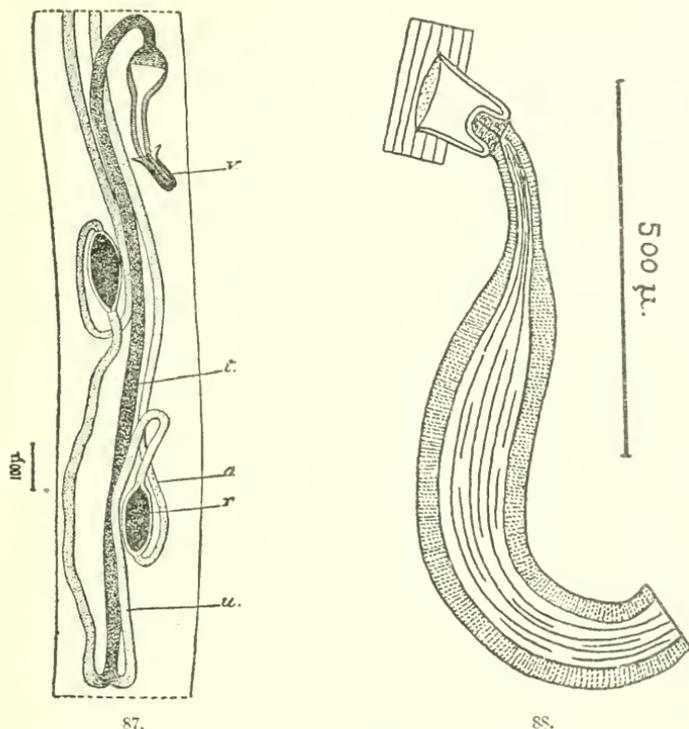
*Host*.—*Otenodactylus gundi*.

*Location*.—Cecum.

*Locality*.—Bou Saâda, Algeria.

Seurat calls the phenomenon of precocious copulation between a mature male and an immature female "progamie," and notes that this progamy is rather common among nematodes. He notes it as occurring in species of *Tropidocerca*, which have enormous seminal receptacles; in *Dispharagus invaginatus* Linstow, where after copulation the vulvar region invaginates to the interior of a cylinder formed by a cuticular fold, which prevents further union; and notes as a most curious example *Maupasina weissii* Seurat, in which, after copulation, the young female secretes a very prominent blackish cuticular ring which seals the vulva. In this

latter connection it may be noted that the cement glands in the tails of *Strongylus* give rise to prominent vulvar plugs.



FIGS. 87, 88.—*OXYURIS HILGERTI*. 87, GENITALIA OF IMMATURE FEMALE. AFTER SEURAT, 1915. *a*, OVARY; *r*, RECEPTACULUM SEMINALE; *l*, MUSCULO-EPITHELIAL OVJECTOR; *u*, UTERUS; *v*, VAGINA. 88, EXCEPTIONAL ARRANGEMENT OF TERMINAL GENITALIA IN FEMALE. AFTER SEURAT, 1915.

Seurat (1915*d*) extended his original description of this species in a later paper. It might be noted in passing that the name of the parasite is marked "n. sp." in both cases, a not uncommon thing but nevertheless one which is very misleading and a thing which writers should guard against in the interests of accuracy.

*OXYURIS FLAGELLUM* Hemprich and Ehrenberg,  
1828.

*Synonym.*—*Oxyuris flabellum* Ehrb. of Nassonov, 1898 (reviewer's error).

*Specific diagnosis.*—*Oxyuris* (p. 65): Mouth without papillae, its aperture almost hexagonal, formed by six bilaterally symmetrical scallops. The tail equals a third or more of the body length. The

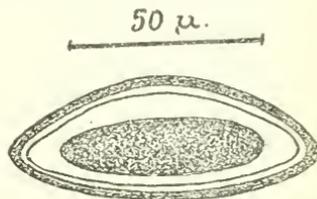


FIG. 89.—*OXYURIS HILGERTI*.  
EGG. AFTER SEURAT, 1915.

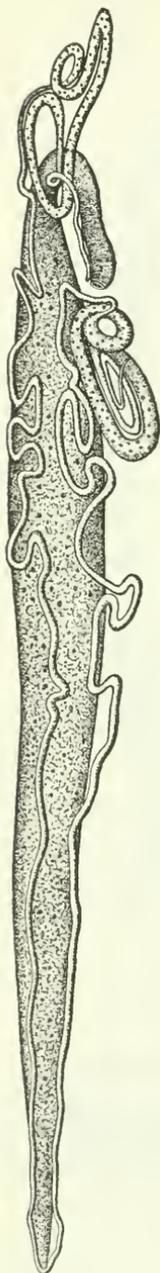


FIG. 90.—*OXYURIS*  
FLAGELLUM. FE-  
MALE GENITALIA.  
ENLARGED.  
AFTER NASSO-  
NOV, 1897.

cylindrical esophagus is followed by a bulb approximately as long as the esophagus and containing a triangular tooth apparatus. The excretory canals begin at the level of the esophagus in a large, strongly granular cell containing a vacuole. The cuticle has a fine transverse striation which disappears behind the anus.

*Male unknown.*

*Female* 25 mm. long. Esophagus, including esophageal bulb, 700  $\mu$  long. Originating in a large cell at the level of the middle of the esophagus, the excretory vessels extend through the lateral fields, which consist of two lateral cells and one median projecting cell perforated by the vessel. Just in front of the vulva the anterior and posterior half of each canal unite to form a reservoir which opens externally through a fine aperture. The cylindrical intestine lies mostly along the right lateral line and is compressed posteriorly. It terminates in a short rectum having a quadrangular cross section. The rectum is joined to the body wall by four membranes and shows large rectal cells on its anterior boundary. The anus is 7 mm. from the end of the tail. The ovaries (fig. 90) originate in the anterior portion of the body and increase in diameter with egg production. At their transition into the oviducts they narrow abruptly. Just in front of the anus, the oviducts enter the large uterus, which passes to the anterior portion of the body and turns back as the vagina, which is short and surrounded by circular muscles. The muscles are not present at the vulva, which is a broad cleft with swollen edges situated 4 mm. from the head (fig. 91). The eggs are apparently of typical *Oxyuris* form, flattened on one side.

*Host.*—*Procarvia syriaca* (*Hyarax syriacus*).

*Location.*—Cecum.

*Locality.*—Near Mount Sinai, Palestine.

Hemprich and Ehrenberg describe two varieties of this species as follows: 1. Variety *obtusa*; yellowish, the curved tail more than a third of the body length, neither pointed nor alate. 2. Variety *acuta*; white, the straight tail not exceeding a third of the body length, pointed but not alate. It seems possible that these writers were dealing with two

species, in which case it would be difficult to say to which of these the name *O. flagellum* should be applied. Schneider (1866), who re-described this species, does not comment on this point, and I find no note on it in the reviews of Nasonov's (1897) Russian article.

Nasonov has made a histological and minute study of this species, some of his findings being as follows: The mouth is not papillate, as stated by Hemprich and Ehrenberg, and its lumen is hexagonal instead of triangular, as stated by Schneider (1866). Histologically, the cuticle is found to consist of two layers, which are quite independent except in the lateral lines, where they unite. In some places, especially near the genital aperture, these layers are remote from one another, the outer cuticular sheet bowing out near the vulva, the space between such separations being filled with a homogenous, colorable substance. The matrix, or subcutaneous sheet, consists of a layer of relatively large cells, which are compressed to the side, toward the middle and lateral fields, in the muscular fields where the muscle fibers attach directly to the cuticle. The number of matrix cells in a cross section varies according to the body region—in the tail end there are 6, in the posterior region of the body there are 8, and in the middle and anterior region there are 16.

OXYURIS HAMATA von  
Linstow, 1879b.

*Specific diagnosis.*—*Oxyuris* (p. 65): Cuticle transversely annulated. Mouth with six conical lips (fig. 92), which turn outward to form blunt hook-

pharynx apparently communicating through a constricted aperture with a dilated portion of the esophageal

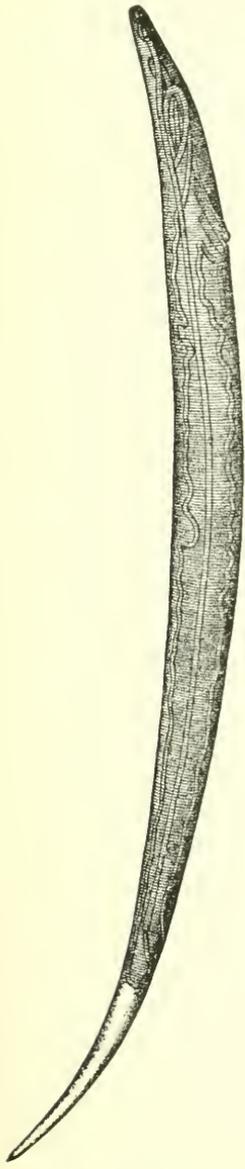


FIG. 91.—OXYURIS FLAGELLUM. FEMALE. ENLARGED. AFTER NASSONOV, 1897.

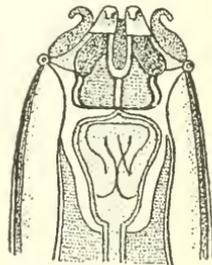


FIG. 92.—OXYURIS HAMATA. ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER VON LINSTOW, 1879.

shaped lamellae. The

lumen, in which is a complex apparatus apparently for masticatory purposes. The esophagus is very long,  $1/3.3$  of the total body length, and terminates in an esophageal bulb provided with valvular teeth.

*Male* unknown.

*Female* 5.6 mm. long and 2 mm. thick [sic!]. The long pointed tail is one-fourth of the body length.

*Host*.—*Myocastor coypus* (*Myopotamus coypus*).

*Location*.—Intestine.

*Locality*.—Stuttgart Zoological Gardens.

Von Linstow states that this species can not be confused with any known species. It is unfortunate that he does not give an interpretation of the buccal and esophageal structures, as these things can seldom be evaluated as well from drawings as from the specimens themselves. Von Linstow states that the female is 2 mm. thick, but it seems likely that this should have been  $200\ \mu$  thick if the length, 5.5 mm., is correctly stated.

OXYURIS OBESA Diesing, 1851.

*Specific diagnosis*.—*Oxyuris* (p. 65): Head with six papillae anteriorly (fig. 93), the submedian papillae with a knob on the tip.

The mouth aperture is circular and posterior of the aperture, and inside the buccal capsule are six cuticular folds with curved margins. The cuticle of the head is not inflated. The esophagus terminates posteriorly in an esophageal bulb bearing a tooth apparatus.

*Male* unknown.

*Female* attains a maximum length of 2.8 to 3 cm. long. The posterior extremity is straight, subulate, and almost as long as the remainder of the body (fig. 94). The anus is about 1.6 cm. from the end of the tail. The vulva is about 8 mm. from the anterior end. The eggs are

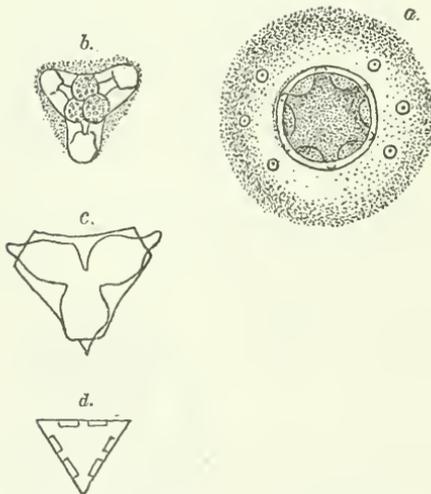


FIG. 93.—OXYURIS OBESA. *a*, HEAD VIEWED FROM THE FRONT; *b*, CROSS SECTION OF ESOPHAGUS; *c*, CROSS SECTION OF ESOPHAGUS POSTERIOR OF *b*; *d*, CROSS SECTION OF ESOPHAGUS POSTERIOR OF *c*. ENLARGED; *b*, *c*, AND *d*  $\times 93$ . AFTER SCHNEIDER, 1866.

thick shelled, elliptical, and without depression. Females 7 mm. long have the sex organs developed and apparently are fertilized, since the vulva bears a brown plug. This plug is not present in older specimens.

*Host.*—*Hydrochoerus hydrochaeris* (*Hydrochoerus capybara*).

*Location.*—Cecum.

*Locality.*—Brazil.

Schneider's (1866) statement that the eggs are without depression may be taken to mean that they are symmetrical instead of flattened in the usual fashion of *Oxyuris* eggs. It is possible that this is the case or that the eggs seen by him were not yet in a final state of development or were seen in an unfavorable aspect.

OXYURIS OBVELATA (Rudolphi, 1802) Dujardin, 1845.

*Synonyms.*—*Ascaris vermicularis*  $\beta$ . *muris* Froelich, 1791; *Ascaris obvelata* Rudolphi, 1802; *Fusaria obvelata* (Rudolphi, 1802) Zeder, 1803; *Ascaris oxyura* Nitzsch, 1821; *Syphacia obvelata* (Rudolphi, 1802) Seurat, 1916.

*Specific diagnosis.*—*Oxyuris* (p. 65): Body elongate fusiform. Cuticle transversely striate and not dilated in the head region. Three broad lips, each bearing a median papilla on its outer face. Mouth cavity simple. The club-shaped esophagus terminates in a subspherical bulb. The rectum is elongate and communicates with the intestine by a valve. Two small cervical alae. The excretory pore lies a little posterior of the esophageal bulb.

*Male* 1.6 mm. long by 115  $\mu$  thick. The posterior extremity is coiled in a spiral. The spicule (fig. 95) is simple, slightly curved, and is 85  $\mu$  long and 7  $\mu$  thick at the base. The small accessory piece, situated transversely posterior of the spicule, is shaped like a ploughshare and is 37  $\mu$  long. The cloacal aperture is 210  $\mu$  from the very narrow posterior end of the body. There are two pairs of preanal and one of postanal papillae. The posterior lip of the cloacal aperture has a small chitinous hook that may be of use in copulation.

*Female* 3.5 to 5.7 mm. long by 115 to 215  $\mu$  thick. The body terminates in a long, narrow tip posteriorly (fig. 96). The esophagus, exclusive of the bulb, is 255 to 330  $\mu$  long by 50 to 70  $\mu$  thick. The subglobular esophageal bulb is 85 to 100  $\mu$  long and 75 to 110  $\mu$  thick. The nerve ring is 100 to 130  $\mu$  from the anterior end. The excretory pore is about 480  $\mu$  from the anterior end. The anus is 515 to 705  $\mu$  from the tip of the tail. The vulva is very prominent and situated on a conical cuticular prominence 540 to 740  $\mu$  posterior of the head. The vagina extends posteriorly from the vulva and is an elongate structure about 170  $\mu$  long. Uterine branches do not extend pos-



FIG. 94.—OXYURIS OBVELATA. FEMALE.  $\times 3$ . AFTER DIESING, 1857.

terior of the anus. The eggs are 110 to 142  $\mu$  long by 30 to 40  $\mu$  thick. The embryo is not formed at the time of oviposition.

*Hosts.*—*Mus musculus*, *Mus musculus albus*, *Micromys minutus* (*Mus minutus*), *Apodemus sylvaticus* (*Mus sylvaticus*), *Epimys rattus* (*Mus rattus*), *Epimys ugandae* (*Mus ugandae*), *Mus musculoides*, *Microtus arvalis* (*Arvicola campestris*, *Lemmus arvalis*, *Arvicola arvalis*), *Eotomys glareolus* (*Arvicola glareolus*, *Arvicola rubidus*), *Pitymys subterraneus* (*Arvicola subterraneus*), *Arvicola amphibius* (*Lemmus amphibius*), *Eotomys rutilus* (*Lemmus rutilus*),

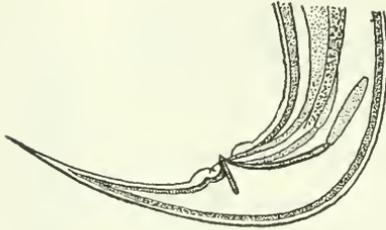


FIG. 95.—*OXYURIS OBVELATA*. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1879.

*Onychomys leucogaster* (*Hesperomys leucogaster*), *Holochilus physodes* (*Hesperomys physodes*), *Peromyscus nasutus* (*Hesperomys nasutus*), *Oxymycterus nasutus*, *Citellus citellus* (*Spermophilus citellus*, *Arctomys citellus*), *Holochilus brasiliensis* (*Holochilomys brasiliensis*), *Mus minutoides* (*Leggada minutoides*), *Neotoma mexicana fallax*, *Arvicanthis barbarus*.

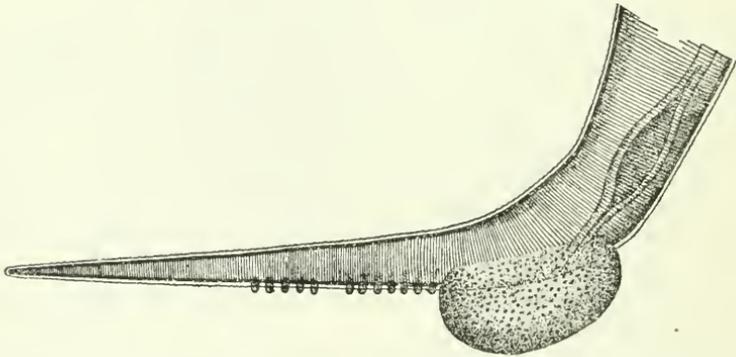


FIG. 96.—*OXYURIS OBVELATA*. POSTERIOR EXTREMITY OF FEMALE, SHOWING FUNGUS GROWTH. ENLARGED. AFTER VON LINSTOW, 1884.

*Location.*—Cecum and large intestine.

*Localities.*—Cosmopolitan: France (Rennes), Germany (Greifswald), Austria (Vienna), Australia (Brisbane), Africa (Fort Portal, Kitagueta), United States (Washington, District of Columbia; Bowie, Maryland; Colorado Springs and San Acacia, Colorado).

For the most part this species has been considerably confused with *Oxyuris tetraptera*. In his original description Rudolphi has confused the two forms. This is not surprising, in that the two occur in the same location in the same hosts and are much the same in

general appearance. They are, however, readily distinguished, and the presence of the two species has been recognized for almost a century. Since Rudolphi has confused two species under a single name it is necessary to restrict the name used by him to one of these species. I have accordingly left as *Oxyuris obvelata* the form which is evidently not covered by *Oxyuris tetraptera*.

The maximum length, 5.7 mm., given for the female by Dujardin (1845) is in excess of that I have found, which fact is possibly associated with the measurements of the distance from the head to the vulva, 1 to 1.33 mm. Von Linstow (1879a) states that back of the vulva aperture is a chitinized hollow cylinder with a somewhat wider aperture which seems to serve for the reception of the male accessory piece. I have not been able to identify this structure. Males are apparently very rare in this species, contrary to my experience with *O. tetraptera*, and none is available to me. I have had to depend on other writers for a description of the male. Von Linstow (1884) notes that males are very rare and apparently short lived in this species. He adds that females 360  $\mu$  long have the vulva closed with a brown plug, the sign of fertilization already accomplished. Von Linstow also notes a fungus growth as common on the skin of many females. This fungus starts at the anus (fig. 96) and apparently arises from fungi growing in the excrement. From this point, where it shows as a sepia-brown body visible to the naked eye, it spreads posteriorly to the end of the tail and anteriorly to the head. *Neotoma mexicana fallax* is recorded here as a host for the first time, the host being collected in Colorado.

Seurat (1916: See Addendum, p. 224) makes this type of the new genus *Syphacia*. He regards *O. stromia* as a synonym.

OXYURIS PUGIO Hemprich and Ehrenberg, 1828.

*Specific diagnosis.*—*Oxyuris* (p. 65): Head alate. Mouth bare. *Male* unknown.

*Female* "Trilinearis" (three lined or three lines (6.5 mm.) long?). Anterior portion of body ovigerous. Tail semialate.

*Host.*—*Procarvia syriaca* (*Hyrae syriacus*).

*Location.*—Large intestine.

*Locality.*—Palestine.

This form has never been described properly. Nassonov (1897) states that he found this form, but, contrary to what some of his reviewers state, he published no study of it, merely quoting Hemprich and Ehrenberg.

## OXYURIS SCIURI Hall, 1916, new name.

*Synonym.*—*Oxyuris* species Parona, 1889.

*Specific diagnosis.*—*Oxyuris* (p. 65): Head not inflated. Mouth with papillae and with distinct internal foldings. Club-shaped esophagus with esophageal bulb. Intestine large and straight.

*Male* unknown.

*Female* 17 mm. long and  $49\ \mu$  (?) thick. The body is much attenuated posteriorly. The swollen portion of the esophagus proper is  $750\ \mu$  from the anterior end and is  $70\ \mu$  in diameter. The bulb is  $21\ \mu$  in diameter. The anus is very small and is  $40\ \mu$  (?) from the tip of the mucronate tail. No anal papillae visible. The vulva is 6 mm. from the anterior end. The oviducts are in compressed, seriate loops; the ovaries are very long.

*Host.*—*Sciurus atrodorsalis*.

*Location.*—Nares and mouth (?).

*Locality.*—Kokarit.

Parona had five females of this species and states that the fact that his material included no males prevented him from describing it as a new species, although he believes it to be new. While it is a good general rule to have both sexes, and especially the more distinctive male, it is a rule with limitations and these limitations are especially applicable in the genus *Oxyuris*, where the males are small, easily overlooked, short lived, and rare. That a carefully described female *Oxyuris* is readily recognized is proven in such a case as that of *O. evoluta*, the male of which is first described in this paper. Even in the case of such a form as Parona's, his comparatively incomplete description will probably prove sufficient to permit of immediate recognition of material from the named host.

Parona states that these worms must have been found in the stomach or intestine. There must have been some error in the labeling which indicates the collection of these worms from the nares and mouth.

I have queried the figures given for the thickness of the body by Parona, on the grounds that it hardly agrees with the general relations of *Oxyuris*. Ten times the figure given would be more likely. For the same reason I have queried the dimensions given for the distance from the anus to the tip of the tail.

Parona states that the esophageal bulb has two swellings. I have interpreted this as a reference to the posterior dilatation of the esophagus proper and to the esophageal bulb.

## OXYURIS STOSSICHI Setti, 1897a.

*Specific diagnosis.*—*Oxyuris* (p. 65): Cuticle finely but somewhat irregularly striate transversely. Anteriorly the cuticle expands laterally to form two alae, the length of which varies with the speci-

men, but is usually about 1 mm. or less. The club-shaped esophagus terminates in the esophageal bulb. The intestine is considerably dilated anteriorly, is sharply constricted behind the enlarged portion, and then pursues an almost rectilinear course with fairly constant diameter to the anal aperture.

*Male* 5 to 8 mm. long and 370 to 580  $\mu$  thick. The posterior extremity of the body (fig. 97) is spirally en-rolled and bears a short conical projection at the tip. The spicule is about 250  $\mu$  long and is 16  $\mu$  thick at the base. It is directed posteriorly toward the projection on the tip of the tail. The cloacal aperture is about 130  $\mu$  from the posterior extremity of the body.

*Female* 12 mm. long and with a maximum thickness of about 1 mm. The esophagus is from 500 to 700  $\mu$  long. The bulb has a diameter of 200  $\mu$ . The anus is 2 to 2.5 mm. from the posterior extremity of the body. The vulva (fig. 98) is about 1.7 mm. from the anterior extremity of the body. The uterus shows large dilata-tions full of innumerable eggs. The eggs (fig. 99) are of the typical asymmetrical shape. They are 70 to 75  $\mu$  long and 35 to 38  $\mu$  thick. The embryonic mass occupies only the central portion, leaving a considerable clear portion.

*Host.*—*Hystrix cristata*.

*Location.*—Intestine.

*Locality.*—Massaua, Eritrea, Italy.

I have taken the dimensions of the esophagus, given by Setti in his general discussion, as probably applying to the female. Also I have dis-regarded his statement that the egg shape is either asymmetrical or symmetrical. This depends entirely on the point of view. The *Oxyuris*

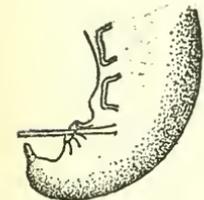


FIG. 97.—*OXYURIS* STOSSICHI. POSTE-RIOR EXTREMITY OF MALE.  $\times$  50. AFTER SETTI, 1897.



FIG. 98.—*OXYURIS* STOSSICHI. FEMALE.  $\times$  10. AFTER SETTI, 1897.

egg is flattened on one side, and this is what is meant by asymmetrical here.

*OXYURIS STROMA* von Linstow, 1884.



FIG. 99.—*OXYURIS* STOSSICHI. EGGS.  $\times$  100. AFTER SETTI, 1897.

*Specific diagnosis.*—*Oxyuris* (p. 65): Three hyaline lips (fig. 100) about a triangular aperture which is first surrounded by a circular disk. Dor-sally and ventrally the underlying parenchyma pro-jects to form three elevations on each side. In each case the median

elevation bears a single papilla and the other elevations bear a double papilla.

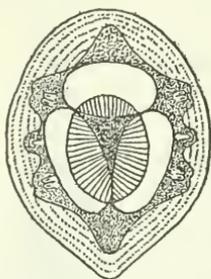


FIG. 100.—OXYURIS STROMA. HEAD VIEWED FROM THE FRONT. ENLARGED. AFTER VON LINSTOW, 1885.

*Male* 1.5 mm. long and 160  $\mu$  thick. The esophagus is  $\frac{2}{9}$  of the total length. The spicule is straight and is 79  $\mu$  long (fig. 101). The accessory piece has a hooked point and is 36  $\mu$  long. The cloacal aperture is  $\frac{2}{31}$  of the total length from the posterior end of the body. There is one pair of large postanal papillae. Anterior of the cloacal aperture are two cuticular bullae, and anterior of these are three peculiar large projecting pads, of which the most anterior is in the median portion of the body.

*Female* 4.6 mm. long and 360  $\mu$  thick. The esophagus is  $\frac{1}{10.7}$  of the total body length. The anus is  $\frac{1}{7}$  of the body length from the posterior extremity. The vulva is  $\frac{4}{15}$  of the body length from the anterior extremity. The eggs are 130 to 140  $\mu$  long and 43  $\mu$  thick. They have a double wall, the outer wall being marked with circular depressions showing a dark spot in the middle (fig. 102). The contained embryos have a strongly developed esophagus with a bulb bearing teeth and terminate in a rounded tail with no appendage.

*Life history.*—The embryos develop in the cecum, where von Linstow has found about 100 immature specimens 580 to 640  $\mu$  long and 49 to 54  $\mu$  thick. The esophagus in these measured  $\frac{1}{6.2}$  and the tail  $\frac{1}{7.1}$  of the total length.

*Host.*—*Apodemus sylvaticus* (*Mus sylvaticus*).

*Location.*—Small intestine; immature forms in the cecum.

*Locality.*—Not given.

Seurat (1916) says this is *O. obvelata*. See Addendum, page 224.

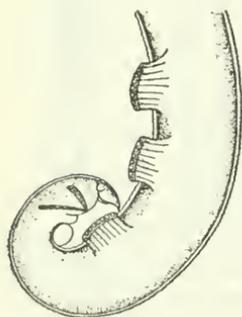


FIG. 101.—OXYURIS STROMA. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1884.



FIG. 102.—OXYURIS STROMA. EGG. ENLARGED. AFTER VON LINSTOW, 1885.

OXYURIS TETRAPTERA (Nitzsch, 1821) von Linstow, 1878a.

*Synonyms.*—*Ascaris dipodis* Rudolphi, 1819, of Stossich, 1898; *Ascaris tetraptera* Nitzsch, 1821; *Oxyuris semilanceolata* Molin,

1858c; *Oxyuris obvelata* (Rudolphi, 1802) Dujardin, 1845, in part, of various authors.

*Specific diagnosis.*—*Oxyuris* (p. 65): There are three very simple lips surrounding a triangular mouth aperture which communicates directly with the esophagus, the lumen of which is also of triangular, though larger, cross section. No papillae appear to be present, probably because they are obscured by the inflated cuticle of the head. The esophagus is somewhat club-shaped, as usual, but is thinnest in its middle portion. The terminal esophageal bulb is elongate oval instead of the customary subspherical in shape. The cuticle of the head (fig. 103) is inflated, the inflated area presenting either a clear or granular appearance. There are two characteristic cervical alae; these are prominent and terminate at the level of the esophageal bulb in a recurved margin, the angle formed by this margin and the lateral border of the membrane being acute and slightly produced (fig. 104). Occasionally lenticular thickenings of the cuticle occur on the dorsal aspect near the posterior end of the cervical alae (fig. 105). The cuticle is transversely striated.

*Male* 2 to 2.5 mm. long and 155 to 175  $\mu$  thick. Head, including the inflated cuticle, 65 to 90  $\mu$  in diameter. The esophagus, exclusive of the esophageal bulb, is 195 to 225  $\mu$  long, with a maximum thickness of about 45  $\mu$ . The ovoid bulb is about 115  $\mu$  long and 75 to 80  $\mu$  thick. The nerve ring is 85 to 115  $\mu$  from the anterior end of the body. The anterior portion of the intestine is greatly dilated and is reflected about the posterior portion of the esophageal bulb to form a depression in which the end of the bulb lies. The rectum is an elongate structure, about 95 to 110  $\mu$  long, tapering from a broad base to the cloacal aperture. The bursa (fig. 106) is very narrow, somewhat serrate or scalloped along its border, and

incised in the vicinity of the cloaca, the posterior and shorter portion extending from this region to the tip of the tail. The maximum



FIG. 103.—OXYURIS TETRAPTERA. FEMALE. ENLARGED. AFTER MOLIN, 1861b.

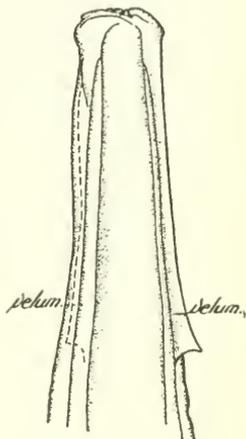
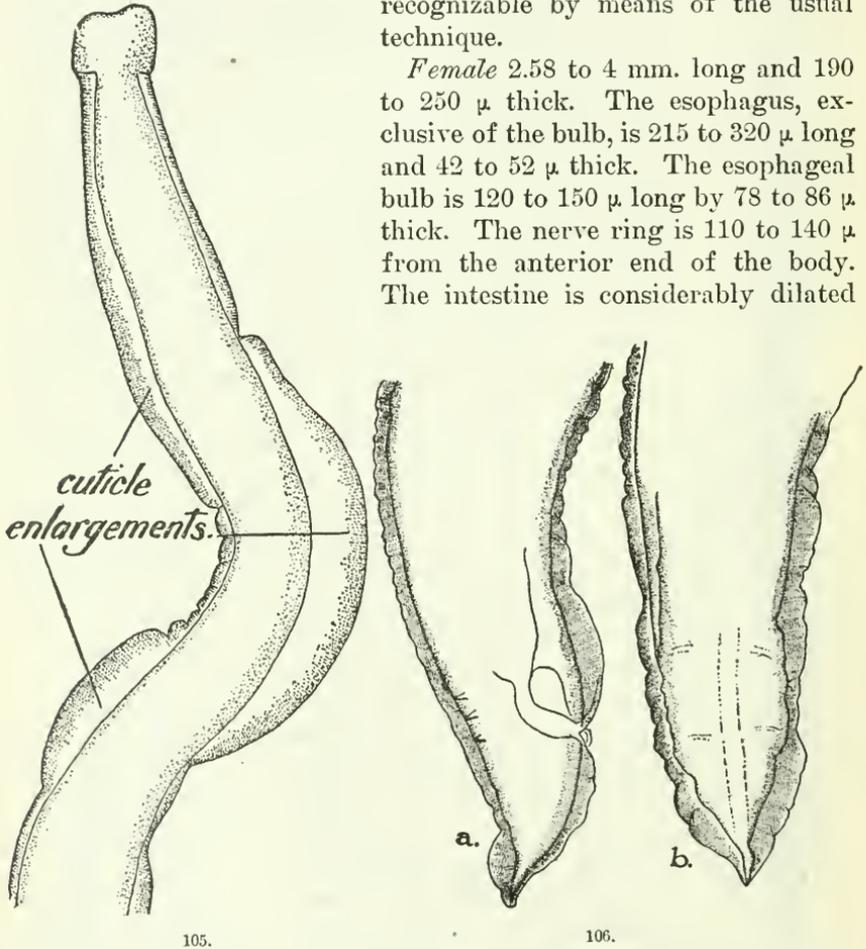


FIG. 104.—OXYURIS TETRAPTERA. ANTERIOR EXTREMITY.  $\times 92.5$ .

width is attained just anterior of the tip of the tail. The spicule is apparently much reduced or imperfectly chitinized and is not visible with ordinary technique. The cloacal aperture is about 135 to 150  $\mu$  from the posterior extremity of the body. The cloacal aperture is situated on an elevation, but any papillae that are associated with it are so much reduced as to be unrecognizable by means of the usual technique.

*Female* 2.58 to 4 mm. long and 190 to 250  $\mu$  thick. The esophagus, exclusive of the bulb, is 215 to 320  $\mu$  long and 42 to 52  $\mu$  thick. The esophageal bulb is 120 to 150  $\mu$  long by 78 to 86  $\mu$  thick. The nerve ring is 110 to 140  $\mu$  from the anterior end of the body. The intestine is considerably dilated



FIGS. 105, 106.—*OXYURIS TETRAPTERA*. 105, ANTERIOR EXTREMITY SHOWING CUTICULAR ENLARGEMENTS  $\times 92.5$ . 106, POSTERIOR EXTREMITY OF MALE. *a*, DORSO-LATERAL VIEW; *b*, DORSAL VIEW.  $\times 170$ .

at its anterior end. The anus is 430 to 600  $\mu$  from the posterior end of the body. The vulva is 1.075 to 1.66 mm. from the anterior end of the body, and is a transverse slit with somewhat swollen lips (fig. 107). From the vulva the vagina proceeds forward a short distance and then turns back to a muscular ovijector, and then a nonmuscular portion which communicates, through a valvular structure, with

the uterus, the point of union being a short distance posterior of the vulva. The uterus extends posteriorly to a point just anterior or just posterior to the anus, where it forms the oviducts. Either the uterus or the oviducts extend posterior of the anus (fig. 108), a distinctive point in distinguishing this species from its common associate, *Oxyuris obvelata*. There is only a short, bluntly pointed clear

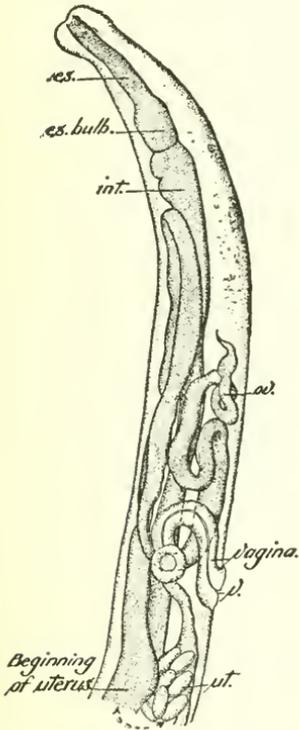


FIG. 107.—*OXYURIS TETRAPTERA*. ANTERIOR EXTREMITY AND REGION OF VULVA IN FEMALE. *es.*, ESOPHAGUS; *es. bulb.*, ESOPHAGEAL BULB; *int.*, INTESTINE; *ov.*, OVARY; *ut.*, UTERUS; *v.*, VULVA.  $\times 46$ .

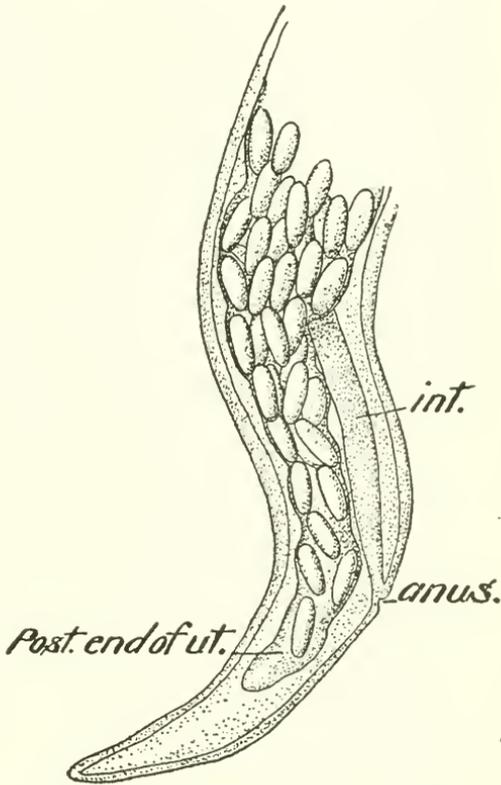


FIG. 108.—*OXYURIS TETRAPTERA*. POSTERIOR EXTREMITY OF FEMALE.  $\times 92.5$ .

tail posterior of the reproductive structures, another feature which distinguishes this species from *O. obvelata* where there is a long tail extending posterior of the anus. The eggs are of the typical *Oxyuris* shape, 84 to 90  $\mu$  long and 34 to 40  $\mu$  thick.

*Hosts.*—*Mus musculus*, *Apodemus sylvaticus* (*Mus sylvaticus*), *Cricetus cricetus* (*Cricetus frumentarius*, *Cricetus vulgaris*), *Jaculus jaculus* (*Dipus jaculus*), *Jaculus sagitta* (*Dipus sagitta*).

*Location.*—Large intestine.

*Localities.*—Germany (Saxony); Italy (Padua); Austria (Trieste); United States (Washington, District of Columbia; Colorado Springs, Colorado).

The name *Ascaris dipodis* Rudolphi, listed by Stossich as a synonym of *Oxyuris tetraptera*, antedates the name proposed by Nitzsch, but Rudolphi (1819) did not describe this species and lists it with a cross, meaning "not seen." It can not therefore be considered as an available name for this species.

Molin's measurements indicate that the worm is one-fourth as thick as it is long, an obvious error. He states that the spicule is papilliform, a statement which is copied by Stossich. I have been unable to identify any spicule in this species.

This species has been very much confused with *O. obvelata*, but the two are readily distinguishable.

*Spiroptera quadriolata* (q. v.) is probably *O. tetraptera*.

OXYURIS TRIRADIATA Hall, 1916, new species.

*Specific diagnosis.*—*Oxyuris* (p. 65): Mouth with three prominent outer lips (fig. 109), each bearing two papillae anteriorly, and with three conical inner lips forming the triradiate mouth aperture (fig. 110) common in species of *Oxyuris*. This communicates through the simple pharynx with the club-shaped esophagus, which becomes gradually thicker posteriorly and is separated by a constriction from the powerful esophageal bulb. This bulb (fig. 111) is strongly muscled and the lumen is lined with chitin which is developed into a dental apparatus in the posterior portion of the bulb. The bulb communicates with the intestine by means of a valve which projects into the lumen of the intestine. The anterior portion of the intestine is dilated to form a wide elongate saccular structure, and the posterior portion is constricted to form a narrower cylindrical structure. There are no lateral alae, but the cuticle around the head and neck, to a distance half the length of the esophagus, is swollen, often forming incidentally a narrow ring just back of the head. The cuticle is very distinctly transversely striate.

*Male* 3.38 to 4.00 mm. long and 200 to 285  $\mu$  thick. The head diameter is about 55  $\mu$ . The esophagus, exclusive of the bulb, is 310 to 345  $\mu$  long and 43 to 50  $\mu$  thick at the posterior end. The esophageal bulb is 100 to 105  $\mu$  long and 95 to 105  $\mu$  thick. The nerve ring is 200 to 260  $\mu$  back of the anterior extremity of the body. The prominent cuticular striation disappears at the origin of the bursal membrane anterior of the cloacal aperture (fig. 112). The bursa forms

an elliptical structure to a point near the end of the body proper, where the elliptical form terminates in an incision, the bursa then expanding again to form a terminal bursal structure resembling, to some extent, that of the strongyles. The bursa is supported by a median extension of the cuticle forming a dorsal ray and by lateral extensions forming lateral rays, one on each side. These three rays diverge at approximately right angles from the posterior end of the body. They tend to curve ventrally near their tips and the lateral rays curve somewhat posteriorly near their tips. The rays are approximately equal in length, ranging from 85 to 115  $\mu$ . Near

the middle of the dorsal ray is a transverse ridge on the dorsal aspect, with its distal edge directed backward (fig. 113). Ventral of the main copulatory bursa are two symmetrically disposed accessory membranes, each supported by a single wavy ray. These membranes originate laterally at a

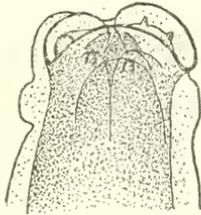


FIG. 109.—*OXYURIS TRIRADIATA*. HEAD.  $\times 340$ .

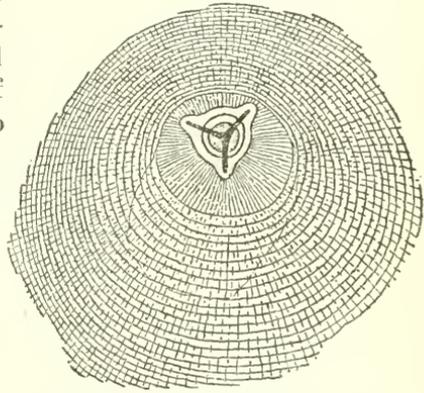


FIG. 110.—*OXYURIS TRIRADIATA*. HEAD VIEWED FROM THE FRONT DIAGONALLY.  $\times 340$ .

point just posterior of the incision which divides the main bursa into the rayed portion and the anterior elliptical portion. The median insertion of these membranes is on either side of the blunt, conical posterior termination of the body proper. Measured from the anterior origin, these bursal membranes are 45 to 50  $\mu$  long. Between their bases is a large papilla in the median line. At a point slightly anterior of this papilla the posterior portion of the body is protracted laterally to form two large papillae suggestive of the prebursal papillae of the strongyles. The spicule is a bluntly elongate conical affair, 43 to 52  $\mu$  long and 10 to 15  $\mu$  thick at the base. It is usually not well chitinized, but may show fairly heavy chitinous lines at the thick base. The cloacal aperture is 115 to 138  $\mu$  from the posterior extremity of the dorsal ray.

*Female* 4.27 to 6.25 mm. long, with a maximum thickness, exclusive of the dorso-ventral line through the greatly swollen lips of the vulva, of about 430  $\mu$ . The head attains a maximum diameter of 75 to 80  $\mu$ . The esophagus, exclusive of the esophageal bulb, attains a maximum length of 400 to 415  $\mu$  and a maximum thickness of 75 to

80  $\mu$ . The esophageal bulb attains a maximum length of 125  $\mu$  and a maximum thickness of 110 to 115  $\mu$ . The nerve ring is 170 to 215  $\mu$  from the anterior extremity of the body. The anus is 850 to 950  $\mu$  from the posterior extremity of the long narrow tail (fig. 114). The cuticular striations continue to the very tip of the tail. The vulva (fig. 115) is located about 1.5 mm. from the anterior extremity of the body and is a transverse slit lying between the enormously devel-

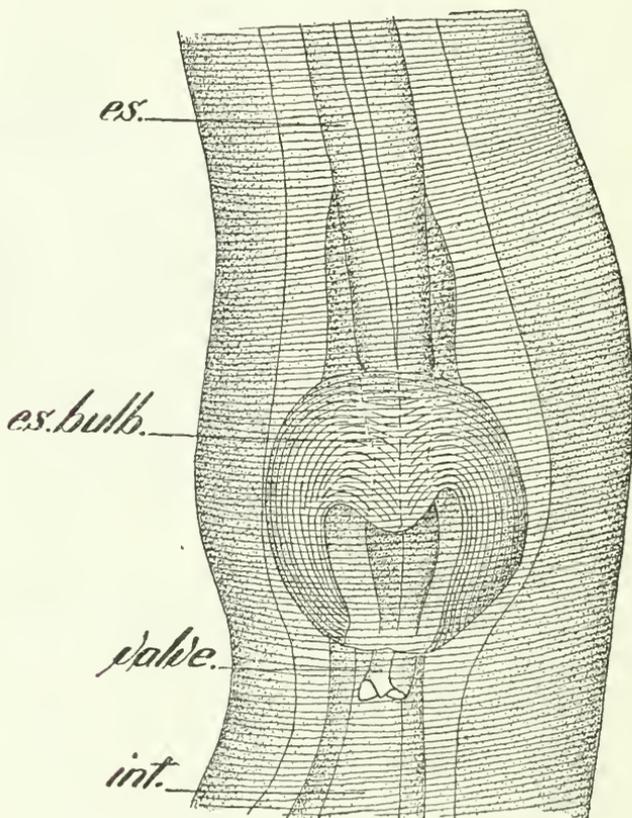


FIG. 111.—*OXYURIS TRIRADIATA*. ESOPHAGEAL BULB.  $\times 340$ .

oped anterior and posterior lips. The part of the body lying inside of the cuticle is depressed by the pushing in of the vulva while the depression is filled on the outside of the cuticle and beyond the line of the body by the large cuticular labia. From the extreme borders of the two lips the anteroposterior measurement attains a maximum of about 500  $\mu$ . This vulva is readily visible to the naked eye. The short muscular vagina extends posteriorly and communicates with the uterus. Apparently the reproductive tubes do not extend posterior of the anus. The ovaries extend forward almost or quite to the region of the esophagus. Eggs not found.

*Hosts*.—*Ammospermophilus leucurus cinnamomeus*, *Callospermophilus lateralis*.

*Location*.—Cecum and large intestine.

*Localities*.—United States (Pagosa Springs and Mack, Colorado).

*Type material*.—No. 16582 U.S.N.M. (Bureau of Animal Industry helminthological collection).

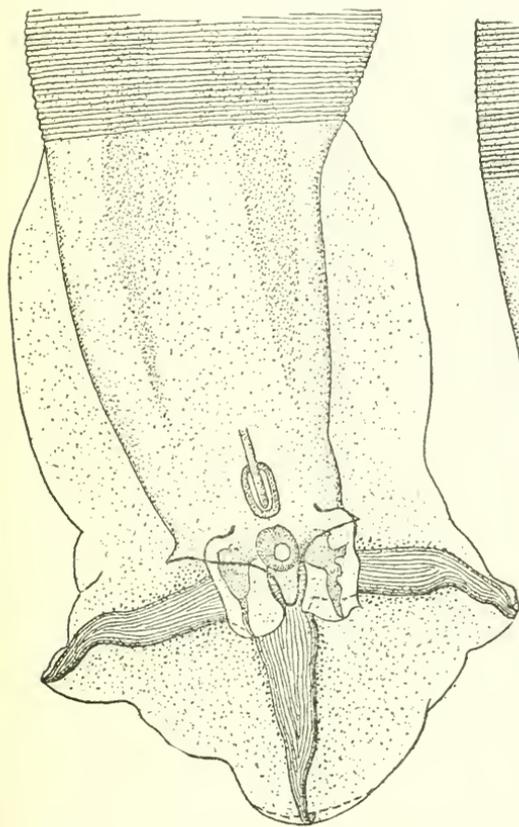


FIG. 112.—*OXYURIS TRIRADIATA*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW.  $\times 340$ .

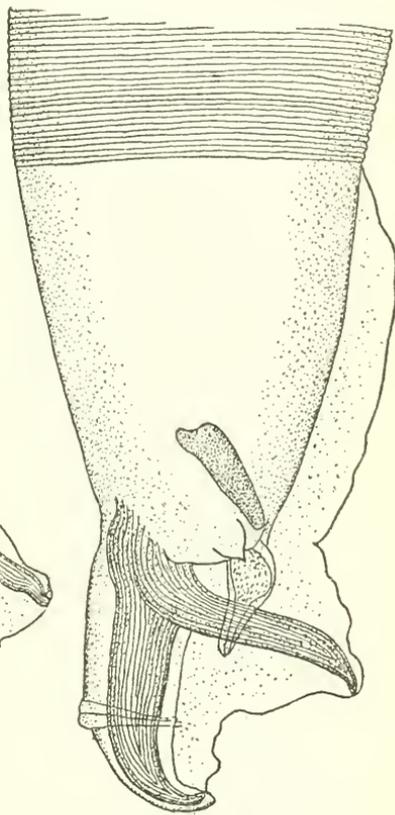


FIG. 113.—*OXYURIS TRIRADIATA*. POSTERIOR EXTREMITY OF MALE, LATERAL VIEW.  $\times 340$ .

Fertilization of the egg appears to take place rather late. Although I have an abundance of male and female material, including some from cases of heavy individual infestation, I find no gravid females. It is difficult to see the relation between the short, thick spicule and the enormous vulvar labia; perhaps the labia enlarge after fertilization.

This species should be found fairly widely distributed. It occurs in hosts of at least two genera and over a fairly wide range. Pagosa Springs is near the southern edge of the State of Colorado and Mack is near the middle of the western edge.

The resemblance between the bursa in this species and that of the type species of the genus, *O. equi*, is rather interesting.

I am indebted for the alcoholic host material from which these worms were collected to Mr. E. R. Warren, of Colorado Springs.

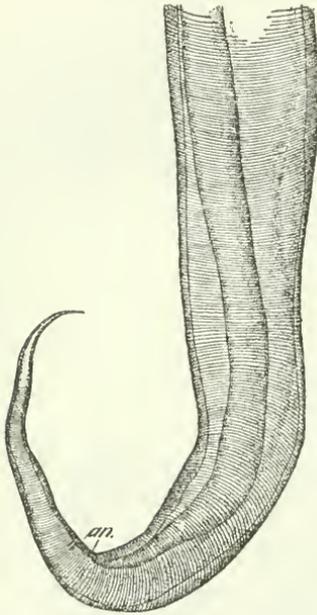


FIG. 114.—*OXYURIS TRIRADIATA*. POSTERIOR EXTREMITY OF FEMALE. *an.*, ANUS.  $\times 46$ .

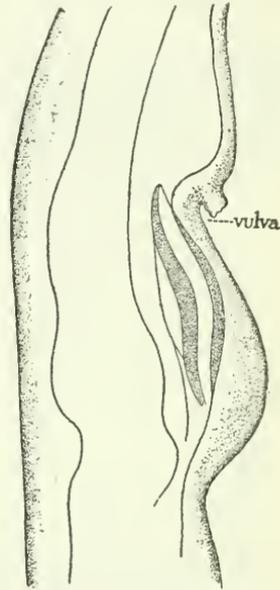


FIG. 115.—*OXYURIS TRIRADIATA*. FEMALE IN REGION OF VULVA, SHOWING DEVELOPMENT OF CUTICLE ANTERIOR AND POSTERIOR OF VULVA.  $\times 170$ .

*OXYURIS UNGULA* von Linstow, 1905.

*Specific diagnosis.*—*Oxyuris* (p. 65): Mouth with three lips. The esophagus is club-shaped, the diameter increasing posteriorly, and is separated by a constriction from the esophageal bulb. The bulb equals one-fifth of the total length of the esophagus. The anterior portion of the intestine has a smaller diameter than the esophageal bulb. The lateral cervical glands,  $260 \mu$  long, extend anteriorly along the esophagus. There are two cervical alae with a diameter equal to one-ninth of the body diameter and terminating posteriorly at a point opposite the posterior end of the esophagus. The cuticle is transversely striate.

*Male* 2.12 mm. long and  $180 \mu$  thick. Esophagus one-fifth of the total body length. The tail is one twenty-second of the total body length and is hoof-shaped in lateral view (fig. 116). On each side are two projections, of which the anterior is round and directed laterally and the posterior is more spherical and directed posteriorly.

*Female* 4.5 mm. long and 350  $\mu$  thick. The tail is  $1/5.7$  of the total body length and is elongate and finely pointed. The esophagus is  $1/7.5$  of the total body length. The nerve ring is 100  $\mu$  from the anterior end of the body. The excretory pore is close behind the nerve ring. The vulva separates the anterior portion of the body from the posterior portion in the ratios of 2:5 to 2:7. The eggs are of the typical *Oxyuris* shape, flattened on one side, and are 120  $\mu$  long and 36  $\mu$  thick.

*Larvae* 420  $\mu$  long and 79  $\mu$  thick. The esophagus is  $1/6.4$  and the tail  $1/8$  of the total body length.

*Host*.—*Sciurus vulgaris*.

*Location*.—Intestine.

*Locality*.—Germany (Bredlauken b. Insterburg).

Von Linstow (1906) states that the three males found by him were not sexually developed, the spicule and testis not being present. He also states that the cuticle is transversely striated at intervals of 130 to 170  $\mu$ . Considering the length and thickness of this worm, it seems more likely that 13 to 17  $\mu$  was intended.

Von Linstow further notes that this species can not be confused with *Oxyuris acutissima* from the same host for several reasons, among others,

that *O. acutissima* has no esophageal bulb. I take it that Rudolphi's allusion to a posterior swelling of the esophagus probably covers an observation on the esophageal bulb. At any rate, circumstances indicate that Rudolphi's species was an *Oxyuris* and as such must have had an esophageal bulb.

OXYURIS PALLARYI Seurat, 1915b.

*Specific diagnosis*.—*Oxyuris* (p. 65): Small forms, usually curved in an S-shape or the shape of an interrogation mark. Cuticle transversely striated at intervals of 10  $\mu$ . Two lateral alae in the median portion of the body. Excretory pore very small, opening at the level of the anterior end of the intestine in the female (fig. 117), and a little posterior of this in the male (fig. 118); the pore is in commu-

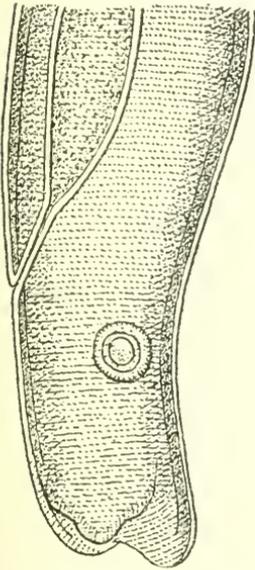


FIG. 116.—OXYURIS UNGUIS. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1906.

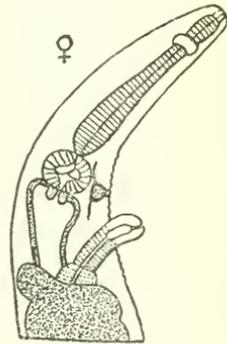


FIG. 117.—OXYURIS PALLARYI. ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER SEURAT, 1915a.

nication with a large vesicle which is very prominent as a result of its refractive appearance. The mouth has three lips. The esophagus, including the bulb, is a fifth of the length of the body in the male and a sixth in the female; it is encircled by the nerve ring at

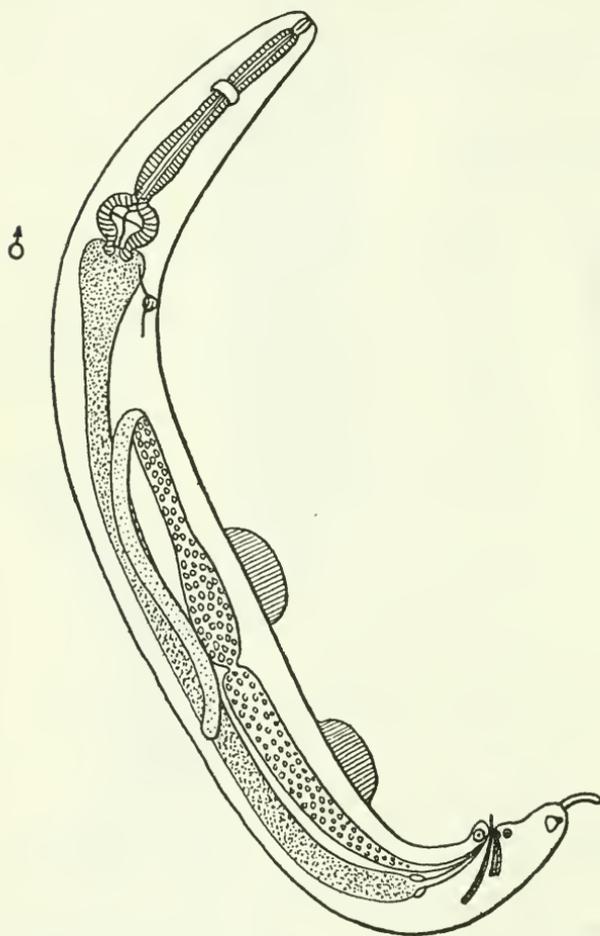


FIG. 118.—*OXYURIS PALLARYI*. MALE. ENLARGED. AFTER SEURAT, 1915a.

the union of the anterior and middle thirds.

*Male* 2 mm. long with a maximum thickness of 180  $\mu$ . Body commonly curved in an interrogation mark. Esophagus, including the esophageal bulb, 430  $\mu$  long. Excretory pore 50  $\mu$  posterior of the esophageal bulb. Two straight lateral alae in the region of the intestine and terminating anterior of the cloacal aperture (fig. 119). The cloacal aperture is in the center of a conical eminence. The tail is short, 130  $\mu$  long, and terminates in a dorsal point 70  $\mu$  long.

Posterior of the cloacal aperture are two straight caudal alae, sustained by a pair of large stalked papillae; the caudal glands open just anterior of these papillae. There are also a pair of sessile preanal papillae and a pair of sessile adanal papillae. The spicule is 84  $\mu$  long and slightly curved. The gubernaculum (fig. 120) is 55  $\mu$  long and terminates at its distal extremity in a hook like the barb of a fishhook. On the ventral surface of the body there are two large cuticular bosses on which the cuticular striae are especially prominent; the more anterior of these is in the middle of the body, and the other one

is midway between the first and the cloacal aperture; similar bosses have been noted in *Oxyuris stroma*, which Seurat says is *O. obvelata*.

*Female* 2.9 mm. long with a maximum thickness of 275  $\mu$ . The body is massive and curved in the shape of a letter S. The tail is one-sixth of the entire body; it attenuates gradually and terminates in a soft point. The esophagus is 400  $\mu$  long and the esophageal bulb 85  $\mu$  long. The intestine is wider than the esophageal bulb. The two lateral alae arise posterior of the esophageal bulb, at the level of the vulva, and extend to the region of

the rectum, 170  $\mu$  anterior of the anus. The vulva (fig. 117) opens on the ventral surface, slightly posterior of the esophageal bulb and 100  $\mu$  posterior of the excretory pore; the vulva is prominent for the reason that the vagina is everted, forming a prominent appendix 60  $\mu$  long. In a young female, 1.8 mm. long, and recently fertilized, the vagina is not everted, but the vulva is covered with a maroon-colored plaque which prevents any further attempts at fertilization. The ovijector is directed posteriorly and includes, first, a tubular portion lined with a cuticular membrane, corresponding to the vestibule and sphincter, and 120  $\mu$  long, characterized by the thickness of its muscular wall; second, the musculo-epithelial portion, which has a uniform thickness for 150  $\mu$ , then dilates to form an ovoid reservoir, 215  $\mu$  long, in which the spermatozoa accumulate and where fertilization takes place, and then diminishes to its original thickness and continues posteriorly to the vicinity of the rectum, where it divides into two branches which extend anteriorly and parallel to join the uterus. In the young female the uterus is straight and the eggs are arranged in a row; in the mature female the uterus occupies all the space about the intestine posterior of the vulva with the exception of that about the rectum. The ovaries are massive, blackish in color, and are situated side by side immediately posterior of the vulva. The eggs are numerous, thick shelled, elongated, and flattened on one face; they are 84 by 25  $\mu$  in diameter.

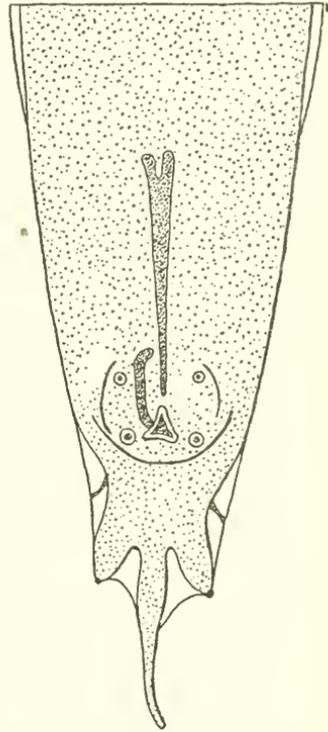


FIG. 119.—*OXYURIS FALLAX*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. ENLARGED. AFTER SEURAT, 1915a.

*Host.*—*Atlantoxerus getulus* (*Xerus getulus*).

*Location.*—Cecum.

*Locality.*—Mogador, Morocco.

Seurat states that the male of this species has its closest affinities with *O. stroma*, but that the females of the two species are so different that he wonders if the female described for *O. stroma* is really the female belonging with the male of that species. He also states that these two species are related to *O. hilgerti* and *O. obvelata*.

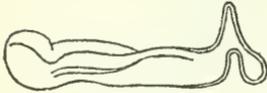


FIG. 120.—OXYURIS PALLARYI.  
GUBERNACULUM. ENLARGED.  
AFTER SEURAT, 1915G.

OXYURIS POLYOON von Linstow, 1909.

*Specific diagnosis.*—*Oxyuris* (p. 65): The cuticle is transversely striated at intervals of 7 to 8  $\mu$ ; anteriorly it is strongly thickened over a distance of 120  $\mu$ , the body parenchyma being thinned over the same interval. The rounded head end bears three lips. The esophagus is thin and terminates in a spherical bulb provided with teeth in the interior; the esophagus and its bulb are separated by a slight constriction; the small posterior half of the esophagus is pigmented brown; the esophagus is two-sevenths of the body length in the male and five twenty-thirds of the length in the female. The nerve ring encircles the esophagus about 180  $\mu$  from the anterior end of the body. The excretory pore is on the ventral surface in the neck region near the constriction between the esophagus and its bulb.

*Male* 3.26 mm. long and 330  $\mu$  thick; the tail is one seventy-fourth of the total length and is bent toward the ventral surface in the form of a hook, forming a coil of two turns. The vesicula seminalis is very large, with a length equal to about one-fourth of the entire body length. The testes extend so far anteriorly that they divide the body in the ratio of 11:8 anteriorly and posteriorly (meaning of original description not clear). The spermatozoa are flat, 16  $\mu$  long and 10  $\mu$  thick. The spicule (fig. 121) is 230  $\mu$  long and is forked at its proximal extremity. There are four pairs of prominent conical papillae, of which one pair is preanal, one adanal, and two pairs postanal.

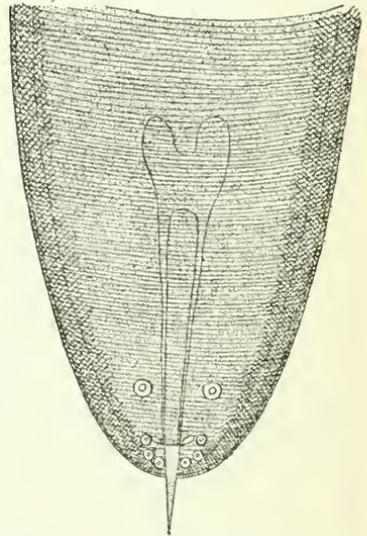


FIG. 121.—OXYURIS POLYOON. POSTERIOR  
EXTREMITY OF MALE. ENLARGED. AFTER  
VON LINSTOW, 1909.

*Female* 5.28 mm. long and 350  $\mu$  thick; the long finely pointed tail is two-elevenths of the total length of the body. The vagina opens far anterior of the middle of the body and divides the anterior from the posterior portion in the ratio of 19:41; it extends posteriorly and the ovaries extend to a point near the esophageal bulb. The small eggs are 80 by 23  $\mu$  in diameter and are uncommonly numerous.

*Host*.—*Geosciurus capensis* (*Xerus setosus*).

*Location*.—Intestine.

*Locality*.—Rehoboth, German Southwest Africa.

Seurat (1915*b*), in his paper describing *Dermatoxys getula*, notes in comment on that species that it has very close affinities with *O. polyoon*. As a distinguishing feature he notes the cuticular formations in the form of a comblike structure in *D. getula*. It seems quite likely that closer inspection would show the presence of these structures on *O. polyoon*, as it has other features, among them the peculiar distribution of pigment in the esophagus, in common with species of *Dermatoxys*. The present writer is of the opinion that more study will probably show that this species should be transferred to the genus *Dermatoxys*.

#### Genus DERMATOXYS Schneider, 1866.

*Generic diagnosis*.—Oxyurinae (p. 65): Males with a curving longitudinal row of transverse comblike crests on the ventral surface. Cervical alae present. Esophageal bulb with or without teeth. Males with very long well-developed caudal bursa. Massive deep colored ovaries in the region of the vulva, communicating by narrow oviducts with the uteri; the two uteri unite in the vicinity of the anus to form the long ovijector which extends anteriorly to the vagina.

*Type-species*.—*Dermatoxys veligera* (Rudolphi, 1819) Schneider, 1866.

#### ANALYTICAL KEY TO SPECIES OF DERMATOXYS.

1. Esophageal bulb without teeth. Male with 10 to 17 crests on the ventral surface; over 10 mm. long. Female over 15 mm. long.

*Dermatoxys veligera*, p. 99.

Esophageal bulb provided with teeth. Male with over 20 crests on the ventral surface; less than 5 mm. long. Female less than 10 mm. long.

*Dermatoxys getula*, p. 103.

#### DERMATOXYS VELIGERA (Rudolphi, 1819) Schneider, 1866.

*Synonym*.—*Ascaris veligera* Rudolphi, 1819.

*Specific diagnosis*.—*Dermatoxys* (p. 99): White worms, the body rather straight and stiff. Cuticle with fine, transverse striations, spaced at intervals of about 5  $\mu$  in the middle portion of the body and at wider intervals in the posterior portion. Two cervical alae ex-

tending from the head to a point posterior of the esophageal bulb. Excretory pore very small and difficultly visible, situated posterior of the esophageal bulb. Mouth with three well-developed lips, each bearing three papillae. Buccal cavity very shallow, closed anteriorly by three teeth inserted on the three lips. The esophagus terminates

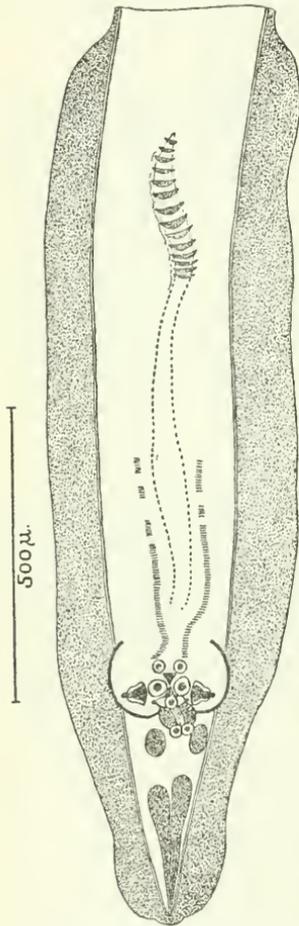


FIG. 122.—*DERMATONYX VELIGERA*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. AFTER SEURAT, 1915b.

posteriorly in a bulb, the union being marked only by the external widening and, frequently, by some rugose markings; the esophagus proper, exclusive of the bulb, is widened anteriorly to form a short thick portion and diminished posteriorly to form a long slender portion, the latter showing a variable and very noticeable brown pigmentation. The esophagus length, including the bulb, is one-ninth of the length of the female and two-fifteenths of the length of the male. The nerve ring encircles the esophagus proper at the union of the anterior and middle thirds.

*Male* 8 to 11.5 mm. long, with a maximum thickness of 435  $\mu$ . The body is straight, with a moderate curve ventrally at its posterior extremity. The caudal bursa (figs. 122 and 123) is formed of two very long alae, 1.5 mm. long and rather wide, with a very distinct border marked by several

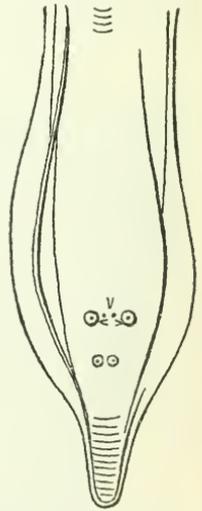


FIG. 123.—*DERMATONYX VELIGERA*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. ENLARGED. AFTER SCHNEIDER, 1866.

fine parallel longitudinal striations; the alae are curved ventrad and meet posterior of the conical termination of the body proper. The distance from this conical termination to the cloacal aperture is about 400  $\mu$ . About 700  $\mu$  anterior of the cloacal aperture is a series of 10 to 17 cuticular crests, of variable size and slightly irregular outline approximating that of a sector of a circle, the crests being disposed in a somewhat irregular longitudinal series. Between this

series and the cloacal aperture the ventral surface also bears two rows of small shields or bosses. The region about the cloacal aperture bears several large sessile papillae; there are six preanal papillae, of which four are in the same transverse line along the superior lip of the cloaca; the inferior lip bears three papillae, of which the median is the larger; immediately posterior is a contiguous pair of large papillae, and a little posterior of these is a pair of large cuticular shields. The apertures of the caudal glands open at the level of the origin of the tail. Spicule (fig. 124) very small, 85  $\mu$  long; no gubernaculum.

*Female* 16 to 17 mm. long, with a maximum thickness of 600  $\mu$ . The posterior extremity (fig. 125) is conical, regularly attenuated, and may terminate in a point covered by a small, brown, chitinous, thimble-shaped cap; this appears to be deciduous and is often not present. The tail is about 3 mm. long, or almost one-sixth of the length of the body. The excretory pore opens on the ventral surface, about 1.3 mm. posterior of the esophageal bulb. The vulva is about 85  $\mu$  broad, not prominent, and is situated anterior of the middle of the body, about 7 mm. from the anterior extremity. It is commonly

covered with a brown or reddish-brown plug. It opens into a vagina lined with a thick cuticle and joining a cuticular ovijector (fig. 126) which extends anteriorly a distance of 1 mm.; both the vagina and the ovijector are provided with a thick muscular tunic. In its distal region, corresponding to a sphincter, there is a deeper colored glandular organ, which in turn connects with the anterior musculo-epithelial portion of the ovijector, a straight tube 12 mm. long which extends to a point just posterior of the anus; in this posterior portion it enlarges and contains a number of eggs; from this portion the uteri diverge as straight tubes containing two or three rows of eggs and extending parallel to the preceding portion of the ovijector for a

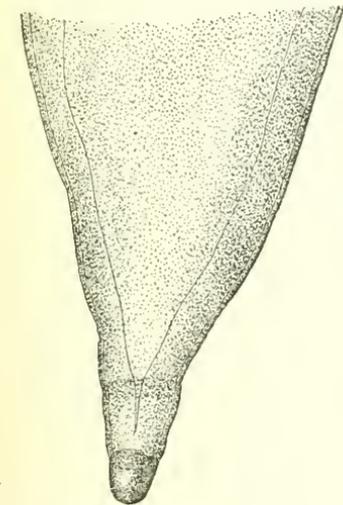


FIG. 125.—DERMATOXYS VELIGERA.  
POSTERIOR EXTREMITY OF FEMALE.

distance of 9 mm. Their anterior extremities, slightly dilated to form in each a receptaculum seminis, communicate with the ovaries by narrow S-shaped oviducts; the massive ovaries, of deeper color,



FIG. 124.—  
DERMATOXYS  
VELIGERA. SPICULE.  
ENLARGED.  
AFTER SEURAT,  
1915b.

are situated side by side posterior of the vulva. The eggs (fig. 127), 110 by 50  $\mu$  in diameter, have a very thick shell, stippled externally, slightly flattened on one side, and showing an interruption at one end for the exit of the embryo which is covered by a very distinct vitelline membrane.

*Hosts.*—*Sylvilagus brasiliensis* (*Lepus brasiliensis*), *Sylvilagus auduboni baileyi*, *Sylvilagus nuttalli pinetis*, *Lepus kabilicus*, *Lepus californicus melanotis*.

*Location.*—Cecum (very rarely in small intestine).

*Localities.*—Brazil; Algeria (Winton); United States (Amo, Howbert, Monument Park, and Natural Corral, Colorado; Murray County, Oklahoma).

I am unable to confirm Seurat's statement that the head is larger than the body immediately following it in this worm or that the cervical alae terminate posteriorly at the level of the esophageal bulb. The wide distribution of this species, which was described from Brazil in 1866 and not again noted for almost half a century, is rather surprising.

The record from *Lepus*

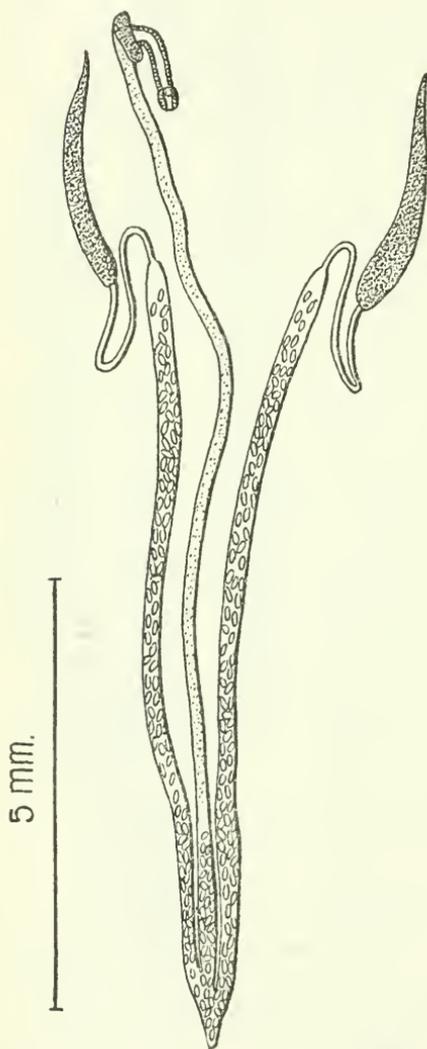


FIG. 126.—*DERMATOXYUS VELIGERA*. FEMALE GENITALIA. AFTER SEURAT, 1915b.

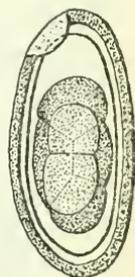


FIG. 127.—*DERMATOXYUS VELIGERA*. EGG. ENLARGED. AFTER SEURAT, 1915b.

*californicus melanotis* is based on specimens collected by Mr. Herman Douthitt from a "jack rabbit" in Oklahoma. As the species named ranges all over Oklahoma and is the one probably involved, according to Mr. Gerrit Miller, I have assumed this to be the host.

## DERMATOXYLS GETULA Seurat, 1915b.

*Specific diagnosis.*—*Dermatoxys* (p. 99): Two long cervical alae (fig. 128) arising at the head, where they attain their maximum width and gradually diminishing in width to the point near the middle of the body where they terminate. The cuticle is transversely striated at intervals of 9  $\mu$ . The excretory pore is very small and opens in the center of a clear elongated elliptical zone near the union of the intestine and the esophagus. The mouth (fig. 129) has three lips, a dorsal and two latero-ventral, each bearing two papillae and with a triangular tooth on the internal border; the points of these three labial teeth are in contact and limit the aperture of the mouth. The buccal cavity is shallow, 20  $\mu$  deep, and bordered laterally by two rows of tubercles situated at two levels. The esophagus is long and cylindrical and terminates posteriorly in a spherical bulb provided with teeth. The length of the esophagus and bulb is a fourth of the length of the body in the male and a fifth in the female. The nerve ring encircles the esophagus one-seventh of its length from the anterior end.

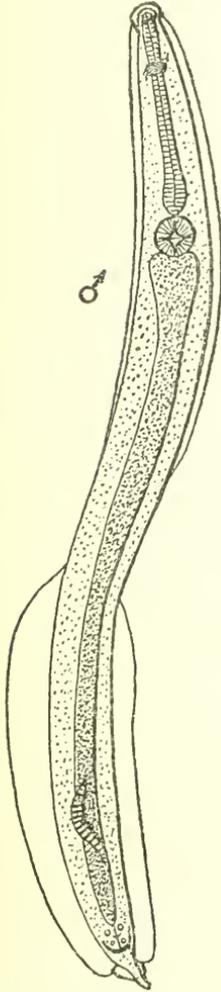


FIG. 128.—*DERMATOXYLS GETULA*. MALE. ENLARGED. AFTER SEURAT, 1915a.

*Male* 2.5 to 3.3 mm. long, with a maximum thickness of 290  $\mu$ . Two very long caudal alae (fig. 128), as wide as the body, extend along the posterior third of the body, terminating posterior of the cloacal aperture and leaving only a short caudal extremity devoid of these alae. The cloacal aperture (fig. 128) opens 110  $\mu$

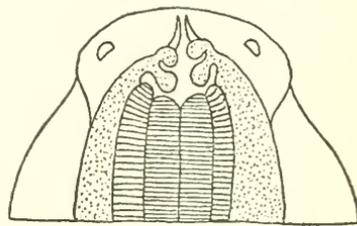


FIG. 129.—*DERMATOXYLS GETULA*. ANTERIOR EXTREMITY, DORSAL VIEW. ENLARGED. AFTER SEURAT, 1915a.

from this caudal extremity in the center of a very prominent conical eminence; posterior of this eminence the body is abruptly truncated ventrally and terminates in a narrow point 75  $\mu$  long, the orifices of the caudal glands opening at the origin of this point. Anterior of the cloacal aperture the ventral surface bears a curving longitudinal row of about 25 transverse parallel crests (figs. 128 and 130). There is a

pair of very large papillae some distance anterior of the cloacal aperture; there are two pairs of smaller adanal papillae; the inferior lip of the cloacal aperture bears 3 postanal papillae, of which the median is unpaired; and there is one pair of very small papillae toward the posterior third of the caudal extremity. The inconspicuous spicule is only  $65\ \mu$  long.

*Female* 5.5 mm. long, with a maximum thickness, exclusive of the alae, of  $310\ \mu$ . The cervical alae extend very little beyond the vulva. The tail is conical and has a length equal to a fifth of that of the body. The vulva (fig. 131) is not prominent and is situated a little posterior of the anterior third of the body. The very long ovjector is remarkably complex; the vagina is very short and communicates with a long vestibule, 1.7 mm. long, characterized by the thickness of its muscular tunic and lined with a thick cuticle; this vestibule turns back on itself and extends posteriorly in a winding course to a large ovoid sphincter,  $250\ \mu$  long and  $100\ \mu$  thick, and conspicuous from its

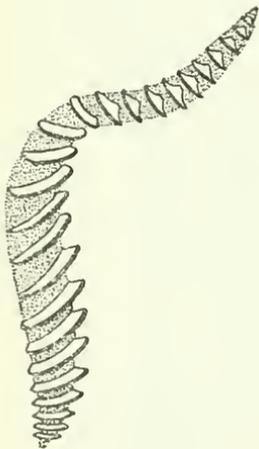


FIG. 130.—DERMATOXYS GETULA. ROW OF CRESTS ON VENTRAL SURFACE OF MALE. ENLARGED. AFTER SEURAT, 1915a.

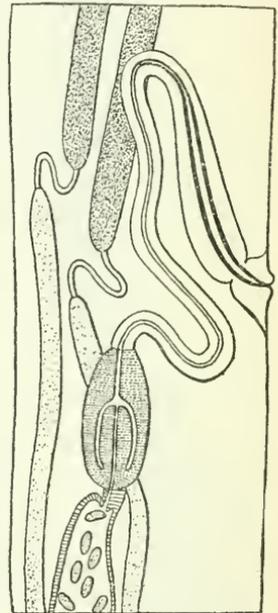


FIG. 131.—DERMATOXYS GETULA. FEMALE BODY IN REGION OF VULVA. ENLARGED. AFTER SEURAT, 1915a.

deep, almost black, color; this sphincter has a very narrow lumen and eggs do not remain in it any more than in the vestibule; beyond the sphincter is the tubular ovjector, a large sac filled with eggs and extending posteriorly to the level of the anus, where it divides to form the two uteri; these extend anteriorly to the level of the vulva, where they are connected with the ovaries by a very short oviduct curved in the form of a letter S; the uteri are straight and contain only two or three rows of eggs; one uterus descends posterior of the anus for a third of the length of the tail and then extends anteriorly; the ovaries are blackish and are folded on themselves in the dorsal region between the vulva and the esophageal bulb. The eggs have a thick shell and are  $55$  to  $60\ \mu$  long and  $25\ \mu$  thick.

*Larva.*—Larvae of both sexes in the fourth stage are frequently found among the adult worms. The *female larva* is 2.3 mm. long and has a relatively larger esophagus than the adult, the esophagus being two-fifths of the entire body length; the vulva is anterior of the middle of the body and is covered by the larval cuticle. The *male larva* is 1.6 mm. long and also has a relatively larger esophagus, equaling one-third of the entire body length; the tail is folded at its extremity. Just after the last ecdysis the young male is still without the prominent bursal alae of the adult (fig. 132).

*Host.*—*Atlantoxerus getulus* (*Xerus getulus*).

*Location.*—Cecum.

*Locality.*—Mogador, Morocco.

Seurat states that this species has affinities with *Oxyuris polyoon* von Linstow from *Xerus setosus*.

Family uncertain.

HETERAKIS VERRUCOSA Molin, 1860b.

*Specific diagnosis.*—Genus? Head not distinctly delimited from body. Body strongly attenuate posteriorly and adorned laterally with warty prominences arranged in a double series and continuing to the posterior extremity of the tail. Anterior extremity truncate, the mouth without lips or papillae and the cuticle loose and folded about the mouth. The esophagus ends in a bulb with a tooth apparatus. The intestine is composed of large cells, and there are three large cells at the rectum.

*Male* 7.5 mm. long and 300  $\mu$  thick. The caudal extremity is curved in a hook shape, subulate, and terminates in a sharp tip. There are two very slightly curved spicules with alate membranes.

*Female* 12 mm. long and 500  $\mu$  thick. The caudal extremity is straight and subulate, terminating in a sharp point. The eggs (fig. 133) are flattened on one side and are 100  $\mu$  long. The shells are perpendicularly striate.

*Host.*—*Dasyprocta aguti* (*Dasyprocta agouti*).

*Location.*—Stomach.

*Locality.*—Brazil (Caçara).

Molin states that this worm is meromyarian, and von Drasche (1882) has pointed out that on this account it can not be a species of *Heterakis*. The fact that no sucker is mentioned and that the worm

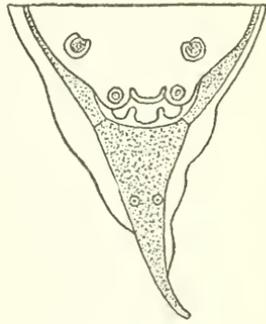


FIG. 132.—DERMATOXYIS GETULA. POSTERIOR EXTREMITY OF YOUNG MALE, VENTRAL VIEW. ENLARGED. AFTER SEURAT, 1915a.



FIG. 133.—HETERAKIS VERRUCOSA. EGGS. MAGNIFIED. AFTER VON DRASCHE, 1883.

is found in the stomach is further evidence to the same effect. Von Drasche thinks the worm may be placed near *Nematoxys* Schneider, 1866 (which is *Cosmocerca* Diesing, 1861, renamed). The esophagus, musculature, and lateral papillae suggest *Oxysoma*, Schneider, 1866, but as *Oxysoma* is without standing as a nematode genus, being pre-occupied by *Oxysoma* Gervais, 1849 (arachnoid), and as I have no similar material sufficiently close to this species to properly evaluate it, I have left the name unchanged and the species unplaced.

### Superfamily STRONGYLOIDEA Weinland, 1858.

*Synonyms*.—Strongyliidea Carus, 1863, in Travassos, 1914*b*; Stringyloidae Travassos, 1914*b*; Strongyloidea Weiland, 1858, of Travassos, 1914*b*.

*Superfamily diagnosis*.—Nematoda (p. 4): Meromyarian or poly-myarian. Males with well-developed caudal bursa supported by rays; in forms near the outer limit of the superfamily the bursa is occasionally very small and the rays atypical, or the bursa may be lacking altogether, the species in question being only referable to this superfamily on the ground that transitional but recognizably strongyle forms, found at times in the same locations and with the same habits, relate them to it. Esophagus without posterior bulb. Mouth naked or with a buccal capsule and six papillae, distinct or indistinct. Male usually with two spicules and female usually with two ovaries. Oviparous or viviparous.

*Type-family*.—Strongylidae Cobbold, 1864.

#### ANALYTICAL KEY TO FAMILIES OF STRONGYLOIDEA.

1. Polymyarian; usually in respiratory or circulatory tract.

Metastrongylidae, p. 162.

Meromyarian; usually found in the digestive tract..... 2.

2. Buccal capsule present..... Strongylidae, p. 107.

Buccal capsule not present..... Trichostrongylidae, p. 123.

The use of the musculature as a basis for the diagnosis of families, and especially for use in keys, is perhaps unfortunate, for the reason that it is a point not readily applied. At the same time the division of the strongyles along this line, following Railliet and Henry (1910), seems to be more fundamental and well considered than the division with reference to the presence or absence of a buccal capsule, following Leiper (1908). The arrangement of Railliet and Henry groups the trichostrongyles with the Strongylidae; that of Leiper groups them with the Metastrongylidae. While Leiper's arrangement is a better working arrangement, especially in compiling keys, it is not so fortunate in correlating other distinctive features as is that of Railliet and Henry. For one thing, the presence

of a rhabditiform embryo in the Strongyloidea and its absence in the Metastrongyloidea, as divided by Railliet and Henry, is a feature that points to ancestral differences of importance. The writer has followed Travassos (1914*b*) in treating all three groups as of coordinate family rank.

### Family STRONGYLIDAE Cobbold, 1864.

*Family diagnosis.*—Strongyloidea (p. 106): Meromyarian. Buccal capsule present. Bursa highly developed, with a typical system of supporting rays consisting of one or two dorsal rays and two lateral ray systems of six rays each. Male with two spicules and female with two ovaries. Vulva at times anterior of the middle of the body, but usually posterior of the middle. Oviparous, eggs segmenting when laid. Development, so far as known, direct. Embryo rhabditiform. In digestive, rarely in respiratory, system.

*Type-genus.*—*Strongylus* Mueller, 1780.

#### Subfamily STRONGYLINAE Railliet, 1893.

*Subfamily diagnosis.*—Strongylidae (p. 107): Meromyarian. Buccal capsule present. In digestive, occasionally in respiratory, system. Development direct, at times complex, involving cutaneous infection, nodular development or other embryonic or larval migration.

*Type-genus.*—*Strongylus* Mueller, 1780.

#### ANALYTICAL KEY TO TRIBES OF STRONGYLINAE.

1. No description.....Tribe uncertain, p. 121.  
Recognizable forms..... 2.
2. Dorsal and latero-dorsal rays originate separately, the dorsal trunk ending in 4 digitations; vulva close to anus and uteri divergent...Ransomeae, p. 115.  
Dorsal and latero-dorsal rays originate in a common trunk, or if separately, there are 2 dorsal branches with 3 digitations; vulva close to anus and uteri convergent, or vulva remote from anus and uteri divergent..... 3.
3. Dorsal and externo-dorsal rays originate separately; vulva close to anus and uteri convergent.....Cyclicostomeae, p. 114.  
Dorsal and externo-dorsal rays originate in a common trunk; vulva remote from anus and uteri divergent..... 4.
4. Dorsal ray tridigitate; vulva in posterior third of body...Strongyleae, p. 107.  
Dorsal ray bifurcate; vulva in middle or anterior portion of body.  
Bunostomeae, p. 112.

#### Tribe STRONGYLEAE Railliet and Henry, 1912*a*.

*Synonym.*—Ankylostomeae Railliet and Henry, 1909*b*.

*Tribe diagnosis.*—Strongylinae (p. 107): Vento-ventral and latero-ventral rays close together and parallel. Medio-lateral and postero-lateral rays not close together and parallel. Dorsal and externo-

dorsal rays originate in a common trunk, the dorsal ray ending in tridigitate terminations. The vulva in the posterior third of the body and the uteri divergent.

*Type-genus.*—*Strongylus* Mueller, 1780.

ANALYTICAL KEY TO GENERA OF STRONGYLEAE.

1. No corona radiata; buccal capsule opens dorsally-----*Uncinaria*, p. 111.  
Corona radiata present; buccal capsule does not open dorsally----- 2.
2. Posterior two-thirds of buccal capsule covered with round knobs.  
*Trachypharynx*, p. 109.  
Buccal capsule without a covering of knobs-----*Strongylus*, p. 108.

Genus STRONGYLUS Mueller, 1780.

*Synonyms.*—*Strongilus* Rudolphi, 1801; *Sclerostoma* Rudolphi, 1809; *Sclerostomum* Dujardin, 1845; *Sclerostomum* Sonsino, 1878; *Steongylus* Giles, 1892.

*Generic diagnosis.*—Strongyleae (p. 107): Anterior extremity truncated, straight or slightly curved toward the ventral surface. The open, circular mouth, transverse or oblique, is followed by a chitinous buccal capsule and the edge of the mouth is furnished with one or several series of numerous denticles, the corona radiata. The two equal spicules are long and slender. The bursa is trilobed. The ventro-ventral and latero-ventral rays are parallel, close together and have a common origin. The externo-lateral, medio-lateral, and postero-lateral rays originate in a common trunk and proceed in slightly diverging lines; they are of much the same shape, all tapering somewhat from the base. The dorsal and externo-dorsal rays originate in a common trunk, the latter originating near the base of the common trunk and occupying a relatively independent position. The main stem of the dorsal ray divides to form the two terminal dorsal rays, and each of these gives off an external branch and then forks again distally to form two terminal branches. One of the three branches of the dorsal rays may be missing. Vulva in the posterior third of the body. Uteri divergent.

*Type-species.*—*Strongylus equinus* Mueller, 1780.

ANALYTICAL KEY TO SPECIES OF STRONGYLUS.

1. Undescribed species-----*Strongylus* species, p. 109.  
Described species-----*Strongylus isotrichis*, p. 108.

STRONGYLUS ISOTRICHIS (Molin, 1860b) Hall, 1916.

*Synonym.*—*Sclerostomum isotrichis* Molin, 1860b.

*Specific diagnosis.*—*Strongylus* (p. 108): Head continuous with body. Mouth acetabular in shape, the internal margin with vertical walls and the large circular aperture with a diaphanous border

terminating in a corona radiata. Body subcylindrical, truncated anteriorly.

*Male* 5 mm. long and 300  $\mu$  thick. The large copulatory bursa is obliquely truncate and prolonged in a conspicuous dorsal margin. There are three groups of rays, the ventro-ventral being close together and parallel. The lateral groups of four rays include the externo-dorsal and the lateral. The dorsal group branches twice on each side, the rays therefore having four parts, of which the external is the smaller, and the dorsal rays are bifid. Two long filiform spicules.

*Female* unknown.

*Host*.—*Thrichomys pachyurus* (*Isothrix pachyura*) (?*Echinomys antricola*: see comment below).

*Location*.—Large intestine.

*Locality*.—Barro da Rio Negra, Brazil.

Molin makes this a species inquirenda on account of the lack of female worms for description. He gives no figures and his discussion of the dorsal rays, as transcribed above, is not entirely clear, but it appears to be very close to the genus *Strongylus* at least, and as the generic name *Sclerostomum* is a synonym of *Strongylus* and without other standing, I have transferred the species to *Strongylus*.

Von Linstow (1878) lists this species from *Echinomys antricola*, apparently as a modern equivalent for *Isothrix pachyura*, but it appears that *E. antricola* is a synonym of *Thrichomys apereoides*.

#### STRONGYLUS species.

*Synonym*.—*Sclerostema* species Morgan, 1868.

*Specific diagnosis*.—*Strongylus* (p. 108):

*Host*.—*Castor fiber*.

*Location*.—Cecum and colon.

*Locality*.—United States (Michigan?).

In his work on the American beaver, Morgan (1868) says of the worms found in this animal: "Also in the colon, and especially in the caecum, sclerostema, male and female, species not known." There seems to be nothing to be gained by speculating on this worm without further data, and in view of the site of infestation I have regarded this as *Strongylus*.

#### Genus TRACHYPHARYNX Leiper, 1911.

*Generic diagnosis*.—Strongyleae (p. 107): Oral aperture terminal, surrounded by a corona radiata. The anterior third of the buccal capsule is lined with a thick chitinous investment. The posterior two-thirds of the buccal capsule is surrounded by esophageal musculature and is lined with a thin layer of cuticle bearing a large num-

ber of round cuticular knobs, which project into the buccal cavity (fig. 134). Vulva a short distance in front of the anus (?).

*Type-species.*—*Trachypharynx nigeriae* Leiper, 1911.

TRACHYPHARYNX NIGERIAE Leiper, 1911.

*Specific diagnosis.*—*Trachypharynx* (p. 109): Number of leaves in internal and external crown of corona radiata undetermined. Buccal capsule pear-shaped.

*Male* 11 mm. long.

*Female* 15 mm. long and 460  $\mu$ . thick. Esophagus 1.25 mm. long from the base of the anterior third of the buccal capsule to the beginning of the intestine. The esophageal musculature enclosing the posterior two-thirds of the buccal capsule is 6  $\mu$ . thick; the musculature in the posterior third of the esophagus is 130  $\mu$ . thick. Anus almost at the posterior end of the body. Vulva a short distance anterior of the anus.

*Host.*—"A large rodent."

*Location.*—Not given.

*Locality.*—Nigeria, Africa.

It seems highly desirable that the generic characters be indicated in the proposal of a new genus. If a person has a reason for proposing a new genus, the reason is known to him, and it calls for little effort to state it. To leave it to some one else to write one's generic diagnosis is very unsatisfactory. It should be unsatisfactory to the man who names the genus, since it may readily happen that the man writing the diagnosis

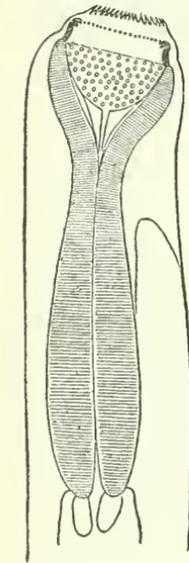


FIG. 134.—TRACHYPHARYNX NIGERIAE. ANTERIOR EXTREMITY. ENLARGED. AFTER LEIPER, 1911.

does not evaluate characteristics in the same way he does. It certainly is unsatisfactory to the writer of the diagnosis. It is bad enough when the type of the new genus is a common species that may be studied readily. It is much worse when the new species is an obscure one, poorly described, and not available to workers in general. This is not detracting from the importance of designating a type-species. Modern workers should write generic diagnoses for their new genera and also designate type-species. To omit either of these things is productive of trouble and confusion.

I have assumed that the measurements given for the esophagus by Leiper refer to the females. His figures do not bear out his statements in regard to the thickness of the esophageal musculature. He states that the posterior end of the male was embedded in a thick brown prostatic secretion and so was not studied; the important bursa characteristics are therefore unknown.

## Genus UNCINARIA Froelich, 1789.

*Synonyms.*—*Unciaria* Fischer, 1799; *Dochmius* Dujardin, 1845; *Uncinaria* von Linstow, 1902; *Uncinnaria* Schmaltz, 1903.

*Generic diagnosis.*—Strongyleae (p. 107): Corona radiata not present. Buccal capsule opens dorsally. Mouth round to oval, aperture oblique, limited by a transparent border. The dorsal portion of the buccal capsule is shorter than the ventral and is supported by a conical structure, the point of which sometimes extends into the cavity. At the mouth aperture the ventral wall is prolonged to form two chitinous plates with cutting edges. Two ventral teeth at the base of the buccal capsule. Genital tubes short and thick, forming a small number of folds in a longitudinal direction.

*Type-species.*—*Uncinaria criniformis* (Goeze, 1782) Looss, 1902.

## UNCINARIA MURIDIS Parona, 1907.

*Specific diagnosis.*—*Uncinaria* (p. 111): Body dirty white, tending to brown in the female; anterior portion a little thinner than the posterior. Head bent in an arc very strongly toward the dorsal surface (fig. 135). Buccal capsule with strong marginal laminae which bend symmetrically toward the median line anteriorly in correspondence with a tooth for each one. The esophagus enlarges posteriorly in a claviform swelling. The intestine is large and straight throughout its course, except for the short rectum.

*Male* 5 mm. long and thinner than the female. Genital bursa bilobed, the intermediate lobule not evident. Rays simple, slightly differentiated, the dorsal bifurcate. The equal spicules (fig. 136) are long and thin, longer than the bursa.

*Female* 7 to 8 mm. long. Tail short, conical, and mucronate. Anus a transverse slit (fig. 137). The coils of the oviduct extend very far forward, almost to the posterior end of the esophagus, and turn back in serrate loops. The vulva is a little in front of the middle of the body. Vulva lips not prominent. Eggs in the vagina region are oval, transparent, and not very numerous. Some are segmenting, others show a larva doubled back on itself in the shell.

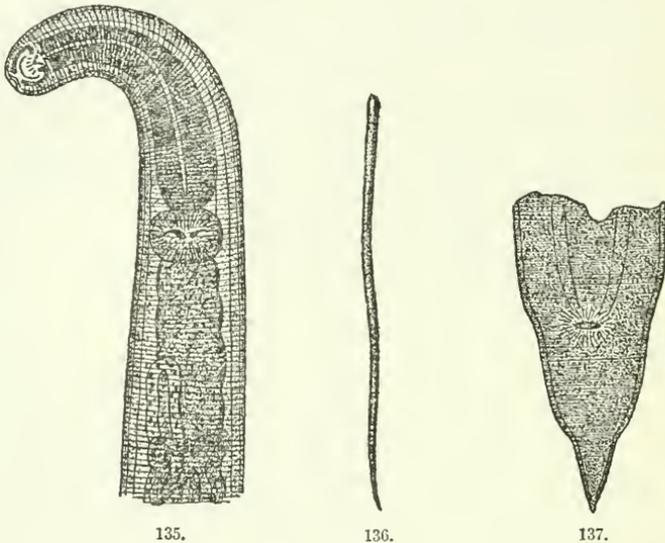
*Hosts.*—*Otomys irroratus*, *Otomys irroratus tropicalis*.

*Location.*—Intestine.

*Localities.*—Kaziba and Fort Portal, Africa.

The species is left in the genus *Uncinaria*, not with any conviction that it belongs there, but because Parona calls it *Uncinaria* and there is not sufficient evidence to show where it belongs. The position of the vulva would indicate that the worm belonged in the Bunostomeae, as would the fact that the dorsal ray is bifurcate. But the figure, which shows that the worm has an esophageal bulb, would indicate

that it does not even belong in the Strongyloidea. Further study and description of the material seems to be necessary. It would have added to the value of Parona's (1909) paper if he had labeled his figures; drawings are not always self-evident.



FIGS. 135-137.—*UNCINARIA MURIDIS*. 135, ANTERIOR EXTREMITY. ENLARGED. AFTER PARONA, 1909. 136, SPICULE. ENLARGED. AFTER PARONA, 1909. 137, POSTERIOR EXTREMITY OF FEMALE, VENTRAL VIEW. ENLARGED. AFTER PARONA, 1909.

Tribe **BUNOSTOMEAE** Railliet and Henry, 1909*b*.

*Synonym.*—Bunostominae Looss, 1911.

*Tribe diagnosis.*—Strongylinae (p. 107): Ventro-ventral and latero-ventral rays close together and parallel. Medio-lateral and postero-lateral rays not close together and not parallel. Dorsal and externo-dorsal rays originate in a common trunk, the dorsal ray ending in a bifurcation. The vulva is in the middle of the body or a little anterior of this, and the uteri are divergent.

*Type-genus.*—*Bunostomum* Railliet, 1902.

Genus **ACHEILOSTOMA** Leiper, 1911.

*Generic diagnosis.*—Bunostomeae (p. 112): Buccal capsule opens slightly dorsally, the aperture unarmed (fig. 138). At the base of the buccal capsule a large ventral tooth and two fan-shaped dorsal teeth (fig. 139). No corona radiata. Dorsal lobe of bursa very distinct and shorter than the lateral lobes. Genital cone prominently developed. The main trunk of the dorsal ray branches to form the

two terminal dorsal rays, each of which terminates in a bifurcation (fig. 140). The externo-dorsal rays originate about halfway between the base of the common trunk and the branching of the main dorsal trunk to form the terminal dorsal rays. The medio-lateral and postero-lateral rays extend almost side by side to the edge of the bursa (fig. 141). The externo-lateral ray terminates about one-third of the distance from the medio-lateral ray to the ventral rays. Vulva in the middle of the body.

*Type-species.*—*Acheilostoma simpsoni* Leiper, 1911.

**ACHEILOSTOMA SIMPSONI** Leiper, 1911.

*Specific diagnosis.*—*Acheilostoma* (p. 112): Cuticle with deep transverse striations in the anterior end of the body. Two large, stout, thorn-shaped cervical papillae curving backward (fig. 138).

*Male* 17 mm. long. (See figs. 140 and 141.)

*Female* 23 mm. long. Cervical papillae 800  $\mu$  from the anterior end. Collar of oral aperture 4  $\mu$  thick. Esophagus 950  $\mu$  long. Eggs in utero are 55 by 32  $\mu$  in diameter "and usually contain a few segments."

*Host.*—"A large rodent."

*Location.*—"Alimentary canal."

*Locality.*—Nigeria, Africa.

In the absence of any definite statement I have referred Leiper's measurements to the female. His statement that the externo-lateral ray "has a thickness almost equal to the two central

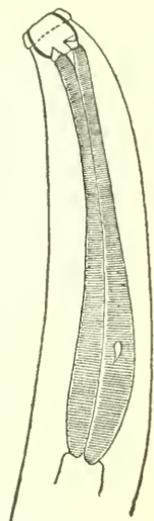


FIG. 138.—ACHEILOSTOMA SIMPSONI. ANTERIOR EXTREMITY. ENLARGED. AFTER LEIPER, 1911.

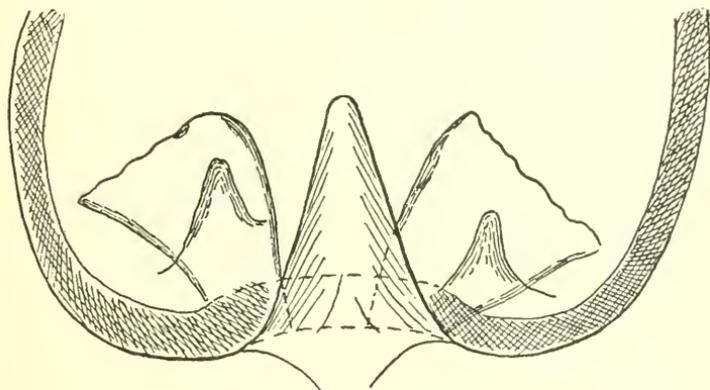


FIG. 139.—ACHEILOSTOMA SIMPSONI. BASE OF BUCCAL CAPSULE. ENLARGED. AFTER LEIPER, 1911.

rays combined" leaves considerable doubt as to what is meant by the two central rays. If it refers to the medio-lateral and postero-lateral

rays, it is not substantiated by his figures. It might refer to the dorsal ray, though this would be the unusual and unlikely comparison.

Tribe **CYLICOSTOMEAE** Railliet  
and Henry, 1912a.

*Synonym.*—Cylichnostomidae Looss, 1902; Cylicostominae Railliet, 1915.

*Tribe diagnosis.*—Strongylinae (p. 107): Ventro-ventral and latero-ventral rays close together and parallel. Medio-lateral and postero-lateral rays not close together and parallel. Dorsal and externo-dorsal rays originate sepa-

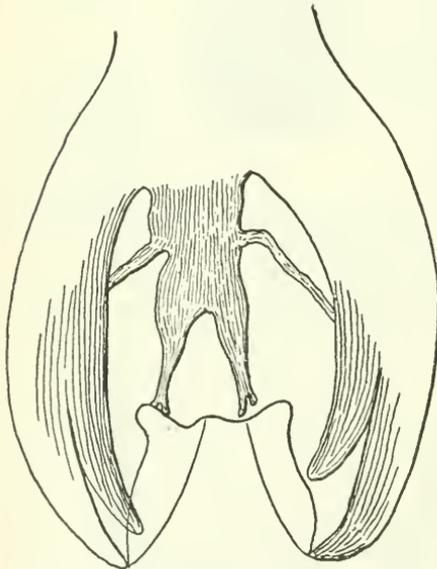


FIG. 140.—ACHEILOSTOMA SIMPSONI. DORSAL VIEW OF BURSA. ENLARGED. AFTER LEIPER, 1911.

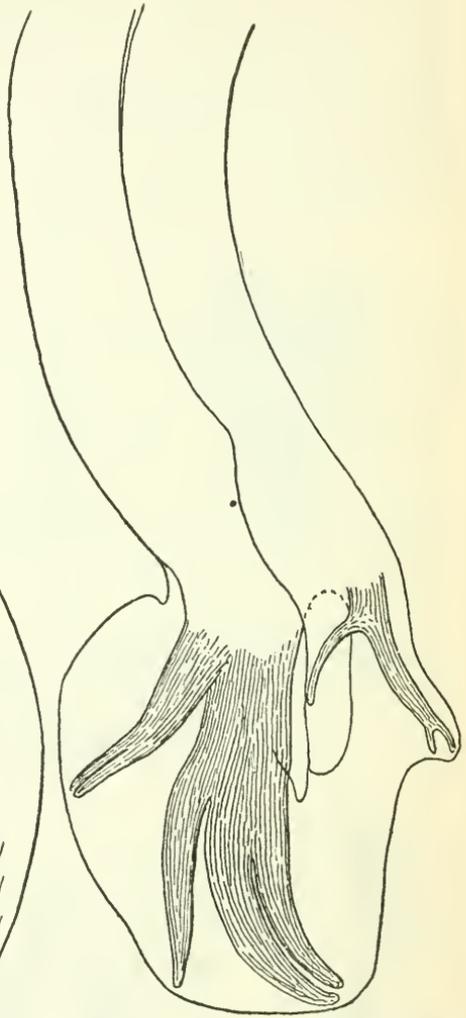


FIG. 141.—ACHEILOSTOMA SIMPSONI. LATERAL VIEW OF BURSA. ENLARGED. AFTER LEIPER, 1911.

rately. The vulva is close to the anus and the uteri are convergent.

*Type-genus.*—*Cylicostomum* Railliet, 1901.

Genus **EUCYATHOSTOMUM** Molin, 1861a.

*Synonym.*—*Encyathostomum* Molin, 1861a.

*Generic diagnosis.*—Cylicostomeae (p. 114): Buccal capsule large, with a wide anterior aperture furnished internally with a crown of numerous, slender, acutely pointed processes, the corona radiata.

Bursa with dorsal lobe projecting posteriorly beyond the lateral lobes. Ventro-ventral and latero-ventral rays close together and parallel and originating in a common trunk with the lateral rays, the latter mutually divergent. The externo-dorsal ray is widely separated from the lateral rays and originates from the dorsal trunk or from one of the paired dorsal rays near its origin. The two long dorsal rays give off two branches externally. In some species the dorsal rays may present the appearance of being fused in the median line to form a single dorsal ray with a bifurcate tip. The equal spicules are long and slender. The vulva is a short distance in front of the anus.

*Type-species.*—*Eucyathostomum longesubulatum* Molin, 1861a.

EUCYATHOSTOMUM COPULATUM Molin, 1861a.

*Synonyms.*—*Eucyathostomum copulatum* Molin, 1861a; *Strongylus cohaerens* Schneider, 1866; *Sclerostomum copulatum* (Molin, 1861a) Stossich, 1899.

*Specific diagnosis.*—*Eucyathostomum* (p. 114): Head truncate, continuous with body, and provided with four large spinelike papillae and two small ones. Mouth caliciform and provided internally with a corona radiata. Body abruptly attenuated at both ends. Cuticle densely striated transversely. Male and female always found attached in permanent copulation at right angles.

*Male* 3.5 to 5 mm. long and 200  $\mu$  thick. Two very long filiform spicules.

*Female* 5 to 9 mm. long and 500  $\mu$  thick. Caudal extremity subulate. Anus prominent and remote from the posterior end of the body. Vulva just anterior of anus.

*Host.*—*Dasyprocta aguti*.

*Location.*—Cecum.

*Localities.*—Caiçara and Ypanema, Brazil.

Schneider and Molin have both studied this species and neither has described the bursa, Schneider stating that the union of the male and female was so firm that he could not separate them for study. The two workers have put the species in different genera, but I have followed the author of the genus *Eucyathostomum* in placing it in that genus. It may not belong there. Molin noted that the male was attached to the mucosa and the female hung free in the intestinal lumen.

RANSOMEAE Hall, 1916, new tribe.

*Tribe diagnosis.*—Strongylinae (p. 107): Ventro-ventral and latero-ventral rays close together and parallel. Medio-lateral and postero-lateral rays divergent. Dorsal and externo-dorsal rays originate separately. Vulva close to anus and uteri divergent.

*Type-genus.*—*Ransomus* Hall, 1916.

## RANSOMUS Hall, 1916, new genus.

*Generic diagnosis.*—Ransomeae (p. 115): Anterior end of head obliquely truncate, so that the mouth faces antero-ventrally. Buccal capsule large, without teeth in its interior. Border of mouth armed with a crown of numerous small, triangular, pointed processes, the corona radiata (fig. 142). The median or dorsal lobe of bursa very little longer than the lateral lobes. Ventro-ventral and latero-ventral rays close together and parallel. Medio-lateral and postero-lateral

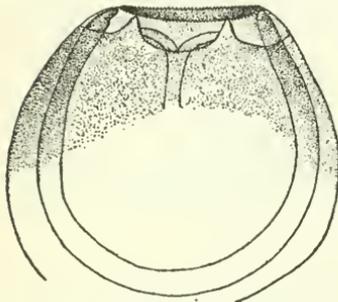


FIG. 142.—RANSOMUS RODENTORUM.  
BUCCAL CAPSULE. ENLARGED.

rays divergent. Dorsal ray and the externo-dorsal rays originate separately. The dorsal trunk sends out two lateral branches and then divides to form a bifurcate termination. Spicules long, tubular, slender, and alate. Gubernaculum present. Vulva a short distance in front of the anus. The vagina is of only moderate length. The uteri are divergent, the muscular ovijectors extending anteriorly and posteriorly from their union with the vagina. Back of the muscular ovijector the posterior uterus turns forward. Eggs apparently not yet segmenting when oviposited.

*Type-species.*—*Ransomus rodentorum* Hall, 1916.

This genus is named after Dr. B. H. Ransom, Chief of the Zoological Division of the United States Bureau of Animal Industry, in recognition of his work in parasitology.

## RANSOMUS RODENTORUM Hall, 1916, new species.

*Synonym.*—*Chabertia* species of Hall, 1912.

*Specific diagnosis.*—*Ransomus* (p. 116): The worms are relatively short and thick. No cervical papillae observed. The esophagus is club-shaped, thick, and prominent. The rectum is distinctly defined but presents no features of interest. Cervical papillae not observed. The cuticle is finely striate longitudinally.

*Male* 4.64 to 8.19 mm. long and 290 to 300  $\mu$  thick at a point near the thickest part of the esophagus, where the body attains its maximum diameter (fig. 143). Diameter of the head in the plane of the buccal aperture is about 170 to 205  $\mu$ . Length of esophagus 685 to 750  $\mu$ , attaining a maximum thickness near the posterior end of 205 to 250  $\mu$ . The nerve ring is located at the union of the anterior and middle third of the esophagus and is 400 to 465  $\mu$  from the anterior end of the body. Excretory pore not observed. The bursa is relatively short and wide (fig. 144). The tips of the externo-lateral and

externo-dorsal rays fall distinctly short of the margin of the bursa, the tips of the other rays reaching nearly or quite to the margin (fig. 145). The ventro-ventral and latero-ventral rays are close together and parallel. The tip of the externo-lateral ray is about equidistant from the tips of the latero-ventral and the externo-dorsal. The medio-lateral and postero-lateral originate in a common stem and diverge slightly from the point of bifurcation. The externo-dorsal rays originate at the root of the dorsal ray and are the thinnest of the rays, the other rays being of rather uniform size. The dorsal ray divides into four branches almost at one level, the two outermost branches passing out from the main trunk and the trunk dividing immediately after to form the two terminal digitations. The four branches are of almost the same thickness, the outer branches being a little the longer. Pre-bursal papillae not seen. The tubular alate spicules (fig. 146) are 830 to 955  $\mu$  long. At the anterior end they attain a maximum diameter of 32  $\mu$ ; posterior to this point they are from 10 to 16  $\mu$  thick. The alae (fig. 147) attain a maximum width of 21  $\mu$ .

The gubernaculum is 43 to 53  $\mu$  long and is deeply bifurcated. The cloacal aperture is near the end of the genital cone.

*Female* 8 to 9.2 mm. long with a maximum thickness of 345 to 365  $\mu$ , the maximum thickness being attained just back of the head and anterior of the vulva. From the thick portion just anterior of the vulva the body diminishes in diameter posteriorly. A short distance back of the vulva the worm bends dorsally (fig. 148). Back of the anus the decrease in diameter is accented, this portion forming a cone. Near the tip of the cone there is a break where the sides of the cone tend for a short distance to approach the parallel and then the body terminates in a conical tip. The esophagus is club-shaped, slightly thinned in the vicinity of the nerve ring and increasing considerably in diameter posteriorly. It is 945  $\mu$  to 1 mm. long

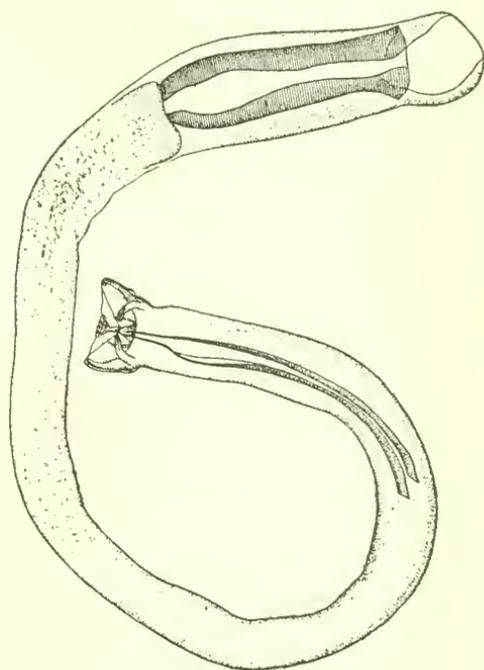


FIG. 143.—*RANSOMUS RODENTORUM*, MALE. ENLARGED.

and attains a maximum thickness of 205 to 275  $\mu$ . The nerve ring is 430 to 490  $\mu$  from the anterior end of the body. The anus is 300 to 350  $\mu$  from the end of the tail. The vulva is a transversely elongated slit with prominent lips and is 645 to 860  $\mu$  from the end of the tail. The vagina is 380 to 390  $\mu$  long and is directed anteriorly from the vulva, the anterior end bending in a somewhat lateral direction to join the ovijectors. The combined lengths of the muscular portions of the ovijector are about 675 to 700  $\mu$ . One is directed anteriorly from the common central portion, the other is directed posteriorly,

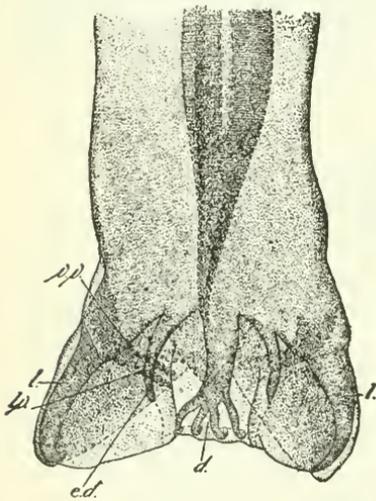


FIG. 144.—RANSOMUS RODENTORUM. BURSA, DORSAL VIEW. *d.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *l.*, POSTERO-LATERAL AND MEDIO-LATERAL RAYS; *l. v.*, LATERO-VENTRAL RAY; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

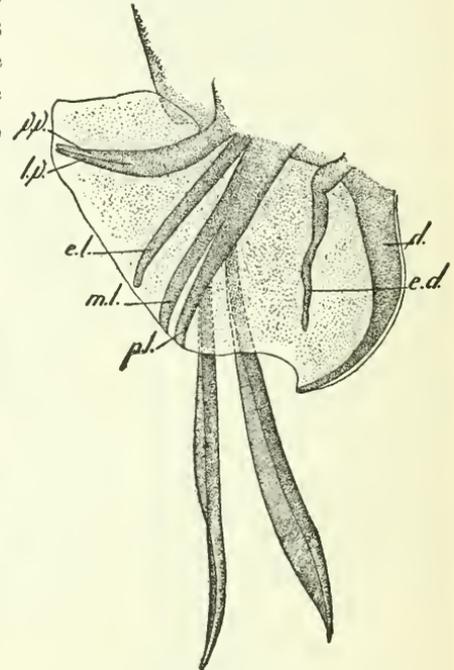


FIG. 145.—RANSOMUS RODENTORUM. BURSA, LATERAL VIEW. *d.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *e. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

but proceeds only a short distance before turning anteriorly. The eggs are ellipsoidal and are 100 to 105 by 55 to 60  $\mu$  in diameter. Eggs not yet segmenting when oviposited.

*Host.*—*Thomomys fossor*.

*Location.*—Cecum; occasionally in small intestine.

*Localities.*—Ruxton Creek (El Paso County, Colorado); Middle Brush Creek (Gunnison County, Colorado); and Crested Buttes, Colorado.

*Type material.*—No. 16181, U.S.N.M. (Bureau of Animal Industry helminthological collection).

The writer is indebted to Mr. E. R. Warren, of Colorado Springs, for the opportunity to collect this material from alcoholic host material collected by Mr. Warren in 1909 and 1910. The species was tentatively reported by the writer in 1912 as *Chabertia* species,

but a subsequent study of the material shows that such structures as the externo-dorsal ray, which originates independently, and the dorsal ray, which terminates in four substantially equal digitations, will not permit of placing this form in that genus.

In passing it may be said that while the writer has followed Railliet and Henry in forming tribes on the basis of ray formation and the location and arrangement of the vulva and uteri, the system is not altogether successful in bringing together groups distinctly similar in other respects. An arrangement which brings together *Strongylus*, with a corona radiata, and *Ancylostoma* and *Uncinaria*, without a corona radiata and with the rather distinctive hookworm

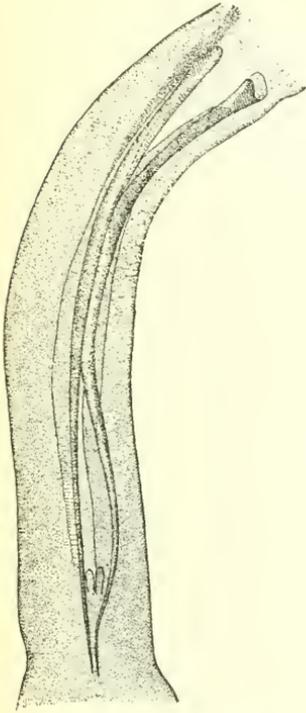


FIG. 146.—RANSOMUS RODENTORUM. PORTION OF MALE BODY, SHOWING SPICULES. ENLARGED.



FIG. 147.—RANSOMUS RODENTORUM. DISTAL EXTREMITY OF SPICULE. ENLARGED.

head, as members of the Strongyleae, at the same time placing *Cylicostomum*, with a corona radiata, in the Cylicostomeae, and *Necator*, with its hookworm mouth, in the Bunostomeae, is not entirely satisfactory. At the same time, Leiper's (1908) division, based on the buccal capsule, and putting hookworms in the Ancylostominae, forms with a corona radiata in the Strongylineae, and such forms as *Kalicephalus* in another unnamed group, is likewise unsatisfactory. The fact that the present grouping is not very satisfactory is one reason for not following other writers who give these groups higher than tribal rank.

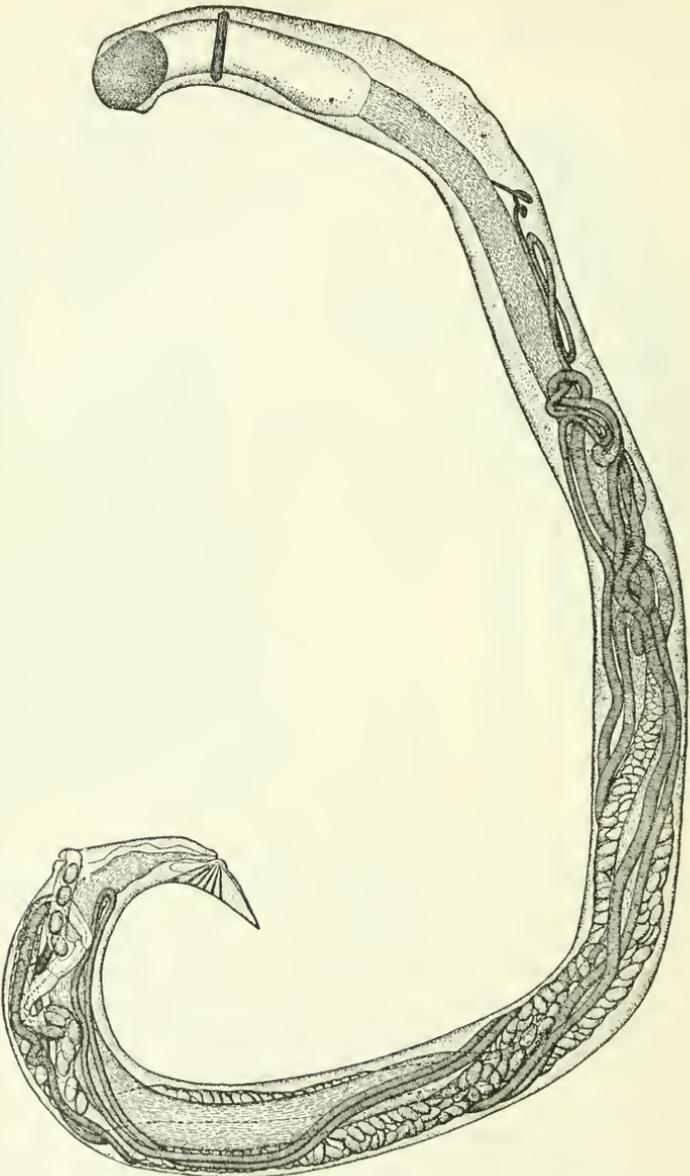


FIG. 148.—RANSOMUS RODENTORUM. FEMALE. ENLARGED.

## Tribe uncertain.

## ANALYTICAL KEY TO UNPLACED SPECIES OF STRONGYLINAE.

1. Found in inguinal glands; undescribed-----*Strongylus lemni*, p. 122.  
 Found in large intestine; described species.  
*Strongylus (Deletrocephalus) brachylaimus*, p. 121.

## STRONGYLUS (DELETROCEPHALUS) BRACHYLAIMUS von Linstow, 1901.

*Specific diagnosis.*—*Deletrocephalus* (?): Cuticle transversely striate at intervals of 21  $\mu$ . At the head end is a prominence, smaller in front and broader behind, with a rounded posterior margin. This surrounds a buccal capsule, in the wall of which are about

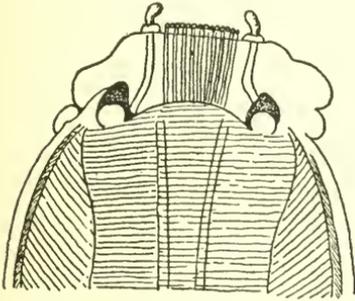


FIG. 149.—STRONGYLUS (DELETROCEPHALUS) BRACHYLAIMUS. ANTERIOR EXTREMITY. ENLARGED. AFTER VON LINSTOW, 1901.

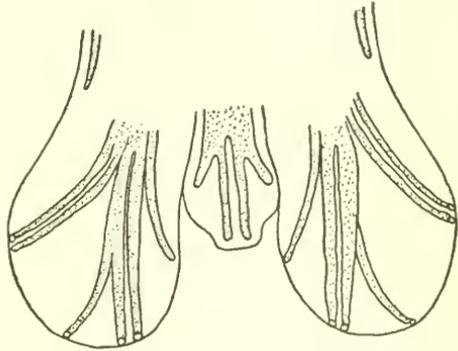


FIG. 150.—STRONGYLUS (DELETROCEPHALUS) BRACHYLAIMUS. BURSA. ENLARGED. AFTER VON LINSTOW, 1901.

50 rods, the ends, some of which are cleft, projecting free anteriorly (fig. 149). At the posterior margin of the head prominence and in the four submedian lines are four large papillae, while outside of the buccal capsule four fine clublike papillae project anteriorly. The esophagus is very short.

*Male* 13 mm. long and 630  $\mu$  thick. The esophagus is one-twenty-seventh of the total length. The bursa (fig. 150) has two large lateral lobes and one small median lobe. Of the six rays in the lateral lobes, the ventro-ventral and latero-ventral are close together and the medio-lateral and postero-lateral are close together. The last two are broad. The medio-lateral and the externo-lateral originate in a common trunk, the externo-lateral branching off and diverging from the medio-lateral, which continues in general the line of the main trunk. The externo-dorsal and the dorsal apparently originate separately. The dorsal trunk divides to form two thick branches, which almost immediately divide to form a short external branch and a longer terminal branch. The very long spicules are 2.96 mm. long. The gubernaculum is 100  $\mu$  long.

*Female* 20 mm. long and 880  $\mu$  thick. The esophagus is one-thirty-second of the total length. The conical pointed tail is one-ninety-

sixth of the total length. The vagina opens just anterior of the anus. The ratio of the body length anterior of the vulva to that posterior of the vulva is 500:11. Anterior of the anus is a semicircular swelling, from which muscles proceed obliquely posteriorly to the dorsal line. The vagina ends in another hemispherical swelling, in front of which the cuticle is swollen for 890  $\mu$ . The eggs are (?) 14 by 7  $\mu$  in diameter.

*Host.*—*Procavia brucei* (*Heterohyrax mossambica*).

*Location.*—Large intestine.

*Locality.*—Rukwa Lake, German East Africa.

The dimensions given for the eggs, “.014 mm. . . . 0.007 mm.,” seem very small for a worm this size, and it is possible that these figures should be 140 by 70  $\mu$ .

Railliet and Henry (1912a) have left the genus *Deletrocephalus* Diesing, 1851a, unplaced in the formation of tribes of Strongylinae. An examination of the available figures and descriptions of the type-species, *D. dimidiatus* Diesing, 1851, indicates that we have in it a member of the Strongylinae in which the vulva is near the anus and the uteri are convergent, as in the Cyclostomeae, but the ray structures are uncertain or contradictory. According to some figures, the externo-dorsal and dorsal rays have separate origins, and according to others they originate in a common trunk. According to von Linstow's figure, the dorsal and externo-dorsal rays of *Stroangylus* (*Deletrocephalus*) *brachylaimus* apparently have separate origins, but it would be unsafe to say positively that this was the case. Nothing is said as to the convergence or divergence of the uteri. It is not certain that von Linstow's species and *Deletrocephalus dimidiatus* are congeneric, and this is additional reason for leaving *Deletrocephalus* unplaced in this paper.

STRONGYLUS LEMMI von Siebold, 1837.

*Synonym.*—*Nematoideum muris-amphibii* Rudolphi of Diesing, 1851.

*Specific diagnosis.*—None.

*Host.*—*Mus musculus* or *Arvicola amphibius* (*Mus amphibius*, *Lemmus amphibius*).

*Location.*—Inguinal glands.

*Locality.*—Not given.

This species is based on a record of Redi (1708). Rudolphi (1810) records it under the heading “Vermes generis dubii” and with the notation “Muris musculi vel amphibii,” and says that he is unable to determine from which species of mouse Redi collected it. Rudolphi (1819) later lists it under the same notation, closing his paragraph

with the word *Nematoideum*. He does not use the form *Nematoideum muris-amphibii*, credited to him by Diesing.

The species found by Redi may have been larval strongyles or they may have belonged in some other superfamily. It is hardly worth while speculating on the subject.

Family TRICHOSTRONGYLIDAE Railliet, 1915.

*Synonym*.—Tricostrongylidae Leiper, 1908, of Travassos, 1914*b*.

*Family diagnosis*.—Strongyloidea (p. 106): Meromyarian. Simple mouth without a buccal capsule. Parasitic only in the digestive system. Development direct and simple, involving in all cases known only the possibility of infection by ingestion.

*Type-genus*.—*Trichostrongylus* Looss, 1905.

ANALYTICAL KEY TO SUBFAMILIES OF TRICHOSTRONGYLIDAE.

1. Body not spirally curled. Females with 2 ovaries.—Trichostrongylinae, p. 123.  
Body frequently spirally curled. Females with 1 ovary.  
Heligmosominae, p. 148.

Subfamily TRICHOSTRONGYLINAE Leiper, 1908.

*Subfamily diagnosis*.—Trichostrongylidae (p. 123): Body straight or curved, but not regularly coiled in a spiral. Females with two ovaries.

*Type-genus*.—*Trichostrongylus* Looss, 1905.

ANALYTICAL KEY TO GENERA OF TRICHOSTRONGYLINAE.

1. Insufficiently described.....Genus uncertain, p. 144.  
Recognizable genera ..... 2.
2. Bursa with 2 distinct dorsal rays, each supporting a small dorsal lobe; ventro-ventral and latero-ventral rays close together and parallel; medio-lateral and postero-lateral close together and parallel—*Nematodirus*, p. 131.  
Bursa with 1 dorsal ray, commonly branched; ventro-ventral and latero-ventral rays, and medio-lateral and postero-lateral rays not close together and not parallel..... 3.
3. Spicules short, spatulate, and appearing as though twisted.  
*Trichostrongylus*, p. 124.  
Spicules long and filiform, straight or curved..... 4.
4. Spicules cleft along almost entire length; ventro-ventral, latero-ventral, and postero-lateral rays originate in a common trunk.....*Citellinema*, p. 141.  
Spicules simple or only cleft at tips; ventro-ventral, latero-ventral, and postero-lateral rays do not originate in a common trunk..... 5.
5. Mouth surrounded by a chitinous ring; cuticle with numerous prominent longitudinal ridges; bursa faintly incised dorsally; postero-lateral and medio-lateral rays do not originate in a common trunk—*Graphidium*, p. 139.  
Mouth not surrounded by a chitinous ring; cuticle without prominent longitudinal ridges; bursa deeply incised dorsally; postero-lateral and medio-lateral rays originate in a common trunk.....*Warrenius*, p. 142.

## Genus TRICHOSTRONGYLUS Looss, 1905.

*Synonyms*.—*Strongylus* Mueller, 1780, of authors; *Trichostrongylus* Travassos, 1914b.

*Generic diagnosis*.—Trichostrongylinae (p. 123): Small and slender. Commonly reddish in color when first collected. Body gradually attenuated forward from the genital aperture. Head small, usually about 10  $\mu$  in diameter, with three small lips and with nodular or punctiform papillae. Cuticle with annular striations. Cervical papillae lacking. Buccal cavity not well differentiated. Esophagus long, with simple well-developed dorsal gland. Nerve ring and excretory pore about 150  $\mu$  from the anterior end. Body of the cervical glands behind the esophagus, one gland behind the other. Bursa with large lateral lobes, without well-developed median lobe. Six supporting rays in each lateral lobe. Ventral rays widely separated, of very different thickness; the ventro-ventral is thin and directed ventrally; the latero-ventral is thick and in close relation with the lateral rays. Postero-lateral ray thinner than the other lateral rays, and located close to the externo-dorsal ray. Dorsal ray short, cleft at the end. Spicules short, spoon-shaped or spatula-shaped, and presenting the appearance of being twisted, this appearance resulting from the arrangement of ridges on the spicules. The proximal end of the spicule is thickened with a knoblike or disklike process toward one side. Toward the posterior end of the spicule a more or less prominent angular projection is usually present, giving the point of the spicule a hooked or barbed appearance. Gubernaculum or accessory piece present, elongated and boat-shaped or shoe-shaped in profile. Prebursal papillae small. Testis simple and not coiled. Ovaries in older individuals slightly wavy, the anterior one disposed in one or several loops. Uteri divergent. Ovijectors well developed. Vulva in the posterior half of the body, slit-shaped or crescentic, surrounded by somewhat protruding chitinous lips. Postanal portion of the body of the female relatively short, with a pair of small caudal papillae near the tip. Eggs of moderate size, thin shelled and colorless, and containing a maximum of 8 to 32 segmentation cells when oviposited. Parasitic in the duodenum, more rarely in the stomach, of herbivores, rodents, and man.

*Type-species*.—*Trichostrongylus retortueformis* (Zeder, 1800) Looss, 1905.

## ANALYTICAL KEY TO SPECIES OF TRICHOSTRONGYLUS.

1. Males less than 3 mm. long and female less than 5 mm. long.

*Trichostrongylus fiberius*, p. 129.

2. Males more than 3 mm. long and females more than 5 mm. long.----- 2.  
 2. Males over 7.5 mm. long; females over 10 mm. long; spicules over 500  $\mu$  long; vulva over 2 mm. from end of the tail; anus more than 150  $\mu$  and less than 1 mm. from end of tail; esophagus, testis, uterus, ovaries, and eggs black.-----*Trichostrongylus pigmentatus*, p. 128.

- Males less than 7.5 mm. long; females less than 10 mm. long; spicules less than 500  $\mu$  long; vulva less than 2 mm. from the end of the tail; anus less than 150  $\mu$  or else 1 mm. or more from the end of the tail; viscera not pigmented black..... 3.
3. Dorsal ray originates asymmetrically from the base of the right externo-dorsal ray; spicules 175  $\mu$  long or longer; vulva 1 mm. or less from the tip of the tail.....*Trichostrongylus calcaratus*, p. 126.
- Dorsal ray symmetrical throughout; spicules less than 175  $\mu$  long; vulva more than 1 mm. from the tip of the tail..... 4.
4. A small dorsal lobe present in bursa; males over 5 mm. long; spicules less than 125  $\mu$  long; vulva more than 1.5 mm. from the tip of the tail; anus 1 mm. or more from the tip of the tail.  
*Trichostrongylus retortaeformis*, p. 125.
- No dorsal lobe present in bursa; spicules more than 125  $\mu$  long; vulva less than 1.5 mm. from the tip of the tail; anus less than 1 mm. from the tip of the tail.....*Trichostrongylus delicatus*, p. 130.

**TRICHOSTRONGYLUS RETORTAEFORMIS**  
(Zeder, 1800) Looss, 1905.

*Synonym.*—*Strongylus retortaeformis* Zeder, 1800.

*Specific diagnosis.*—*Trichostrongylus* (p. 124): Body capillary, very much attenuated anteriorly. Head somewhat inflated at times.

*Male* 5.5 to 7 mm. long with a maximum body thickness just anterior of the spicules of 60  $\mu$ . The bursa (fig. 151) is deeply incised in the middorsal line forming two large lateral lobes and a very small dorsal lobe. The latero-ventral ray is quite thick and the lateral rays diminish from the straight thick externo-lateral to the thin postero-lateral, the last named being close to the externo-dorsal ray. The tip of the externo-dorsal ray is about halfway between the tips of the postero-lateral and the dorsal rays. The dorsal ray divides close to the bursal margin to form two short branches, each of which ends in a double point. The short thick spicules are 100 to 110  $\mu$  long and appear twisted as a result of ridges. Viewed from the side the posterior edge of the spicules is slender and smooth edged. The gubernaculum is boat-shaped and is 63  $\mu$  long. Spicules and gubernaculum are dirty brown in color.

*Female* 6 to 7.7 mm. long and 80 to 90  $\mu$  thick in the region of the vulva. The tail gradually narrows from the point where the posterior uterus bends forward, and is prolonged in a conical point. The anus is only slightly salient and is 1 to 1.2 mm. from the tip of the tail. The vulva aperture is short and often crescentic and is 1.8

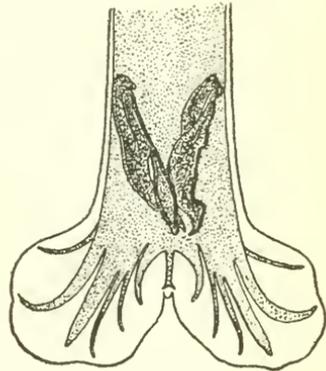


FIG. 151.—TRICHOSTRONGYLUS RETORTAEFORMIS. BURSA.  $\times 150$ . AFTER RAILLET, 1895.

to 2 mm. from the tip of the tail. The middle section of the ovijector is very short, almost hemispherical. The eggs are ellipsoidal and relatively large, 75 to 80  $\mu$  long and 40 to 45  $\mu$  thick.

*Hosts.*—*Oryctolagus cuniculus* (*Lepus cuniculus*), *Lepus europaeus* (*Lepus timidus*).

*Location.*—Small intestine (duodenum); rarely in stomach.

*Locality.*—Europe.

This species has been reported as occasionally causing the death of the host animal. Railliet (1893) states that it is commonly associated with *Graphidium strigosum* in the production of a pernicious anemia.

TRICHOSTRONGYLUS CALCARATUS Ransom, 1911b.

*Specific diagnosis.*—*Trichostrongylus* (p. 124):

*Male* 4.7 to 6.6 mm. long. Maximum thickness 100 to 130  $\mu$  (at base of bursa). Lateral lobes of bursa in preserved specimens tightly curled inward so that it is impossible to spread the bursa out flat. Latero-ventral and externo-lateral rays closely approximate to

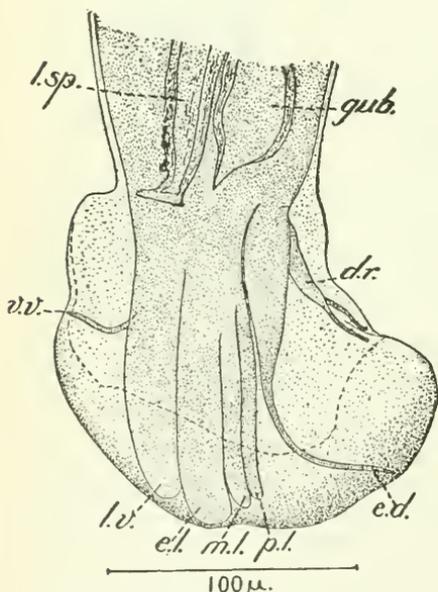


FIG. 152.—TRICHOSTRONGYLUS CALCARATUS. BURSA. AFTER RANSOM, 1911. *d. r.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *e. l.*, EXTERNO-LATERAL RAY; *gub.*, PORTION OF GUBERNACULUM; *l. sp.*, PORTION OF LEFT SPICULE; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAY.

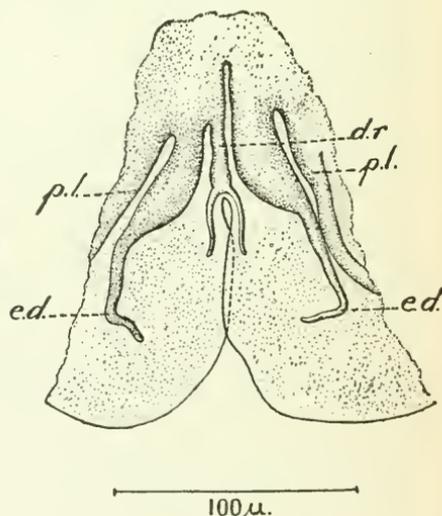


FIG. 153.—TRICHOSTRONGYLUS CALCARATUS. PORTION OF BURSA SHOWING DORSAL RAY. AFTER RANSOM, 1911. *d. r.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *p. l.*, PORTION OF POSTERO-LATERAL RAY.

one another, about equal in thickness, the former slightly the thicker, both much thicker than the other rays (fig. 152). Externo-dorsal ray long, curving dorsad in its distal portion; proximally it is thick, distally it is very slender. Ventro-ventral ray slender, of about the same thickness as the distal portion of the externo-dorsal ray. Pos-

tero-lateral and medio-lateral rays of about equal thickness, the latter slightly the thicker, less than half as thick as the externo-lateral ray, closely approximated, except at their tips, where they diverge slightly, the postero-lateral ray dorsad and the medio-lateral ventrad. Medio-lateral ray closely approximated to the latero-ventral ray. Dorsal ray united at its base with the base of the right externo-dorsal ray; bifurcated distally (fig. 153). The dorsal lobe of the bursa is not distinct from the lateral lobes, and is deeply emarginate between the distal branches of the dorsal ray. Distal branches of the dorsal ray are very slender, with simple unbranched tips. Spicules 175 to 190  $\mu$  long, nearly equal in length but somewhat different in shape, dark brown in color, slightly curved ventrad, with truncate tips and without the ventral angular projection typical of *Trichostrongylus* (fig. 154). Tip of left spicule with a large beaklike process or spur projecting ventrally, and a small spur projecting dorsally. Anterior of the ventral beak a small hook, and in front of the latter a series of two or three small projections, the ventral surface of the distal portion of the spicules for a distance of about 50  $\mu$  thus having a hooked, barbed, and roughened appearance. The ventral surface of the right spicule is smooth. Tip of the right spicule smaller than that of the left, with a small flattened caplike enlargement projecting dorsally and ventrally as very small pointed processes, and laterally as a very small ridge. Gubernaculum about 100 by 35  $\mu$  in length and breadth, respectively, similar in color to the spicules, with an oval body and a short pointed process posteriorly and a longer process anteriorly.

*Female* 5.8 to 7 mm. long by 90 to 120  $\mu$  in diameter at the vulva. Anus 65 to 90  $\mu$  from the tip of the tail (fig. 155). Posterior end of the body is commonly rather abruptly though slightly diminished in size a short distance in front of the anus, then tapers gradually to the tip of the tail; or, beginning some distance in front of the anus, may taper gradually to the tip. Tail straight. Vulva 850  $\mu$  to 1 mm. from the tip of the tail, elongated diagonally, 50 to 60  $\mu$  long, with inconspicuous lips (fig. 156). Combined length of muscular portion

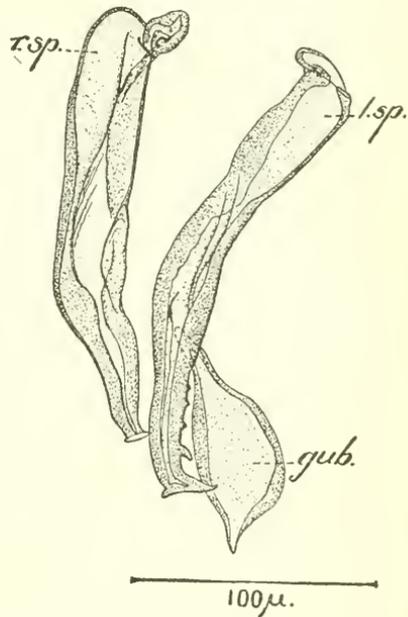


FIG. 154.—TRICHOSTRONGYLUS CALCARATUS. SPICULES AND GUBERNACULUM. AFTER RANSOM, 1911. *gub.*, GUBERNACULUM; *l. sp.*, LEFT SPICULE; *r. sp.*, RIGHT SPICULE.

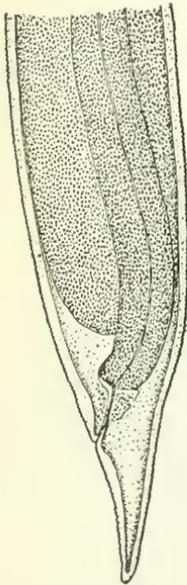
of the ovjectors 450 to 560  $\mu$ . Eggs 60 to 70  $\mu$  long by 30 to 36  $\mu$  wide, in 8 to 32 celled stage when deposited.

*Host.*—*Sylvilagus floridanus mallurus* (*Lepus sylvaticus*).

*Location.*—Small intestine.

*Locality.*—Bowie, Maryland.

In comment on his species Ransom (1911*b*) says that it is closest to *T. retortaeformis*. He also notes that it is perhaps questionable whether the species should be included in *Trichostrongylus* in view of the rather aberrant characters of the dorsal ray of the bursa and of the spicules. The asymmetrical origin of the dorsal ray and the termination of its branches in undivided tips are atypical, as is the shape of the distal portion of the spicules.



100 $\mu$

FIG. 155.—TRICHOSTRONGYLUS CALCARATUS. POSTERIOR EXTREMITY OF FEMALE. AFTER RANSOM, 1911.

TRICHOSTRONGYLUS PIGMENTATUS  
(von Linstow, 1904) Hall, 1916.

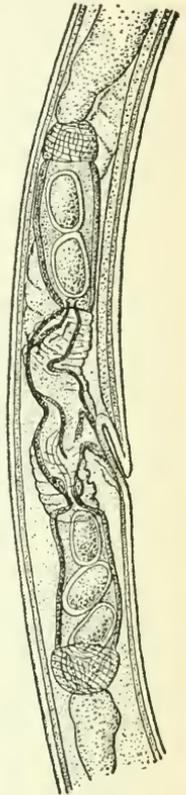
*Synonym.*—*Strongylus pigmentatus* von Linstow, 1904.

*Specific diagnosis.*—*Trichostrongylus* (p. 124): Mouth with three lips, each lip bearing on its summit a small papilla. Esophagus, testis, uterus, ovaries, and eggs colored black.

*Male* 7.7 mm. long and 120  $\mu$  thick. Length of esophagus one-fourteenth of the total body length. Bursa has two large lateral lobes and a very narrow median lobe (fig. 157). The lateral lobes are supported by six slender divergent rays. The dorsal lobe is supported by a

dorsal ray which bifurcates near its distal extremity, each branch in turn forming two terminal branches of which the external are the shorter. Spicules short, 680  $\mu$  long, pale brown in color, and with the usual discoid or scutelliform expansion of the proximal extremity (fig. 158). Posteriorly the spicules terminate in three branches, of which the thicker and longer one is rounded, while the thinner and shorter ones are pointed. Gubernaculum?

*Female* 10.5 mm. long and 140  $\mu$  thick. The tail is acuminate and is one-sixty-sixth of the total length of the body. The anus is there-



100 $\mu$ .

FIG. 156.—TRICHOSTRONGYLUS CALCARATUS. FEMALE IN REGION OF VULVA. AFTER RANSOM, 1911.

fore  $160\ \mu$  from the tip of the tail. The length of the esophagus is one-eighteenth of the total body length. The vulva is situated posteriorly, dividing the body in the ratio of 37:11, and is therefore 2.4 mm. from the tip of the tail. The eggs are  $62\ \mu$  long and  $36\ \mu$  thick.

*Host.*—*Lepus nigricollis*.

*Location.*—Stomach.

*Locality.*—Ranna, Southern Province, Ceylon.

Von Linstow notes that this species is close to *Trichostrongylus retortaeformis*, and while nothing is said of a gubernaculum and the bursa rays are figured as of the same size throughout, it probably belongs in *Trichostrongylus*. The spicule size is large; perhaps it should be  $68\ \mu$ .

TRICHOSTRONGYLUS FIBERIUS Barker and Noyes, 1915.

*Specific diagnosis.*—*Trichostrongylus* (p. 124): Body threadlike; anterior region greatly attenuated, body gradually thickening toward the posterior end.

*Male* 2.8 mm.

long with a body diameter of  $13\ \mu$  just behind the head and of  $90\ \mu$  just anterior of the bursa. Bursa with two wide lateral lobes and a narrow dorsal lobe. "Lateral lobes with two

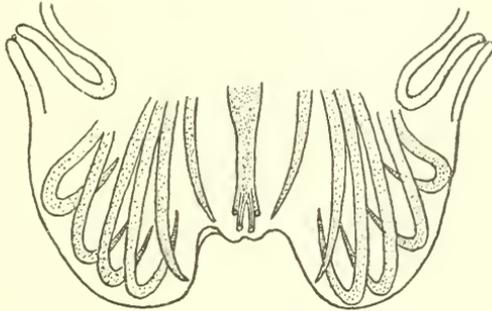


FIG. 157.—TRICHOSTRONGYLUS PIGMENTATUS. BURSA, DORSAL VIEW. ENLARGED. AFTER VON LINSTOW, 1904.



FIG. 158.—TRICHOSTRONGYLUS PIGMENTATUS. SPICULE. ENLARGED. AFTER VON LINSTOW, 1904.

wide, blunt, lateral rays and one narrow, pointed dorso-lateral and one ventro-lateral ray." Spicules short and heavy (fig. 159).

*Female* 4.7 mm. long, with a body diameter of  $30\ \mu$  just behind the head and of  $135\ \mu$  at the level of the vulva. Vulva in the posterior ninth of the body,  $520\ \mu$  from the end (fig. 160). Anus  $80\ \mu$  from the posterior end of the body. Posterior end slightly curved and pointed. Eggs oval, segmented (when oviposited?),  $59$  by  $36\ \mu$  in diameter; shell thick.

*Host.*—*Ondatra zibethica* (*Fiber zibethicus*).

*Location.*—Duodenum and cecum.

*Locality.*—United States (Nebraska).

The description and figures of the bursal rays of this species, which is described in a paper by Barker (1915), are not clear to me. The worm is reported from the cecum of the host, a very unusual location for worms of this genus, except when dead and being passed out.

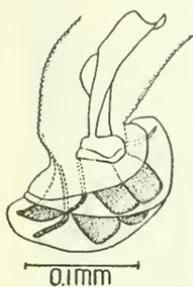


FIG. 159.—TRICHOSTRONGYLUS FIBERIUS. POSTERIOR EXTREMITY OF MALE. AFTER BARKER, 1915.

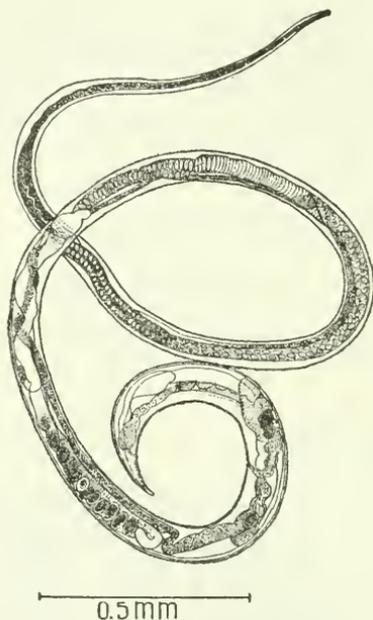


FIG. 160.—TRICHOSTRONGYLUS FIBERIUS. FEMALE. AFTER BARKER, 1915.

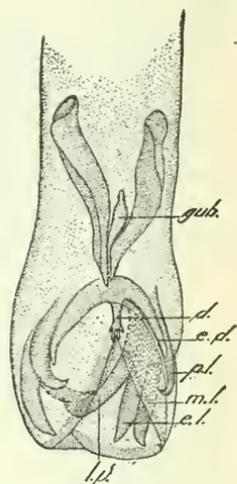


FIG. 161.—TRICHOSTRONGYLUS DELICATUS. BURSA, DORSAL VIEW. *d.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *e. l.*, EXTERNO-LATERAL RAY; *gub.*, GUBERNACULUM; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY. ENLARGED.

TRICHOSTRONGYLUS DELICATUS Hall, 1916, new species.

*Specific diagnosis.*—*Trichostrongylus* (p. 124): Head small, 11 to 12  $\mu$  in diameter. Lips indistinct. Cuticle finely striate transversely and longitudinally, and not inflated in the head and neck region. There is a cervical fold back of the head region.

*Male* 4 to 4.55 mm. long with a maximum diameter in the vicinity of the spicules of 105  $\mu$ . Esophagus simple, 155  $\mu$  long. Cervical fold about 140  $\mu$  back of the head end. Bursa has two large lateral lobes, with curving, finely scalloped border, deeply incised in the median line (fig. 161). No dorsal lobe present. The ventro-ventral ray is comparatively short. The tip of the latero-ventral curves toward the ventro-ventral, though their tips are widely separated (figs. 162 and 163). The tip of the medio-lateral is closer to the externo-lateral than to the postero-lateral. The tip of the postero-lateral curves toward the externo-dorsal. The short dorsal ray is

37 $\mu$  long. It divides distally to form two terminal forks about 16  $\mu$  long. At the base of these forks are two very short lateral spurs externally. The spicules are short, 140 to 155  $\mu$  long, and apparently twisted. The gubernaculum is canoe-shaped and is 70 to 80  $\mu$  long. The spicules and gubernaculum are curved, presenting a convexity dorsally.

*Female* 6 mm. long with a maximum thickness of 103  $\mu$  in the vicinity of the vulva. Cervical fold 95 to 125  $\mu$  back of the head end. Anus 75 to 100  $\mu$  from the tip of the acutely pointed tail (fig. 164). Vulva 1.22 to 1.245 mm. from the tip of the tail. Combined length

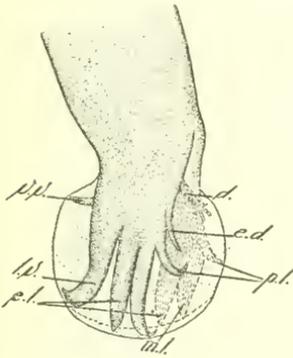


FIG. 162.—TRICHOSTRONGYLUS DELICATUS. BURSA, LATERAL VIEW. *d.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *e. l.*, EXTERNO-LATERAL RAYS; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAYS; *p. l.*, POSTERO-LATERAL RAYS; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

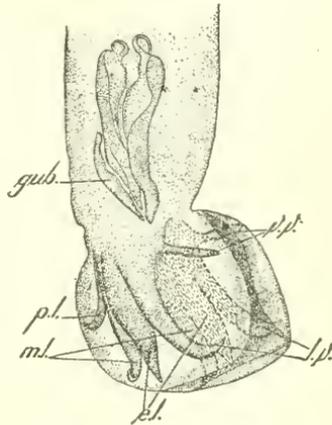


FIG. 163.—TRICHOSTRONGYLUS DELICATUS. BURSA, LATERO-VENTRAL VIEW. *e. l.*, EXTERNO-LATERAL RAYS; *gub.*, GUBERNACULUM; *l. v.*, LATERO-VENTRAL RAYS; *m. l.*, MEDIO-LATERAL RAYS; *p. l.*, POSTERO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAYS. ENLARGED.

of muscular portions of ovijectors between the sphincters, 490  $\mu$  (fig. 165). Eggs 85 by 50  $\mu$  in diameter, segmenting at oviposition.

*Host*.—*Sciurus aberti mimus*.

*Location*.—Small intestine.

*Locality*.—Pagosa Springs, Colorado.

*Type material*.—No. 16571, U.S.N.M. (Bureau of Animal Industry helminthological collection). This species was collected from some of Mr. E. R. Warren's alcoholic host material.

#### Genus NEMATODIRUS Ransom, 1907.

*Generic diagnosis*.—Trichostrongylineae (p. 123): Head not over 50  $\mu$  in diameter; circumoral papillae inconspicuous. Cuticle of head may be inflated and in cervical and head region striated transversely. Cervical papillae apparently absent. Bursa without unpaired dorsal median ray. Dorsal lobe of bursa reduced to two small

short lobules, each supported by a dorsal ray. Ventro-ventral and latero-ventral rays of each lateral lobe of bursa close together, parallel. Six supporting rays in each lateral lobe. Medio-lateral and postero-lateral rays close together, parallel. Externo-lateral ray distally diverges widely from the other lateral rays. Spicules more than  $500\ \mu$  in length, slender, tubular, filiform united by a membrane

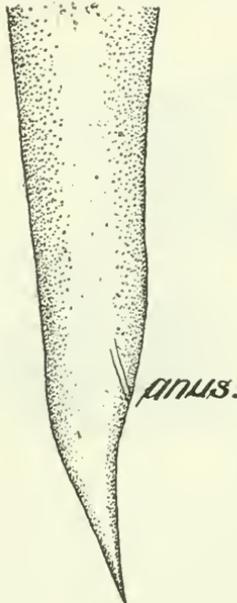


FIG. 164.—TRICHOSTRONGYLUS DELICATUS. POSTERIOR EXTREMITY OF FEMALE.  $\times 345$ .

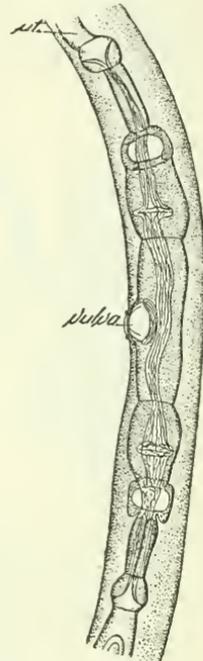


FIG. 165.—TRICHOSTRONGYLUS DELICATUS. BODY OF FEMALE IN REGION OF VULVA. *ut.*, UTERUS.  $\times 102$ .

throughout their length, or only in their distal portion. Gubernaculum absent. Vulva of female behind the middle of the body. Ovijectors well developed. Eggs large, generally over  $150\ \mu$  long.

*Type-species.*—*Nematodirus filicollis* (Rudolphi, 1802) Ransom, 1907.

ANALYTICAL KEY TO SPECIES OF NEMATODIRUS.

1. Spicules about 1 mm. long; female with ovijectors having a combined length of about  $400\ \mu$ .....*Nematodirus spathiger*, p. 133.
- Spicules 3 mm. long or longer; ovijectors having a combined length of  $900\ \mu$  or longer.....*Nematodirus neotoma*, p. 136.

## NEMATODIRUS SPATHIGER (Railliet, 1896) Railliet and Henry, 1909.

*Synonyms.*—*Strongylus spathiger* Railliet, 1896; *Strongylus flicollis* Rudolphi, 1802, of Curtice, 1890; *Nematodirus flicollis* (Rudolphi, 1802) Ransom, 1907, of Ransom, 1911, and others.

*Specific diagnosis.*—*Nematodirus* (p. 131): Body slender, tapering gradually toward the anterior extremity (fig. 166); head between 25 and 50  $\mu$  in diameter; cuticle of head and neck may be slightly inflated, in latter region coarsely striated transversely, elsewhere without transverse striations (fig. 167). Four and probably six inconspicuous circumoral papillae. Mouth small, followed directly by the esophagus; no buccal capsule. Esophagus 400 to 500  $\mu$  long. Cervical papillae not apparent. Lateral membranes absent.

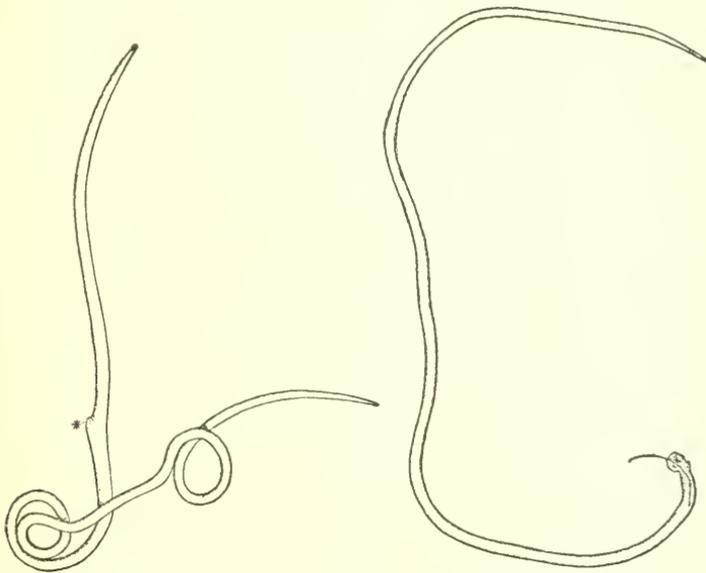
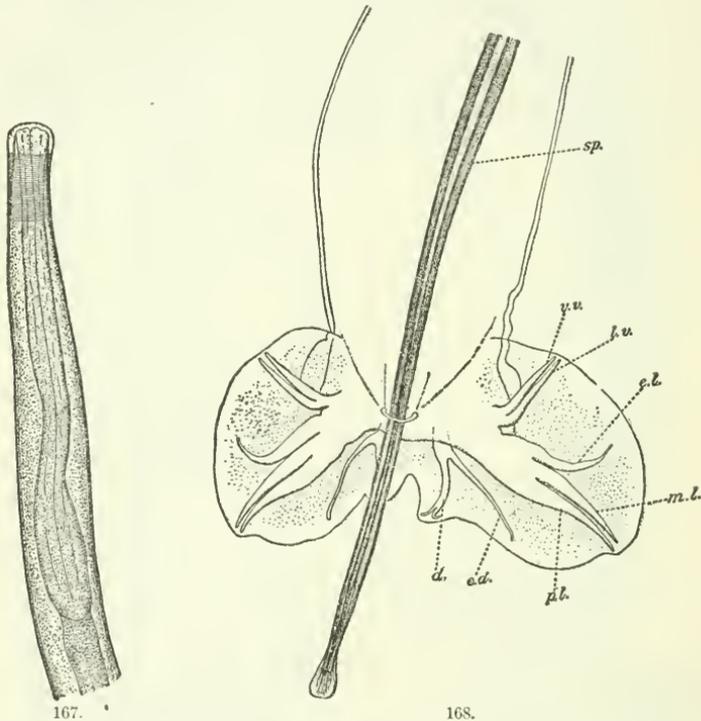


FIG. 166.—NEMATODIRUS SPATHIGER. MALE AT RIGHT, FEMALE AT LEFT. \*VULVA.  $\times 15$ . AFTER RANSOM, 1911.

*Male* 8 to 15 mm. long by 125 to 175  $\mu$  in maximum diameter. Bursa with two large lateral lobes. Dorsal lobe short, deeply emarginate, and thus reduced to two small lobules (fig. 168). Ventral rays slender, close together, parallel. Externo-lateral ray at first close to the medio-lateral ray, distally curves ventrad away from the latter. Distally the medio-lateral and postero-lateral rays curve slightly dorsad. Medio-lateral and postero-lateral rays close together throughout their entire length, the tip of the latter extending slightly beyond that of the former. Tip of the postero-lateral ray about equidistant from the tip of the externo-dorsal ray and the tip of the externo-lateral ray, the latter being about the same distance from the tip of the latero-ventral ray. Lateral rays thicker than the other rays.

Externo-dorsal ray very slender. No median dorsal ray. Each dorsal lobule of the bursa is sustained by a ray whose base is united with the base of the externo-dorsal ray, somewhat thicker than the latter, with somewhat bifid tip. Spicules (figs. 168 and 169) slender, equal, about 1 mm. long, united by a membrane in the posterior two-thirds, more closely toward the tip, where the membrane forms a spatulate enlargement. Prebursal papillae small, inconspicuous.



FIGS. 167, 168.—NEMATODIRUSSPATHIGER. 167, ANTERIOR EXTREMITY OF BODY.  $\times 150$ . AFTER RANSOM, 1911. 168, POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. *d.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *e. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *sp.*, SPICULES; *v. v.*, VENTRO-VENTRAL RAY.  $\times 150$ . AFTER RANSOM, 1911.

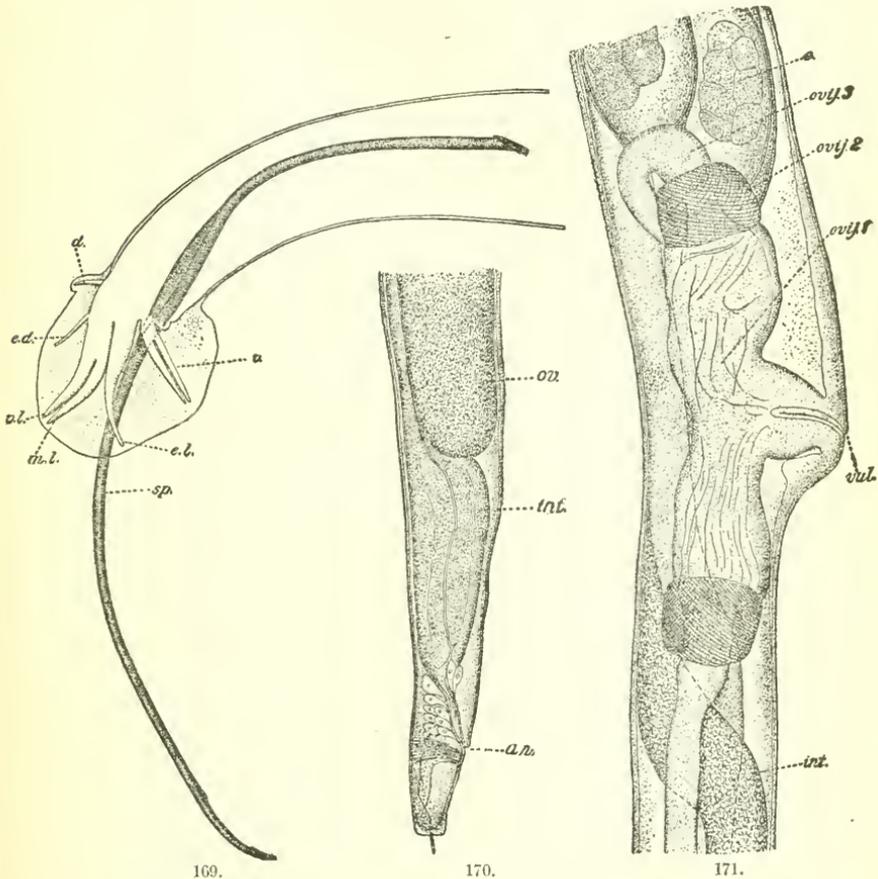
*Female* 12 to 20 mm. long with a maximum thickness of 200 to 250  $\mu$  at the vulva. Thickness suddenly reduced just behind the vulva. Tip of tail truncate, bearing a short, slender, acutely pointed bristlelike process (fig. 170). Anus 70 to 80  $\mu$  from the truncated end of the body. Vulva a transverse slit located about one-third the length of the body from the posterior end. Combined length of the muscular portions of the two ovijectors (fig. 171), including the sphincters, about 400  $\mu$ . Eggs oval, 175 to 200  $\mu$  long by about 100  $\mu$  wide. Embryos develop into filariform larvae before hatching.

*Hosts.*—*Ctenodactylus gundi*. Commonly a parasite of ruminants.

*Location.*—Small intestine.

*Localities.*—United States, Europe, New Zealand, Australia, Tunis.

This species was reported from a rodent for the first time by Seurat (1913), who reports it from the gundi, *Otenodactylus gundi*, in Tunis, listing it as *N. flicollis*. A comparison of Seurat's figures



FIGS. 169-171.—*NEMATODIRUS SPATHIGER*. 169, POSTERIOR EXTREMITY OF MALE, LATERAL VIEW. LETTERING AS IN FIG. 168.  $\times 150$ . AFTER RANSOM, 1911. 170, POSTERIOR EXTREMITY OF FEMALE, LATERAL VIEW. *an.*, ANUS; *int.*, INTESTINE; *ov.*, OVARY.  $\times 150$ . AFTER RANSOM, 1911. 171, BODY OF FEMALE IN REGION OF VULVA, LATERAL VIEW. *e.*, EGG; *int.*, INTESTINE; *ovij. 1*, TERMINAL PORTION OF OVIJECTOR; *ovij. 2*, SPHINCTER OF OVIJECTOR; *ovij. 3*, NON-MUSCULAR PORTION OF OVIJECTOR; *vul.*, VULVA.  $\times 150$ . AFTER RANSOM, 1911.

with those of *N. flicollis* given by Boulenger (1915) and those of *N. flicollis* given by Ransom (1911), which latter Boulenger and also Railliet and Henry (1912c) regard as *N. spathiger*, indicates that Seurat's species is *N. spathiger*, as Seurat suspected it might be.

## NEMATODIRUS NEOTOMA Hall, 1916, new species.

*Synonym.*—*Nematodirus* species Hall, 1912.

*Specific diagnosis.*—*Nematodirus* (p. 131): Long and slender, narrowing toward the anterior end. Head diameter, exclusive of the inflated cuticle, 25 to 45  $\mu$ ; inclusive of the inflated cuticle, attains a maximum of 80  $\mu$ . The cuticle of the head and neck is usually inflated and, as a rule, asymmetrically (fig. 172). The inflated area shows a transverse striation. The remainder of the body is finely striated longitudinally, the striae being 10 to 11  $\mu$  apart, and the striation is continued along the rays of the bursa. A yet finer transverse striation is visible over the body in favorable specimens, and a special transverse striation forms a fine annulation in the region of the vulva and ovijectors. Four circumoral papillae visible. The anterior portion of the esophagus usually has a sinuous course and is narrower than the straight posterior portion.



FIG. 172.—NEMATODIRUS NEOTOMA. ANTERIOR EXTREMITY OF FEMALE.  $\times 170$ .

*Male* 8.1 to 10.6 mm. long with a maximum thickness of 135  $\mu$ . Esophagus 335 to 500  $\mu$  long. The dorsal lobe of the bursa (fig. 173) has a shallow median notch along its border, the two lobules thus formed being supported by the two dorsal rays. These rays bifurcate near their tips, the bifurcated part being about one-fifth of the total length of the ray. The externo-dorsal rays are very long and slender and have a rather sinuous course in most specimens (fig. 174). They are remote from the other rays. The postero-lateral and medio-lateral rays are parallel branches formed by a split in their common stem (fig. 175). Their tips curve back toward the externo-dorsal ray. From the same common stem the externo-lateral ray diverges, its tip turning toward the ventral rays which are parallel and close together. Around the proximal part of the lateral ray and in the area between the externo-lateral and the other lateral rays are a number of clear, transparent maculae. The body terminates in a cone inside the bursa (fig. 176). The spicules are very long, from 3 to 3.42 mm. long, and are only clearly separated for a short distance

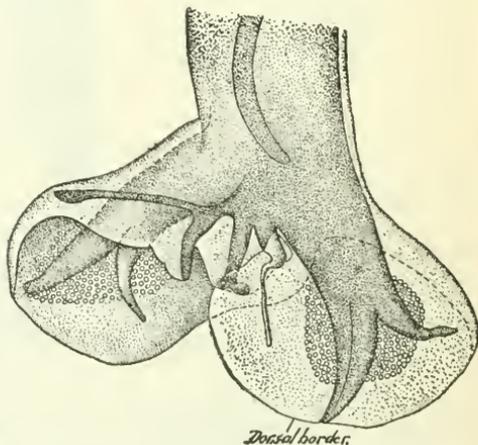
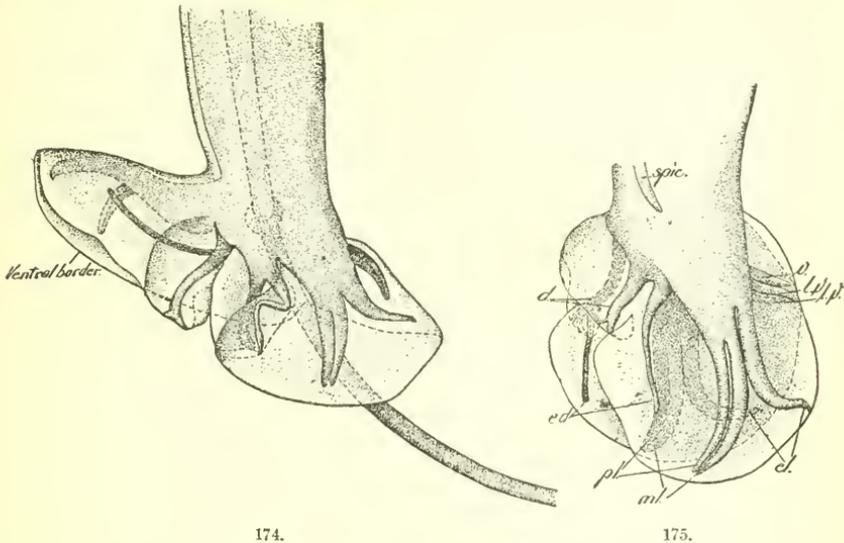


FIG. 173.—NEMATODIRUS NEOTOMA. BURSA, DORSAL VIEW.  $\times 170$ .

along their proximal portion (fig. 177). They are curved at the tip. When extruded the spicules bend around in a wide curve, the tips



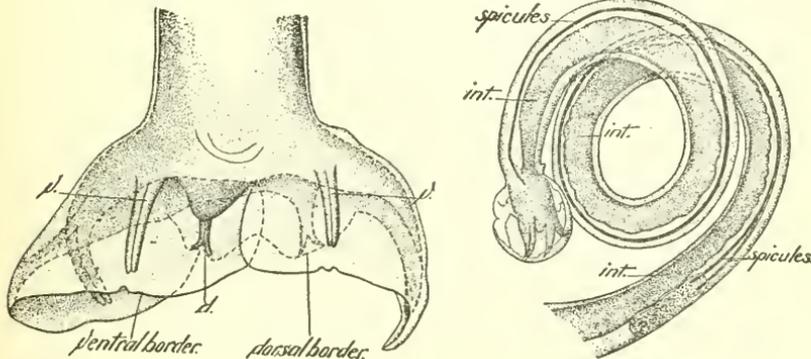
174.

175.

FIGS. 174, 175.—NEMATODIRUS NEOTOMA. 174, BURSA, DORSO-LATERAL VIEW.  $\times 170$ . 175, BURSA, LATERAL VIEW. *d*, DORSAL RAYS; *ed*, EXTERNO-DORSAL RAYS; *el*, EXTERNO-LATERAL RAYS; *lv*, LATERO-VENTRAL RAY; *ml*, MEDIO-LATERAL RAYS; *pl*, POSTERO-LATERAL RAYS; *spic.*, SPICULE; *v*, VENTRO-VENTRAL RAY.  $\times 170$ .

coming back toward the ventral surface or even to it. No prebursal papillae found.

*Female* 18.3 to 22.2 mm. long with a maximum thickness at the vulva of about 225  $\mu$ . The tip of the tail is truncated and bears a



176.

177.

FIGS. 176, 167.—NEMATODIRUS NEOTOMA. 176, BURSA, VENTRAL VIEW. *d*, DORSAL RAY; *v*, THE VENTRAL RAY SYSTEMS FORMED BY THE CLOSELY APPROXIMATED LATERO-VENTRAL AND VENTRO-VENTRAL RAYS.  $\times 170$ . 177, POSTERIOR EXTREMITY OF MALE. *int.*, INTESTINE.  $\times 46$ .

pointed spinelike process (fig. 178). The anus is about 120  $\mu$  from the posterior end of the body. The vulva (fig. 179) is situated at the union of the middle and posterior thirds of the body or slightly in

front of this point. The body is commonly bent at this point. The combined length of the muscular

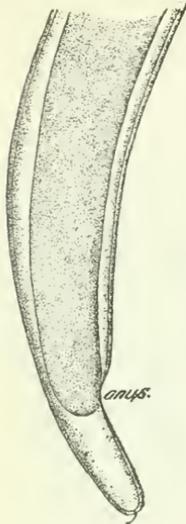


FIG. 178.—NEMATODIRUS NEOTOMA. POSTERIOR EXTREMITY OF FEMALE.  $\times 170$ .

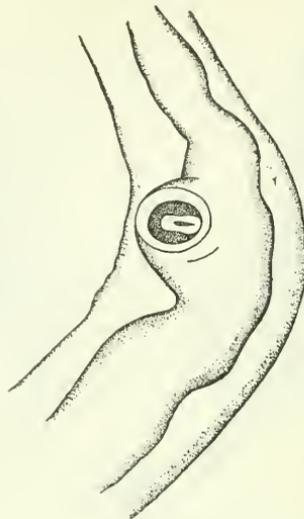


FIG. 179.—NEMATODIRUS NEOTOMA. VULVA.  $\times 91$ .

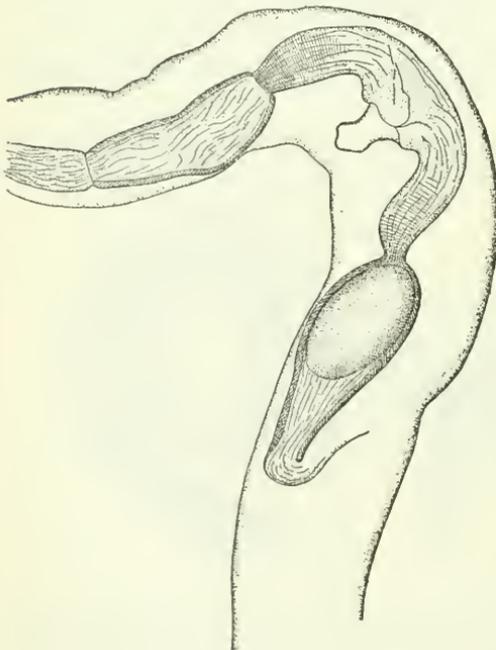


FIG. 180.—NEMATODIRUS NEOTOMA. OVJECTORS.  $\times 91$ .

portions of the ovjectors (fig. 180) is 900 to 955  $\mu$ . The eggs are 145 to 190  $\mu$  by 80 to 90  $\mu$  in diameter.

*Hosts.*—*Neotoma mexicana fallax*, *Neotoma desertorum*, *Neotoma floridana baileyi*, *Neotoma cinerea rupicola*.

*Location.*—Small intestine; rarely in stomach.

*Localities.*—San Acacia, Siebert's ranch (Mesa County), Mack, Cedar Point, and Pawnee Buttes, Colorado.

*Type material.*—No. 16134, U.S.N.M. (Bureau of Animal Industry helminthological collection).

The material from which the above species is described was collected from host material preserved in alcohol by Mr. E. R. Warren, of Colorado Springs. The places of collection are located as follows: One near the northeast corner of Colorado; another near the middle eastern part of Colorado; another near the middle of the southern boundary; and two near the middle of the western boundary. It may be safely predicted that this species

will be found on adequate examination of species of *Neotoma* anywhere in Colorado and probably in *Neotoma* anywhere.

## Genus GRAPHIDIUM Railliet and Henry, 1909a.

*Synonym.*—*Strongylus* Mueller, 1780, of authors.

*Generic diagnosis.*—Trichostrongylinae (p. 123): Cuticle marked with a very prominent and striking longitudinal striation. Mouth large, limited by a chitinous ring. A single dorsal ray, bifurcating near its tip and the bifurcation ending in small forkings. All rays generally divergent, with no adjacent rays close together and parallel. Externo-dorsal rays long and prominent. Spicules long and narrow, branching distally. Vulva in posterior third or fourth of body, at times covered by a cuticular process, the body diameter diminishing abruptly posterior of the vulva. Parasitic in the digestive tract of rodents.

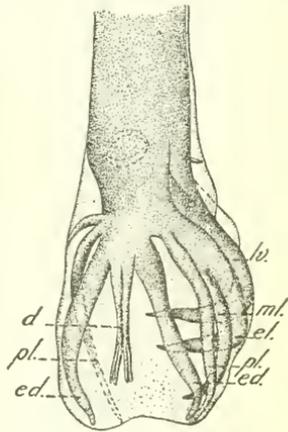
*Type-species.*—*Graphidium strigosum* (Dujardin, 1845) Railliet and Henry, 1909a.

GRAPHIDIUM STRIGOSUM (Dujardin, 1845) Railliet and Henry, 1909a.

*Synonyms.*—*Strongylus retortaeformis* Zeder, 1800, of Bremser, 1824; *Strongylus strigosus* Dujardin, 1845; *Strongylus blasii* von Linstow, 1887.

*Specific diagnosis.*—*Graphidium* (p. 139): Body blood red and filiform. Two small cervical papillae in the form of posteriorly directed teeth, located at some distance from the anterior end. Cuticle with 40 to 60 conspicuous longitudinal wavy striations and a finer transverse striation.

*Male* 8 to 16 mm. long, with a maximum thickness near the base of the bursa of 130 to 175  $\mu$  (300  $\mu$  according to Dujardin; 600  $\mu$  according to Bremser's figures as noted by Dujardin). Head diameter 25 to 35  $\mu$ . Esophagus 365 to 570  $\mu$  long, with a maximum thickness near its posterior extremity of 50 to 60  $\mu$ . Nerve ring 160 to 250  $\mu$  from the anterior extremity. The dorsal ray bifurcates near its tip (fig. 181), each bifurcation ending in two small forks, of which the external and shorter bears one papilla, and the internal and longer bears two papillae. The externo-dorsal ray is very long and prominent. The five rays of the lateral and ventral systems are very uniformly and symmetrically spaced (fig. 182). The filiform spicules are 1.1 to 2.4 mm. long. They present a simple tubular construction of almost uniform diameter except at the posterior extremity where they fray out, the spinelike fringing being directed medially. There is a pair of distinct spinelike prebursal papillae.



1/10mm.

FIG. 181.—GRAPHIDIUM STRIGOSUM. BURSA, DORSAL VIEW. *d*, DORSAL RAY; *ed.*, EXTERNO-DORSAL RAY; *lv.*, LATERO-VENTRAL RAY; *ml.*, MEDIO-LATERAL RAY; *pl.*, POSTERO-LATERAL RAY.

*Female* 11 to 20 mm. long with a maximum diameter in the region of the vulva of 190 to 215  $\mu$  (500 to 600  $\mu$  according to Dujardin; 850  $\mu$  according to Bremser's figure as noted by Dujardin). The body diminishes in diameter quite abruptly posterior of the vulva and terminates in a conical tail with a slight constriction just anterior of the tip. The head diameter is about 35  $\mu$ . The esophagus is 520 to 605  $\mu$  long with a maximum thickness near its posterior extremity of 60 to 80  $\mu$ . The nerve ring is 235 to 260  $\mu$  from the anterior extremity. The straight simple intestine ends in a narrow conical rectum 60 to 85  $\mu$  long. The anus is 138 to 190  $\mu$  from the tip of the tail. The vulva is very slightly salient and is 1.1 to 1.9 mm. from the tip of the tail.

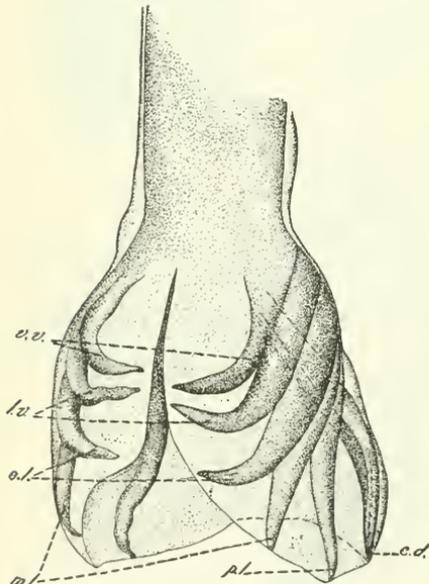


FIG. 182.—GRAPHIDIUM STRIGOSUM. BURSA, VENTRAL VIEW. *c. d.*, EXTERNO-DORSAL RAY; *e. l.*, EXTERNO-LATERAL RAYS; *l. v.*, LATERO-VENTRAL RAYS; *m. l.*, MEDIO-LATERAL RAYS; *p. l.*, POSTERO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAYS.

ing forward as Molin (1861*a*) shows it. The eggs are ellipsoidal, 98 to 106  $\mu$  long by 50 to 58  $\mu$  thick, and are in the morula stage when oviposited.

*Hosts.*—*Oryctolagus cuniculus* (*Lepus cuniculus*), *Lepus europaeus* (*Lepus timidus*).

*Location.*—Stomach; occasionally in small intestine.

The vagina is short, about 170  $\mu$  long and extends forward to meet the median portion of the ovijectors. The combined length of the muscular portions of the well-developed ovijectors is 430 to 470  $\mu$ . The ovijectors and uteri are divergent (fig. 183), the posterior uterus and ovary extending to a point near the anus, not turning

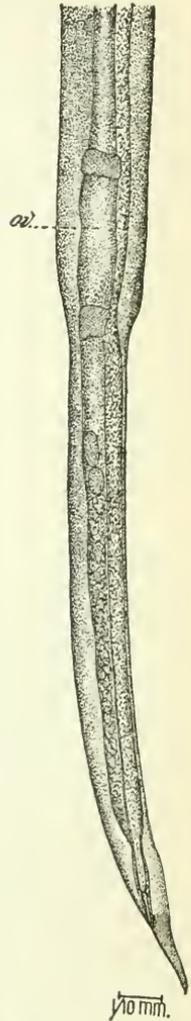


FIG. 183.—GRAPHIDIUM STRIGOSUM. POSTERIOR EXTREMITY OF FEMALE. *ovj.*, OVIJECTOR.

*Locality*.—Europe (France, Germany, Austria).

The writer has had occasion to examine specimens of this species through the courtesy of Professor Railliet, who furnished them to the United States Bureau of Animal Industry. As the comparison with Dujardin's measurements suggests, it is likely that the writer's measurements will be under the maximum for this species as found in the largest specimens.

*CITELLINEMA* Hall, 1916, new genus.

*Generic diagnosis*.—Trichostrongylinae (p. 123): Head surrounded by a sort of collar which forms the external limit of a depression around the head anteriorly. Two spicules, each bifurcating near the proximal wide tubular end to form two long filiform distal processes. Ventro-ventral, latero-ventral, and externo-lateral rays apparently originate from a common stem, which in turn unites at its base with the common stem of the medio-lateral

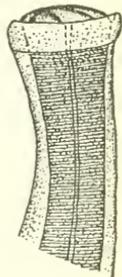


FIG. 184.—*CITELLINEMA BIFURCATUM*. ANTERIOR EXTREMITY OF MALE.  $\times 3\cdot 2$ .

and postero-lateral rays. Nature of dorsal ray not distinguishable in the one available specimen.

This genus and other genera and species following are put in the Trichostrongylinae tentatively on the chance that they like most of the Trichostrongylidae, have a female with two ovaries rather than with one as in *Heligmosomum*.

*Type-species*.—*Citellinema bifurcatum* Hall, 1916.

*CITELLINEMA BIFURCATUM* Hall, 1916, new species.

*Specific diagnosis*.—*Citellinema* (p. 141): Cuticle with pronounced longitudinal striation. Mouth with apparently six lips surrounded by a sort of collar (fig. 184).

*Male* 6.8 mm. long and  $170\ \mu$  thick at the base of the bursa. Head diameter  $26\ \mu$  without the collar and  $38\ \mu$  inclusive of collar. Esophagus  $535\ \mu$  long by  $70\ \mu$  thick. Nerve ring  $170\ \mu$  back of head.

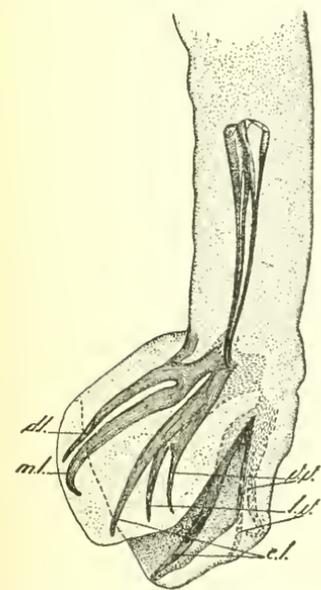


FIG. 185.—*CITELLINEMA BIFURCATUM*. POSTERIOR EXTREMITY OF MALE, LATERO-VENTRAL VIEW. *d. l.*, POSTERO-LATERAL (DORSO-LATERAL) RAY; *e. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

The longitudinal striation of the body cuticle is continued along the bursal rays (fig. 185), while the bursal membrane is transversely

striated. The bursa is apparently not deeply incised dorsally. The rays are arranged as given in the generic diagnosis. The medio-lateral and externo-lateral rays are the largest. The spicules (fig. 186) are  $360\ \mu$  long and are bifurcated  $70\ \mu$  from the proximal end. The proximal end is cup-shaped and is  $35\ \mu$  in diameter.

*Female* unknown.

*Host*.—*Citellus elegans*.

*Location*.—Small intestine.

*Locality*.—Waldon, Colorado.

*Type material*.—No. 16176, U.S.N.M. (Bureau of Animal Industry helminthological collection).

The single male on which this species is described was collected from alcoholic host material collected by Messrs. E. R. Warren and H. R. Durand.

WARRENIUS Hall, 1916, new genus.

*Generic diagnosis*.—Trichostrongylineae (p. 123): Head simple, no lips evident. Cuticle of head inflated. Unilateral cervical wing present (fig. 187). The bursa is deeply incised dorsally to form 2 large lateral lobes and a small, but distinct dorsal lobe. The dorsal, lateral, and ventral ray systems are well defined and separated from one another, the rays of each system being more closely related to one another than to rays of other systems. The dorsal lobe is supported by the dorsal ray which sends out a short branch to each side almost two-thirds of its length from its proximal end and then branches to form two longer terminal branches (fig. 188). The externo-dorsal rays are long wavy rays lying in the lateral lobes and ending in curved terminations, the tips of which are farther

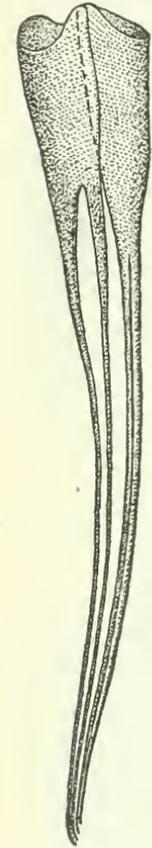


FIG. 186.—CITEL-  
LINEMA BIFUR-  
CATUM. SPIC-  
ULES.  $\times 300$ .

from the bursa margin than are points farther back along the rays. The recurved tip turns toward the dorsal ray and is closer to this than to the postero-lateral. The postero-lateral and medio-lateral rays originate in a common stem (fig. 189). The postero-lateral turns back toward the externo-dorsal and terminates a short distance from the bursa margin. The medio-lateral proceeds direct to a point on the bursa margin, and the externo-lateral, which originates from the common trunk of the postero-lateral and medio-lateral, also proceeds practically straight to the bursa margin. The latero-ventral and ventro-

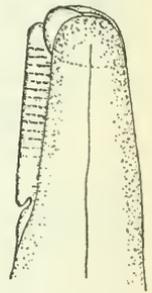


FIG. 187.—WAR-  
RENIUS QUAD-  
RIVITTATI. AN-  
TERIOR EX-  
TREMITY.  $\times$   
300.

ventral rays originate as branches of a thick common stem and diverge from their origin to their termination near the bursa margin (fig. 190). They are unusually large for ventral rays, being longer and thicker than any other rays. The spicules are long and narrow (fig. 191).

*Type-species.*—*Warrenius quadrivittati* Hall, 1916.

**WARRENIUS QUADRIVITTATI**  
Hall, 1916, new species.

*Specific diagnosis.*—*Warrenius* (p. 142): Cuticle transversely striated on the unilateral cervical membrane (fig. 187); everywhere else longitudinally striated, the striation being continued along the bursal rays. The cervical membrane is recurved posteriorly to form a notch.

*Male* 6.21 mm. long by  $112\ \mu$  thick just in front of the bursa. The head is  $30\ \mu$  in diameter, exclusive of the slight cuticular inflation. The cervical membrane is  $60\ \mu$  long. The esophagus is about  $215\ \mu$  long and  $17\ \mu$  thick near its posterior end. The nerve ring is  $130\ \mu$  from the anterior end of the body. The structure of the bursal lobes and rays is that given in the generic diagnosis. The dorsal ray is about  $60\ \mu$  long. The spicules are  $695\ \mu$  long and very narrow. One of them terminates in a long fine wavy tip and the other in a bifurcation, the two parts of the bifurcation running nearly parallel, the thicker tending to curve slightly around the thinner.

*Female* unknown.

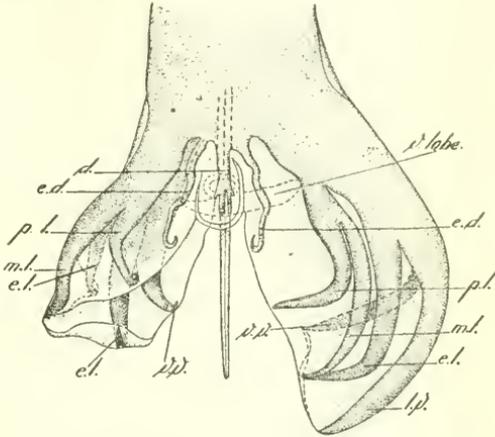


FIG. 188.—WARRENIUS QUADRIVITTATI. BURSA, DORSAL VIEW. *d.*, DORSAL RAY; *e. d.*, EXTERNO-DORSAL RAY; *c. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *v. lobe.*, VENTRAL LOBE OF BURSA; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

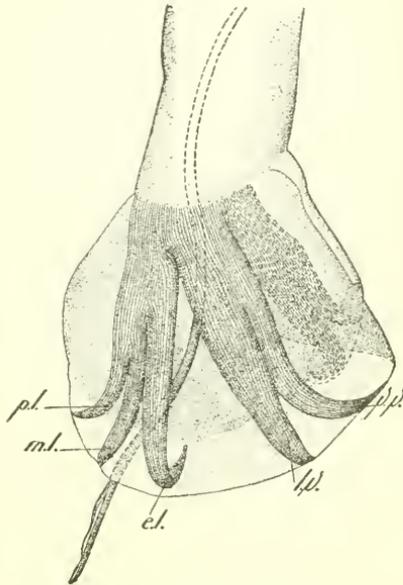


FIG. 189.—WARRENIUS QUADRIVITTATI. BURSA, LATERAL VIEW. *c. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

*Host.*—*Eutamias quadrivittatus*.

*Location.*—Small intestine.

*Locality.*—Crested Butte Mountain, Colorado.

*Type material.*—No. 16185, U.S.N.M. (Bureau of Animal Industry helminthological collection).

This species is based on two males, 1 headless, collected from alcoholic host material, for which I am indebted, as for much other mate-

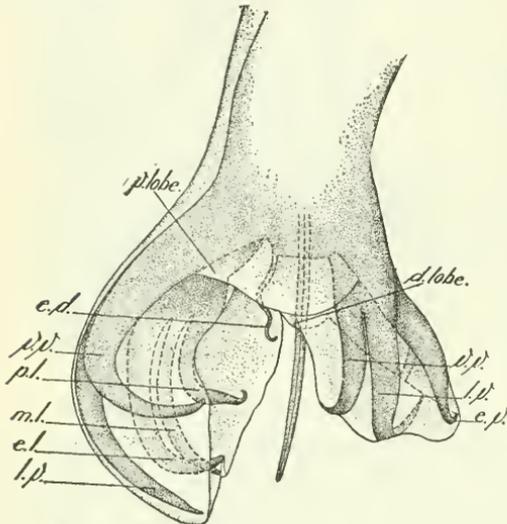


FIG. 190.—WARRENIUS QUADRIVITTATI. BURSA, VENTRAL VIEW. *d. lobe*, DORSAL LOBE OF BURSA; *c. d.*, EXTERNO-DORSAL RAY; *c. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *v. lobe*, VENTRAL LOBE OF BURSA; *v. v.*, VENTRO-VENTRAL RAY.

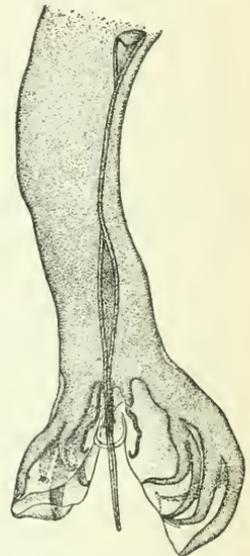


FIG. 191.—WARRENIUS QUADRIVITTATI. POSTERIOR EXTREMITY OF MALE, DORSAL VIEW. ENLARGED.

rial noted in this paper, to Mr. E. R. Warren, after whom the genus is named.

#### GENUS UNCERTAIN.

##### ANALYTICAL KEY TO UNPLACED SPECIES OF TRICHOSTRONGYLINAE.

1. Found under the gastric mucosa-----*Strongylus leporum*, p. 148.  
Found in the intestine----- 2.
2. No description; found in small intestine of rat-----*Strongylus* species, p. 145.  
Described species; not found in intestine of rat----- 3.
3. Cervical alae present-----*Strongylus minutoides*, p. 147.  
Cervical alae probably absent----- 4.
4. North American species from *Erethizon dorsatum* (*Hystrix dorsata*).  
*Strongylus simplex*, p. 145.  
Not North American species and not from *Erethizon* (*Hystrix*)----- 5.
5. Dorsal lobe of bursa very large; female more than 15 mm. long.  
*Strongylus sedecimradiatus*, p. 145.  
Dorsal lobe of bursa small or lacking; female less than 15 mm. long.  
*Strongylus cavalli*, p. 146.

The above key is obviously makeshift in character and in part of a rather unscientific nature, but in the absence of scientific data it is obviously impossible to supply a key based on such data.

## STRONGYLUS species Lutz, 1894.

*Specific diagnosis.*—None.

*Host.*—*Epimys norvegicus* (*Mus decumanus*).

*Location.*—Small intestine.

*Locality.*—São Paulo, Brazil.

In a paper on *Taenia nana* (*Hymenolepis nana*), Lutz (1894) states that in examining *Mus decumanus* at São Paulo, Brazil, he found, in the small intestine of one rat, one male of a probably undescribed species of *Strongylus*. There are no further data or description of any sort.

## STRONGYLUS SIMPLEX Leidy, 1856.

*Specific diagnosis.*—(?) Trichostrongylineae (p. 123): "Body cylindrical, anteriorly rather abruptly narrowed. . . . Head obtusely conical, not alated nor papillated."

*Male* 5 to 7.5 mm. long and 335  $\mu$  thick. "Body . . . curved, with the caudal extremity incurved." Bursa with a dorsal and two lateral lobes sustained by rays.

*Female* 8 to 10 mm. long and 500  $\mu$  thick. Body straight. Tail compressed, conical, and acute. Vulva one-third of body length from posterior extremity.

*Host.*—*Erethizon dorsatum* (*Hystrix dorsata*).

*Location.*—Small intestine.

*Locality.*—North America.

It is impossible to locate this species generically on the basis of the above description.

## STRONGYLUS SEDECIMRADIATUS von Linstow, 1899.

*Synonym.*—*Strongylus sedecimradiatus* Linstow, 1899, of Travassos, 1914b.

*Specific diagnosis.*—(?) Trichostrongylineae (p. 123): The cylindrical head end is separated from the remainder of the body by a circular furrow. Cuticle strongly striated transversely.

*Male* 8.2 mm. long and 140  $\mu$  thick. The esophagus is 1/14.2 of the total body length. The bursa has a very large dorsal and two lateral lobes (fig. 192). The externo-lateral and medio-lateral rays are close together and parallel. All other rays diverge from adjacent rays. There are two dorsal rays, slightly divergent, which send out an externo-dorsal ray laterally a short distance from their proximal origin and then bifurcate to form the two distal branches. The spicules are 530  $\mu$  long.

*Female* 16.2 mm. long and 180  $\mu$  thick. The distance from the anus to the tip of the tail is one sixty-eighth of the body length. The eggs are 59 by 31  $\mu$  in diameter.

*Host.*—*Cuniculus paca* (*Coelogenys paca*, *Cavia paca*).

*Location*.—Intestine.

*Locality*.—Ypanema, Brazil.

The above description of the bursal rays is based on von Linstow's figure and its accuracy depends on the correctness of the interpretation of the ventral rays. If the apparent

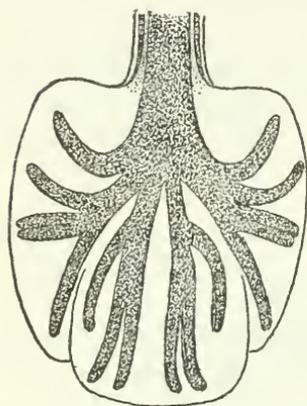


FIG. 192.—*STRONGYLUS SEDECIMRADIATUS*. BURSA, DORSAL VIEW. ENLARGED. AFTER VON LINSTOW, 1899.

ventro-ventral ray is that and not a combined ventro-ventral and latero-ventral ray, the interpretation is as given. If what appears to be the ventro-ventral ray is really two rays, then the medio-lateral and postero-lateral rays are close together and parallel, the externo-dorsal ray lies in the lateral lobe and the externo-dorsal ray above described is merely another branch of the dorsal. It seems unsafe to assign this species generically on the

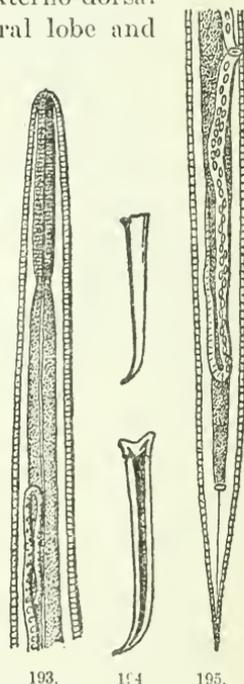
description given. Travassos (1914*b*) states that this is a species of *Heligmosomum*, but does not give his evidence or reason for the statement.

*STRONGYLUS CAVALLI* Parona, 1907.

*Specific diagnosis*.—Trichostrongylineae (p. 123): Body white, very narrow, anguilliform in both sexes, thinning anteriorly. Cuticle not striated. Anterior extremity simple, not dilated. Esophagus not very long (fig. 193). Intestine straight.

*Male* 10 mm. long. Bursa large and bilobed, the lobes 500 to 800  $\mu$  long. Rays differing slightly in length and form. Spicules equal, 500 to 800  $\mu$  long, conical, hooked at the distal extremity and with two small conical projections at the proximal extremity (fig. 194).

*Female* 10 to 12 mm. long. The posterior third of the body is thicker than the anterior portion. The tail is not very long and ends in an acuminate extremity. The vulva is in the posterior fourth of the body and shows as a transverse slit with raised margins. Uteri are divergent (fig. 195), the posterior ovary and uterus being a little



FIGS. 193-195.—*STRONGYLUS CAVALLI*. 193, ANTERIOR EXTREMITY. ENLARGED. AFTER PARONA, 1909. 194, SPICULES. ENLARGED. AFTER PARONA, 1909. 195, ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER PARONA, 1909.

shorter than the anterior. The anterior ovary extends beyond the middle of the body and forms a loop in the posterior third. The eggs are oval, relatively large, 80 to 85  $\mu$  long and 45  $\mu$  thick, in the morula stage at oviposition.

*Hosts.*—*Otomys irroratus*, *Otomys irroratus tropicalis*, *Funisciurus carruthersi*.

*Location.*—Intestine.

*Locality.*—Natakiva, Africa.

The inadequate description of the bursal rays leaves the present generic position of this species in doubt. The description of the uteri, however, indicates that it belongs in the Trichostrongylineae within the limits of that subfamily as defined in this paper.

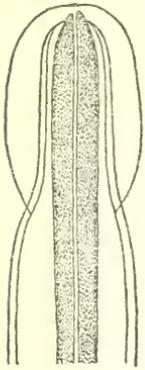


FIG. 196.—STRONGYLUS MINUTOIDES. ANTERIOR EXTREMITY. ENLARGED. AFTER PARONA, 1909.

STRONGYLUS MINUTOIDES Parona, 1907.

*Specific diagnosis.*—Trichostrongylineae (p. 123): Body white, filiform, diminishing in size anteriorly. Two cervical alae, with integral margins, present (fig. 196).

Mouth with two salient teeth. Esophagus elongated, its length equal to about one-sixth that of the entire body and without dilation. Intestine straight throughout its course.

*Male* 4 mm. long. The testes extend forward almost to the level of the esophagus. The large bursa has two lateral lobes sustained by large lateral rays. The medio-lateral and postero-lateral rays are close together and parallel. The spicules are equal, long, thin, and straight (fig. 197). Males found alone or twisted in several turns around the body of the female.

*Female* 7 to 8 mm. long. Tail conical, not very long, and pointed (fig. 198). Vulva a little anterior of the anal aperture and not prominent. Uteri divergent. Eggs large and oval, with thin shell and very little developed at oviposition.

*Host.*—*Arvicanthi pulchellus*.

*Location.*—Intestine.

*Locality.*—Ibanda, Africa.

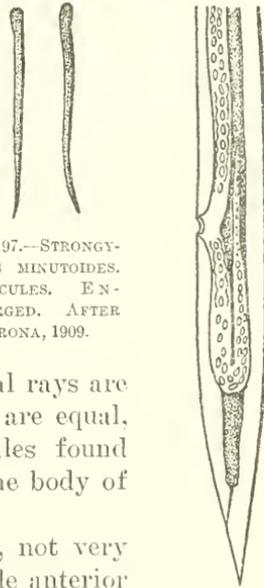


FIG. 197.—STRONGYLUS MINUTOIDES. SPICULES. ENLARGED. AFTER PARONA, 1909.

FIG. 198.—STRONGYLUS MINUTOIDES. POSTERIOR EXTREMITY OF FEMALE, LATERAL VIEW. ENLARGED. AFTER PARONA, 1909.

As in the foregoing species the brief description of the male bursa does not permit at present of a generic determination of this species, but the presence of two uteri in the female indicates that it belongs in the subfamily Trichostrongylinae.

**STRONGYLUS LEPORUM** (Moniez, 1880) Moniez, 1889.

*Synonym.*—*Spiroptera leporum* Moniez, 1880.

*Specific diagnosis.*—(?) Trichostrongylinae (p. 123): Body red from red coloration of coelomic fluid. Body attenuates anteriorly, then enlarges abruptly in the head region. Cuticle transversely striated, except on the bursa of the male. Head with four simple lips without appendices.

*Male* less than 10 mm. long and with a maximum thickness of 270  $\mu$ . Bursa with a dorsal and two lateral lobes. The bursa is longitudinally striated. The dorsal ray bifurcates at the proximal third, each branch dividing to form two short terminal forks, of which the external is the shorter. The spicules are deep red, 1.98 to 2.03 mm. long and enlarge gently distally. Toward the distal extremity, over a distance of half the spicule length to just the distal part, they are united by a thin chitinous lamella forming a channel. This chitinous lamella projects slightly beyond the spicules, forming a sort of appendage, below which is a hook attachment to the spicule. The free portions of the spicules have a minimum diameter of 22  $\mu$ , while the united distal portions have a maximum diameter of 65  $\mu$ .

*Female* a little more than 10 mm. long, with a maximum thickness of 450  $\mu$ . Eggs average 80 by 40  $\mu$  in diameter, thin shelled, and segmenting at oviposition.

*Hosts.*—*Oryctolagus cuniculus* (*Lepus cuniculus*), *Lepus europaeus* (*Lepus timidus*).

*Location.*—Under the gastric mucosa.

*Locality.*—Northern France (Ambleteuse, Pas-de-Calais; Groffliers, Pas-de-Calais; Forest of Marchiennes).

This species, originally described by Moniez as a *Spiroptera*, was later described as a *Strongylus*, but without the bursa characteristics necessary for present-day generic determination. Moniez indicates that there are five simple rays in each lateral lobe, but gives no further data.

**Subfamily HELIGMOSOMINAE** Travassos, 1914b.

*Subfamily diagnosis.*—Trichostrongylidae (p. 123): Body frequently coiled in a spiral. Females with one ovary.

*Type-genus.*—*Heligmosomum* Railliet and Henry, 1909a.

## ANALYTICAL KEY TO GENERA OF HELIGMOSOMINAE.

1. Two separate dorsal rays, vulva anterior-----*Heligmosomoides*, p. 160.  
 One branching dorsal ray, vulva posterior----- 2.
2. Body not spirally enrolled, prominent longitudinal cuticular markings.  
*Heligmosomum*, p. 149.  
 Body spirally enrolled, without prominent longitudinal cuticular markings.  
*Viannia*, p. 158.

## Genus HELIGMOSOMUM Railliet and Henry, 1909a.

*Synonym*.—*Strongylus* Mueller, 1780, of authors.

*Generic diagnosis*.—Heligmosominae (p. 148): Usually minute forms. Cuticle of normal thickness. Body commonly with cuticular markings other than simple striations, the longitudinal markings being especially prominent. Vulva in posterior portion of body, close to anus. A single ovary present. Uterus provided with well-developed ovijector. Two filiform spicules, less than 1 mm. long; gubernaculum present or absent. Nature of bursal rays not known to me from type-species, but from new species included in this genus is apparently as follows: Vento-ventral and latero-ventral rays divergent, the latero-dorsal ray straight, the ventro-ventral curving posteriorly. The externo-lateral and medio-lateral rays run close together and parallel throughout most of their extent, but their tips diverge distally. The postero-lateral ray diverges from the medio-lateral, curving posteriorly, so that its tip is not far from the tip of the externo-dorsal ray. The externo-dorsal ray is very thin, the thickest rays being the medio-lateral and externo-lateral. The dorsal ray originates as a thick stem, which bifurcates to form two long branches, which are cleft near their ends to form two small branches. Between the main bifurcation and the origin of the ray the main stem sends out two small posteriorly directed spurs. The bursa forms, usually, a small dorsal lobe and two large lateral lobes.

*Type-species*.—*Heligmosomum costellatum* (Dujardin, 1845) Railliet and Henry, 1909a.

This genus was proposed by Railliet and Henry by the designation of *Strongylus costellatus* Dujardin, 1845, as type-species. No generic diagnosis was given and as the species is nowhere adequately described and nowhere figured, the present writer was unable to determine the basis on which the genus was proposed or the probable generic characteristics. The included species are also so poorly described and the existing figures so contradictory that little light was obtained by an examination of these. A request for material of the type or included species was made to Professor Railliet by Dr. B. H. Ransom, noting the fact that the generic characteristics were not evident from the published descriptions of these species. In

reply Professor Railliet stated that he was unable to locate any material of the species in question, but that the species was created to replace *Metastrongylus* Molin, 1861a. Professor Railliet called attention to the fact that in his generic diagnosis of *Metastrongylus*, Molin (1861a) gives as a leading feature the presence of one ovary and uterus in the female, and that Stiles and Hassall (1905) in selecting a type-species of *Metastrongylus* selected *Metastrongylus paradoxus*, on the ground that it was the common and available species, overlooking the fact that Railliet (1893) had already pointed out that Molin was in error in stating that *M. paradoxus* had but a single ovary. The generic characters being fixed by the type-species, it becomes necessary to create a new genus for the forms with a single ovary which Molin had in mind in creating the genus *Metastrongylus*. With this explanation available it is readily evident that the new genus is quite important, so much so that Travassos has very properly made it the type of a new subfamily.

*Type-species*.—*Heligmosomum costellatum* (Dujardin, 1845) Railliet and Henry, 1909a.

ANALYTICAL KEY TO SPECIES OF HELIGMOSOMUM

1. Males over 10 mm. and females over 15 mm. long.  
*Heligmosomum costellatum*, p. 150.  
Males less than 10 mm. and females less than 15 mm. long..... 2.
2. Males not over 2.25 mm. long; females less than 2.5 mm. long.  
*Heligmosomum minutum*, p. 151.  
Males over 2.25 mm.; females 2.5 mm. long or longer..... 3.
3. Males over 5 mm. long; females over 8 mm. long; with large cervical alae.  
*Heligmosomum gracile*, p. 153.  
Males not over 5 mm. long; females not over 8 mm. long; or larger forms without cervical alae..... 4.
4. Males 4.5 to 5 mm. long; females 6.4 to 8 mm. long; spicules 600 to 675  $\mu$  long.  
*Heligmosomum laeve*, p. 153.  
Males not over 3.5 mm. long; females not over 4.37 mm. long; spicules less than 580  $\mu$  long..... 5.
5. Males 2.6 to 2.8 mm. long and females 3.5 mm. long; spicules 550 to 560  $\mu$  long.....*Heligmosomum brasiliense*, p. 154.  
Males 2.5 to 3.5 mm. long and females 3.44 to 4.37 mm. long; spicules 360 to 440  $\mu$  long.....*Heligmosomum verrillatum*, p. 155.

The principal tangible differences in the descriptions of species of *Heligmosomum* are in regard to size, and these differences have been used in the foregoing key. If the published figures of the bursae were used, it is doubtful whether the species would appear to have any thing like generic relation.

HELIGMOSOMUM COSTELLATUM (Dujardin, 1845) Railliet and Henry, 1909a.

*Synonyms*.—*Strongylus costellatus* Dujardin, 1845; *Metastrongylus costellatus* (Dujardin, 1845) Molin, 1861a; *Strongylus polygyrus* Dujardin, 1845, of Stossich, 1899.

*Specific diagnosis.*—*Heligmosomum* (p. 149): Body red, filiform, curved in an arc, somewhat narrowed anteriorly. Cuticle bears two opposed ridges or prominent lines from which regular folds originate on each side and pass obliquely to the rear, like ribs. Cuticle transversely striate. Head obtuse,  $66\ \mu$  in diameter exclusive of the surrounding cuticular expansion, and  $100\ \mu$  in diameter inclusive of the surrounding cuticular expansion. Mouth round. Esophagus muscular and club-shaped.

*Male* 11 mm. long and  $170\ \mu$  thick. Ratio of length to width, 65:1. Bursa  $310\ \mu$  long, composed of two large lobes, each supported by four rays (?), and more or less enrolled on one another. Two narrow spicules  $930\ \mu$  long.

*Female* 16.8 mm. long and  $250\ \mu$  thick in the middle and  $207\ \mu$  thick in the rear. Tail narrowing, conical, acute, not mucronate. Anus  $100\ \mu$  from the tip of the tail. Vulva  $630\ \mu$  from the tip of the tail. Uterus provided with muscular ovijector. Eggs 100 to  $110\ \mu$  long.

*Host.*—*Microtus arvalis* (*Arvicola arvalis*).

*Location.*—Intestine and in tubercles in the stomach.

*Locality.*—France (Rennes).

The above very inadequate description is from Dujardin (1845), and although this is the type-species of the genus, no better descriptions and no figures whatever appear to be in existence. This is an example of the difficulties resulting from the proposal of genera by the designation of a type-species without the statement of the generic characteristics. As already noted, both things should be expected of present-day workers.

HELIGMOSOMUM MINUTUM (Dujardin, 1845) Railliet and Henry, 1909a.

*Synonyms.*—*Strongylus minutus* Dujardin, 1845; *Metastrongylus minutus* Molin, 1861a.

*Specific diagnosis.*—*Heligmosomum* (p. 149): Body filiform, reddish, recurved in an arc. Two membranous alae,  $10\ \mu$  wide and striated transversely. These striations are less distinct on the cuticle where they occur at intervals of  $14.5\ \mu$ . The head is alate, abruptly narrowed and obtuse. It is  $23\ \mu$  thick exclusive of the alae, and is  $35\ \mu$  thick inclusive of the alae. The cervical alae are separated from the body alae by an incision at one point.

*Male* 2.25 mm. long and 51 to  $70\ \mu$  thick inclusive of the alae. The ratio of length to thickness is 32:1. The bursa is  $90\ \mu$  long and  $157\ \mu$  wide and is widely opened. It is formed of a double rounded lobe supported by two simple rays posteriorly and by two rays with five digitations laterally. The two filiform spicules are  $265\ \mu$  long.

*Female* 2.4 mm. long and a little thicker than the male. Ratio of length to thickness is 34:1. The tail is narrow, conoid, and obtuse.

Anus is  $110\ \mu$  from the tip of the tail. The prominent vulva is situated immediately in front of the anus. The single uterus is provided with muscular ovijector. Eggs  $90$  by  $75\ \mu$  in diameter, relatively large and variable in size.

*Hosts*.—*Microtus arvalis* (*Arvicola arvalis*), *Apodemus sylvaticus* (*Mus sylvaticus*), *Pitymys subterraneus* (*Arvicola subterraneus*).

*Location*.—Small intestine.

*Locality*.—France (Rennes).

The above description is from Dujardin (1845). Von Linstow (1882) describes and figures what he regards as the same species

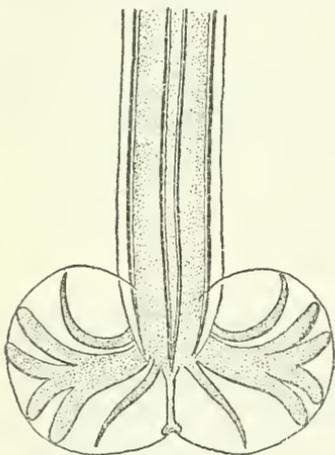


FIG. 199.—HELIGMOSOMUM MINUTUM. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1882. [PROBABLY NOT *H. MINUTUM* (DUJARDIN). SEE TEXT.]

collected from *Talpa europaea*. The differences in the two descriptions seem to the present writer to hardly warrant combining them, especially in view of the different hosts. Linstow's male is only  $990\ \mu$  long and  $46\ \mu$  wide. The cuticle is very thick and has peculiar transverse folds which form several longitudinal rows on the body. The intestinal wall is filled with refractive nuclei. I have commented on this finding in the discussion of *Heligmosomum vexillatum*. The bursa has two lobes defined by the narrow dorsal ray which bifurcates near its distal extremity to form a fork inclosing the shallow middorsal incision of the bursa (fig. 199). The three lateral rays and the latero-ventral ray form a divergent system of thick rays. The

somewhat narrower ventro-ventral ray curves posteriorly away from the latero-ventral. The narrow externo-dorsal rays lie a little nearer the externo-lateral rays than to the dorsal rays. The spicules are  $197\ \mu$  long, filiform, and united at the tip. The male is spirally rolled and invisible to the naked eye. It is, according to von Linstow, the smallest of all known strongyles.

It appears, then, that von Linstow's male specimens were less than half the length of Dujardin's, whereas the spicules in the latter case, instead of being more than twice as long were roughly 35 per cent longer. In view of this and the difference in host animals, it seems more likely that comparative study would show von Linstow's species to be a new one than that the two species would prove to be identical.

## HELIGMOSOMUM GRACILE (F. S. Leuckart, 1842) Railliet and Henry, 1909a.

*Synonyms.*—*Strongylus gracilis* F. S. Leuckart, 1842; *Metastrongylus gracilis* (F. S. Leuckart, 1842) Molin, 1861a; *Strongylus myoxi* Rudolphi, 1819, of Diesing, 1851, and Stossich, 1899.

*Specific diagnosis.*—*Heligmosomum* (p. 149): Body whitish brown, thinning anteriorly. Head small, elongate, and obtuse. Mouth simple and orbicular. Two large cervical alae present.

*Male* 6 to 7 mm. long. Large campanulate bursa, slightly incised on the dorsal border, and with small rays. Spicules long and filiform.

*Female* 9 mm. long. Body thickens posteriorly and terminates in a conical mucronate point.

*Host.*—*Glis glis* (*Myoxus glis*).

*Location.*—Intestine.

*Localities.*—Germany (Freiburg), Austria (Trieste), Italy (Pisa).

This worm was originally described under the specific name used here by Leuckart. Dujardin has quoted Leuckart's description with the comment that it is very probably identical with some one of the species made by him (Dujardin), i. e., one of the species now transferred to the genera *Heligmosomum* and *Viannaia* as *H. costellatum*, *H. laeve*, *H. minutum*, and *V. polygyra*. At the same time Dujardin did not go farther in attempting to identify Leuckart's species with any one of these, and there seems to be nothing to be gained by suppressing what may prove to be a good species on the strength of a casual opinion. *Strongylus myoxi* Rudolphi, 1819, has never been described and must be regarded as a *nomen nudum*, since there are at least two species of *Heligmosomum*, *H. gracile* and *H. laeve*, described from species formerly referred to the genus *Myoxus*. Stossich (1899), however, regards *Strongylus gracilis* and *Metastrongylus gracilis* as synonyms of *Strongylus myoxi*, but does not discuss the point.

## HELIGMOSOMUM LAEVE (Dujardin, 1845) Railliet and Henry, 1909a.

*Synonyms.*—*Strongylus laevis* Dujardin, 1845; *Metastrongylus laevis* (Dujardin, 1845) Molin, 1861a; *Strongylus polygyrus* Dujardin, 1845, of Stossich, 1899.

*Specific diagnosis.*—*Heligmosomum* (p. 149): Body filiform, reddish, slightly attenuate anteriorly, more or less enrolled, but not in a permanent manner. Cuticle slightly striate transversely at intervals of less than 2  $\mu$ . Two lateral lines or crests are visible at times. Head thinned, obtuse, 38  $\mu$  in diameter, exclusive of the surrounding vesicular cuticle, and 60  $\mu$  in diameter, inclusive of the vesicular cuticle.

*Male* 4.5 mm. long and 109  $\mu$  thick. Ratio of length to width, 43:1. Bursa often outspread, 200  $\mu$  long and 400  $\mu$  wide, and sustained by six or seven rays. Two filiform spicules 600  $\mu$  long.

*Female* 6.4 mm. long by 115  $\mu$  thick anteriorly and 118  $\mu$  thick posteriorly. Ratio of length to thickness, 53-56:1. Tail thin, conical, truncate, mucronate, or terminating in a narrow point, and 23  $\mu$  long. Anus 102  $\mu$  from the tip of the tail. Vulva is 380  $\mu$  from the tip of the tail. The single uterus is provided with a muscular ovijector. Eggs 72 to 74  $\mu$  long.

*Hosts.*—*Pitymys subterraneus* (*Arvicola subterraneus*), *Apodemus sylvaticus* (*Mus sylvaticus*), *Eliomys querinus* (*Myoxus nitella*), *Dipodillus campestris* (*Dipodilla campestris*).

*Location.*—Intestine.

*Localities.*—France (Rennes), Algeria (high plateaus).

It is evident from the above description of the female that Dujardin does not regard the length of the tail and the distance from the anus to the tip of the tail as the same thing. Unless the tail is defined as the portion of the body posterior of the anus, it would seem requisite that some landmark be furnished for the anterior boundary in order to make records of tail lengths of any use.

*H. laeve* is recorded from *Dipodillus campestris* (*Dipodilla campestris*) in Algeria by Seurat (1914e).

Since the foregoing was written, a paper by Seurat (1915g), giving an extended description of this species, has come to hand. Some of the features of his description are: There are 14 longitudinal crests along the body; the esophagus is short, 420 to 500  $\mu$  long; the male is 5 mm. long with a maximum thickness of 130  $\mu$ ; the spicules are 675  $\mu$  long and united at their distal extremity; the gubernaculum is asymmetrical, being prolonged anteriorly on the left side; the female is 6.5 to 8 mm. long with a maximum thickness of 150  $\mu$ , and forms a spiral of 9 turns when removed from the host; caudal extremity of female conical and at times invaginated; the anus is 80  $\mu$  from the tip of the tail and the vulva is 70  $\mu$  anterior of the anus; there is a short cuticular vagina and a simple genital tube; the eggs have a thin shell and are ovoid, 77  $\mu$  by 42 to 45  $\mu$  in diameter, segmenting when oviposited. Seurat notes that there are some differences between his measurements and those of Dujardin. He gives an extended description of the female genitalia and some good figures.

HELIGMOSOMUM BRAZILIENSE Travassos, 1914b.

*Specific diagnosis.*—*Heligmosomum* (p. 149): Body red. Cuticle with transverse striations and with prominent longitudinal markings. The esophagus is sinuous and is 280  $\mu$  long. Head slightly dilated.

*Male* 2.6 to 2.8 mm. long and 90 to 100  $\mu$  thick. The large bursa is trilobed, and the posterior lobe is very small. The ventro-ventral and latero-ventral rays are divergent, and the medio-lateral and externo-lateral rays are divergent. The dorsal ray terminates in four digitations. The spicules are long and filiform, with a sinuous distal extremity.

*Female* 3.5 mm. long and 130  $\mu$  thick. The posterior extremity is truncate. The anus is about 71  $\mu$  from the tip of the tail. The vulva is about 140  $\mu$  from the tip of the tail. The single uterus contains numerous ellipsoidal eggs. The eggs are 63 by 28  $\mu$  in diameter.

*Host*.—*Epimys norvegicus* (*Mus decumanus*).

*Location*.—Small intestine.

*Locality*.—Rio de Janeiro, Manguihos, Brazil.

*Life history*.—Unknown.

The statements regarding the rays as given above are to be regarded as the present writer's interpretation of Travassos's statements. It is greatly to be desired that every ray in the strongyle bursa be referred to specifically in descriptions rather than that some of them be considered as individual rays which branch. The dorsal ray may be treated as an exception to this, but it is very confusing to treat the ventral rays and combinations of the lateral rays as one ray.

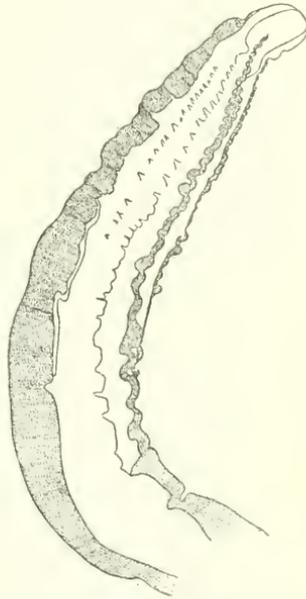


FIG. 200.—*HELIGMOSOMUM VEXILLATUM*. ANTERIOR EXTREMITY OF FEMALE. ENLARGED.

***HELIGMOSOMUM VEXILLATUM* Hall, 1916, new species.**

*Specific diagnosis*.—*Heligmosomum* (p. 149): Lips indistinct. Cuticle of head very slightly dilated. Cuticle with very fine and close, but very distinct transverse striation. A number of wavy cuticular markings, possibly 8 or 10 in number, formed by a sort of permanent cuticular folding, originate at the head and continue for some distance back (fig. 200), the distance in some females being as much as 500  $\mu$ . Two of these pennantlike markings, from which the species takes its name, seem to be constant and more prominent than the others. The other markings are not always evident. Intestinal cells contain small amounts of refractive granules distributed throughout the entire length of the intestine.

Male 2.5 to 3.5 mm. long, with a maximum thickness of about  $80\ \mu$  (fig. 201). Head about  $25\ \mu$  in diameter. Esophagus frequently bent

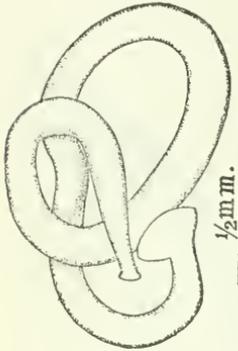


FIG. 201.—HELIGMOSOMUM VEXILLATUM. MALE.

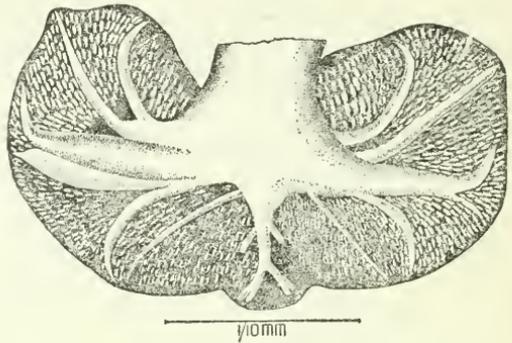


FIG. 202.—HELIGMOSOMUM VEXILLATUM. BURSA, DORSAL VIEW.

or sinuous to some extent and about  $250\ \mu$  long and  $30\ \mu$  thick near the posterior end in a small specimen. The nerve ring is about  $110\ \mu$  from the anterior end of the body.

The intestine is straight. The bursa is set on at approximately right angles to the long axis of the body and has a spread width equal to more than three times the maximum thickness of the body (fig. 202). The body terminates posteriorly in a cone which projects ventral of the bursa (fig. 203). The arrangement of the bursal rays is that given in the generic diagnosis. The tips of the externo-dorsal and postero-lateral rays are fairly close together; at an interval from this are the medio-lateral and externo-lateral rays, with their tips not so close together; and at a less interval is the latero-ventral ray, with its tip still farther removed from the ventro-ventral ray than was the case with the two preceding related pairs. The dorsal ray is about  $65\ \mu$  long and the

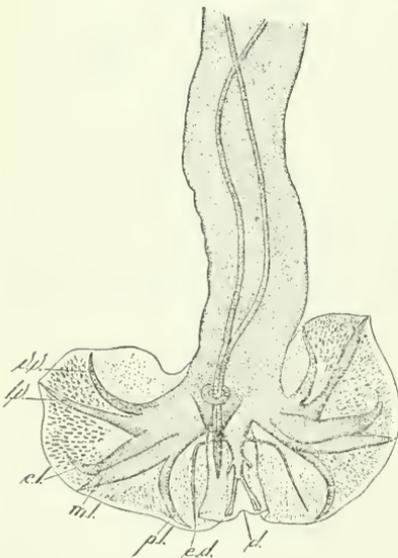


FIG. 203.—HELIGMOSOMUM VEXILLATUM. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. *d.*, DORSAL LOBE AND RAY; *c. d.*, EXTERNO-DORSAL RAY; *c. l.*, EXTERNO-LATERAL RAY; *l. v.*, LATERO-VENTRAL RAY; *m. l.*, MEDIO-LATERAL RAY; *p. l.*, POSTERO-LATERAL RAY; *v. v.*, VENTRO-VENTRAL RAY. ENLARGED.

spurs nearest the proximal end originate about one-third of the distance from the base to the ends of the ray. The main branches

originate about two-thirds of this distance. The bursal areas between the rays are marked with irregular maculae, following in a general way the contour lines of the rays. This marking results in a certain opacity, with the result that the rays commonly appear as light lines against a darker and more opaque background, contrary to the usual condition in the strongyle bursa, where the rays are usually more opaque than the bursal membrane. The simple, filiform spicules are 360 to 440  $\mu$  long.

*Female* 3.44 to 4.37 mm. long and with a maximum thickness of about 90  $\mu$ . The head diameter is about 25  $\mu$ . Esophagus is 275 to 290  $\mu$  long, with a maximum thickness of about 30  $\mu$ . Nerve ring about 110  $\mu$  from the anterior end of the body. The intestine is straight. The rectum is a narrow cylindrical to elongate conical structure about 25  $\mu$  long. The anus is 34 to 42  $\mu$  from the tip of the tail. The tail is conical and shows the transversé striation prominently. The vulva is 122 to 127  $\mu$  from the tip of the tail (fig. 204), and on the dorsal side opposite the vulva is often a projecting cuticular structure. The ovijectors are not well preserved in my material, and I am unable to give any details of structure. The single uterus has few eggs, commonly three to nine, in it. The eggs are oval, about 70 by 32  $\mu$  in diameter.

*Host*.—*Thomomys fossor*.

*Location*.—Small intestine.

*Locality*.—Livermore (Larimer County), Colorado.

The refractive granules in the intestinal wall are evidently similar to the rhabditin described by Cobb (1914) from *Rhabditis monhystrera* and to the refractive nuclei found by von Linstow (1882) in what he regards as *Heligmosomum minutum*. It is interesting to note that all these species are forms with one ovary and that Leuckart has established the presence of the rhabditiform embryo for a species of *Heligmosomum*. It suggests that the presence of the interesting nutritional granules studied by Cobb will probably be demonstrated in a much larger number of allied parasitic and nonparasitic forms on further investigation.

*Type material*.—No. 16142, U.S.N.M. (Bureau of Animal Industry helminthological collection).

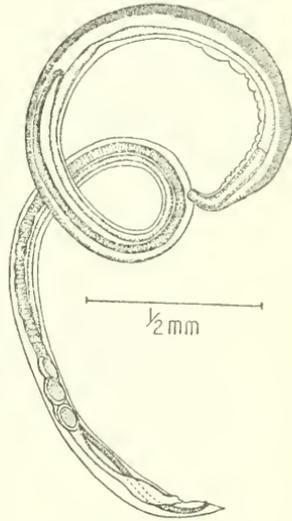


FIG. 204.—*HELIGMOSOMUM VEXILLATUM*. FEMALE.

I am indebted for this material also to the kindness of Mr. E. R. Warren. The worms were collected from host material collected by him and preserved in alcohol.

Genus VIANNAIA Travassos, 1914b.

*Synonyms*.—*Strongylus* Mueller, 1780, part; *Metastrongylus* Molin, 1861a, part; *Heligmosomum* Railliet and Henry, 1909a, part.

*Generic diagnosis*.—Heligmosominae (p. 148): Body strongly rolled in a spiral, with slight transverse striations and without evident longitudinal striations. Cuticle enormously thickened, especially in the male. Spicules short; gubernaculum present or absent, and only slightly visible when present. Vulva only slightly anterior of the anus. Ovijector well developed. Single uterus and ovary. In small intestine of rodents and marsupials.

*Type-species*.—*Viannaia viannai* Travassos, 1914b.

ANALYTICAL KEY TO SPECIES OF VIANNAIA.

1. Worms less than 3 mm. long.....*Viannaia hydrocheri*, p. 158.  
 Worms 6 mm. long or longer.....*Viannaia polygyra*, p. 158.

VIANNAIA HYDROCHERI Travassos, 1914b.

*Specific diagnosis*.—*Viannaia* (p. 158): Body red and rolled in a spiral. Cuticle very thick. Esophagus claviform and 310  $\mu$  long.

*Male* 2.3 to 2.4 mm. long and 150  $\mu$  thick. Large bursa with well developed lateral lobes. Ventro-ventral and latero-ventral rays divergent and medio-lateral and postero-lateral rays divergent. Dorsal ray branches dichotomously. Spicules characteristic, of about the same size, 170 to 180  $\mu$  long, but slightly differing in shape; no gubernaculum.

*Female* 1.9 mm. long and 120  $\mu$  thick. Vulva 71  $\mu$  from the tip of the tail. A single uterus with few eggs: eggs 42 to 49  $\mu$  by 28 to 35  $\mu$  in diameter.

*Host*.—*Hydrochoerus hydrochaeris* (*Hydrocherus capibara*).

*Location*.—Small intestine.

*Locality*.—Estado do Rio, Angra dos Reis, Brazil.

*Life history*.—Unknown.

It would have been better if Travassos had elaborated or illustrated his statement that the spicules are characteristic.

VIANNAIA POLYGYRA (Dujardin, 1845) Hall, 1916.

*Synonyms*.—*Strongylus polygyrus* Dujardin, 1845; *Metastrongylus polygyrus* Dujardin (1845) Molin, 1861a; *Strongylus spirogyrus*

Leuckart, 1867; *Strongylus laevis* Dujardin, 1845, of Stossich, 1899; *Strongylus costellatus* Dujardin, 1845, of Stossich, 1899; *Heligmosomum polygyrum* (Dujardin, 1845) Railliet and Henry, 1909a.

*Specific diagnosis.*—*Viannaia* (p. 158): Body red, filiform, thinning anteriorly and tightly rolled into a spiral of 6 to 18 turns, impossible to straighten without breaking. Cuticle finely striated longitudinally and transversely, the transverse striation being the more distinct and spaced at intervals of 20 to 22  $\mu$ . The head is narrow and obtuse and has a diameter, inclusive of its vesicular swelling, of 45 to 55  $\mu$ .

*Male* 6 to 7.2 mm. long and 90  $\mu$  thick. Ratio of length to thickness 80:1. Body rolled in a spiral of five to six turns. Head 24  $\mu$  in diameter exclusive of vesicular swelling, and 42  $\mu$  in diameter inclusive of swelling. Bursa 300  $\mu$  long and 250  $\mu$  wide, formed of two large lobes more or less enrolled. Two filiform spicules 580  $\mu$  long.

*Female* 10 to 13 mm. long and 95 to 105  $\mu$  thick near the middle, 130 to 140  $\mu$  thick posteriorly in the region of the uterus. Ratio of length to thickness 120:1. Body rolled in 10 to 18 spiral turns. Head 27 to 32  $\mu$  in diameter exclusive of vesicular swelling, and 55  $\mu$  in diameter inclusive of swelling. Tail 20  $\mu$  long, thin, conical, diaphanous, truncated, and terminating abruptly in a narrow point. Anus 75  $\mu$  from the tip of the tail. Vulva 300  $\mu$  from the tip of the tail. The single uterus is provided with a muscular ovjector. Eggs 66 by 62  $\mu$  in diameter.

*Hosts.*—*Microtus arvalis* (*Arvicola arvalis*), *Apodemus sylvaticus* (*Mus sylvaticus*).

*Location.*—Intestine, at times in pedunculated cysts on the external aspect of the intestinal wall.

*Locality.*—France.

Travassos (1914b) states that this species should be transferred to his new genus *Viannaia* and it is here transferred to that genus, principally on the authority of Travassos, who has had material representative of both genera and is in a better position to judge where *Strongylus polygyrus* Dujardin belongs than I am. At the same time the available descriptions of Dujardin's species are not sufficiently detailed to warrant the assertion in this paper that Travassos is right.

Von Linstow (1878b and 1879a) has described a parasite, which he determined as *Strongylus polygyrus* Dujardin, from *Arvicola campestris*, but the worm as described and figured differs so much from *Strongylus polygyrus* and the other species now assigned to the genera *Heligmosomum* and *Viannaia*, and from any other proposed genera known to me, that I have transferred it to the new genus *Heligmosomoides*.

Leuckart (1867) records some investigations into the life history of what he calls "*Str. spirogyrus* der Waldenmäuse," apparently an unconscious substitution for *Str. polygyrus*. He finds that this species has a rhabditiform embryo. The embryos develop in two to three days and measure 500  $\mu$  in length. The tooth apparatus is weak, so that it is easily overlooked, and exists for only a short time. Possibly correlated with this is the fact that the animal grows only a little during its free existence. In spite of this it remains alive 8 to 12 weeks in saliva. The attempt to bring about the further evolution of the worm in its host, the wood mouse, gave what Leuckart regarded as a doubtful result. Fourteen days after feeding to a mouse, the mouse was found to contain an extraordinary number of these parasites, but these, if not completely grown, were yet of such considerable size, 8 to 10 mm., that without a control experiment he does not feel warranted in referring them to the feeding. It seems likely, nevertheless, that the feeding was successful.

It will be noted that in this species, as in *H. laeve*, Dnjardin does not regard the length of the tail and the distance from the anus to the tip of the tail as identical.

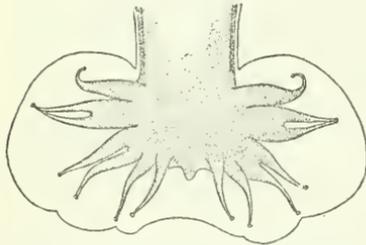


FIG. 205.—HELIGMOSOMOIDES LINSTOWI. BURSA. ENLARGED. AFTER VON LINSTOW, 1878.

broad and presenting the appearance of a double ray. The lateral rays arise from a common trunk and are divergent (fig. 205). There are two dorsal rays with separate origins, their tips located close to the tips of the postero-lateral rays. Between the dorsal rays and posterior of the elocæa are 14 small raylike structures terminating in papillæ (fig. 206). Two well-developed prebursal papillæ present. The bursa is set on at right angles to the long axis of the worm. The vulva is near the head. One ovary.

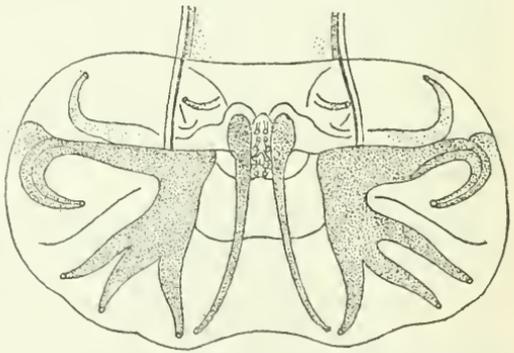


FIG. 206.—HELIGMOSOMOIDES LINSTOWI. BURSA. ENLARGED. AFTER VON LINSTOW, 1879.

HELIGMOSOMOIDES Hall,  
1916, new genus.

*Generic diagnosis.*—*Heligmosominae* (p. 148): Body commonly coiled in a spiral. Male with filiform spicules. Bursa with broad, shallow dorsal incision. Ventro-ventral and latero-ventral rays divergent, from a common trunk, the latero-ventral ray

*Type-species.*—*Heligmosomoides linstowi* Hall, 1916.

I am not sure that my interpretation of von Linstow's figures of the bursa is correct. The figures present some peculiarities.

HELIGMOSOMOIDES LINSTOWI Hall, 1916, new name.

*Synonym.*—*Strongylus polygyrus* Dujardin, 1845, of von Linstow, 1878b and 1879a.

*Specific diagnosis.*—*Heligmosomoides* (p. 160): Worm, reddish, spirally coiled. Mouth aperture triangular with four circumnoral papillae. Cuticle dilated about head and with 16 longitudinal striations, in part wavy, along body. Transverse striations present and spaced at about the same interval as the longitudinal.

*Male* 4 mm. long and 78  $\mu$  thick. The bursa structure is that given in the generic diagnosis. The spicules are 540  $\mu$  long.

*Female* 7.2 mm. long and 96  $\mu$  thick. The anus is 98  $\mu$  from the tip of the tail, the tail ending in a fine terminal point 16  $\mu$  long. The vulva is anterior, 240  $\mu$  from the anterior end. The vagina is 720  $\mu$  long and is directed posteriorly (presumably). It joins an ovijector 180  $\mu$  long (fig. 207). At the anterior end of this is a spherical body.

Anterior of the latter is a muscular uterus 180  $\mu$  long and anterior of this is the ovary. The eggs are 75 by 43  $\mu$  in diameter.

*Life history.*—In eggs placed in moist earth embryos (fig. 208) develop in eight days. The embryo is 310  $\mu$  long and 23  $\mu$  thick. The mouth has two conical projections and the tail is awl-shaped. The esophagus is  $1/2.4$  and the tail  $1/4.7$  of the total body length.

*Host.*—*Microtus arvalis* (*Arvicola campestris*).

*Location.*—Intestine, partly in saclike depressions apparently caused by the worm.

*Locality.*—Germany.

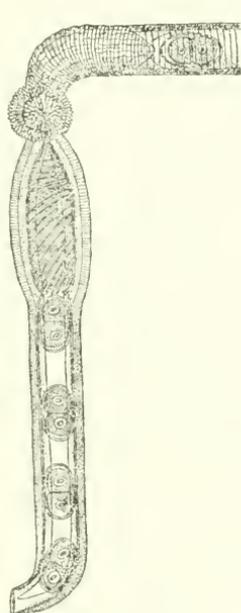


FIG. 207.—HELIGMOSOMOIDES LINSTOWI. VAGINA AND OVIJECTOR. ENLARGED. AFTER VON LINSTOW, 1882.

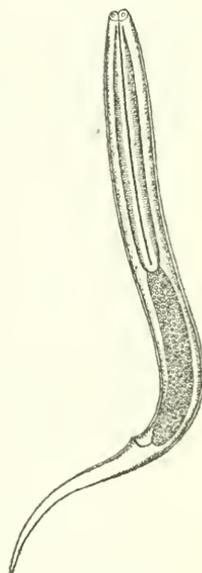


FIG. 208.—HELIGMOSOMOIDES LINSTOWI. EMBRYO. ENLARGED. AFTER VON LINSTOW, 1882.

This species is described by von Linstow (1878*b* and 1879*a*) as *Strongylus polygyrus* Dujardin, but unless the figures of other species are misleading in conveying the idea that there is one branching dorsal ray, or unless von Linstow has erred in figuring his material as having two dorsal rays and in stating that the vulva is anterior, we are bound to conclude that von Linstow's species is not even congeneric with Dujardin's. On the available evidence, I have regarded his species as new and erected a new genus for it. His terminology in regard to the female genitalia is not in accordance with present-day terminology and I have altered it accordingly in the above diagnosis. He also makes the statement that the spherical body anterior of the uterus is composed of unicellular glands which empty their secretion into the lumen. While this may be correct, it might also be noted that a somewhat spherical muscular structure is a common feature of the ends of the ovijectors.

#### Family METASTRONGYLIDAE Leiper, 1908.

*Family diagnosis*.—Strongyloidea (p. 106): Polymyarian. Buccal capsule present or absent. Bursa present or absent; when present, frequently atypical in structure and number of rays. Oviparous, with eggs in variable stages of segmentation when oviposited, or viviparous. Embryo not rhabditiform. Usually in respiratory and circulatory systems, rarely in digestive system.

*Type-genus*.—*Metastrongylus* Molin, 1861*a*.

#### ANALYTICAL KEY TO SUBFAMILIES OF METASTRONGYLIDAE.

1. Buccal capsule absent.....Metastrongylinae, p. 162.  
Buccal capsule present..... 2.
2. Bursa much reduced or lacking; when present, with few and atypical rays.  
Two ovaries.....Rictulariinae, p. 168.  
Bursa well developed, with typical rays. One ovary.....Ollulaninae, p. 177.

#### Subfamily METASTRONGYLINAE Leiper, 1908.

*Subfamily diagnosis*.—Metastrongylidae (p. 162): Buccal capsule absent. Male with two equal spicules and female with two ovaries. Eggs in varying stages of development when oviposited. Embryo not rhabditiform. Parasitic in the respiratory and circulatory systems.

*Type-genus*.—*Metastrongylus* Molin, 1861*a*.

The life history in this group is not as yet very well ascertained. Romanovitch and Slavine (1914) state that when eggs of *Dictyocaulus filaria* are placed in water, embryos form, two ecdyses follow, the cuticle being retained, and that such encapsuled larvae produce

infection with the adult worm when fed to sheep. This points to a direct development without intermediate host for the worms in this group. The fact that lungworms have been found in newborn animals and in the fetus, suggests that the life history is not entirely a simple one.

Genus *SYNTHETOCAULUS* Railliet and Henry, 1907.

*Synonym.*—*Strongylus* Mueller, 1780, part, of authors.

*Generic diagnosis.*—*Metastrongylinae* (p. 162): Body capillary. Mouth with three lips. Posterior extremity of the body of the male reinforced by a chitinous arc. Bursa with the ventro-ventral and latero-ventral rays close together and parallel, and with the medio-lateral and postero-lateral rays close together and parallel. The dorsal rays are united in a thick trunk of quite disproportionate size. Two punctate, striate, or pectinate spicules, slightly bent. Between the spicules and at some distance anterior of the bursa is an unpaired chitinous accessory structure forming an angle open to the rear. In the bursa region are two paired chitinous accessory structures, elongate and approximately parallel. Vulva a little in front of the anus. Uteri convergent. Eggs without a trace of segmentation when oviposited. Embryo with a tail prolonged by an undulate appendix.

*Type-species.*—*Synthetocaulus pulmonalis* (Froelich, 1802) Hall, 1916.

ANALYTICAL KEY TO SPECIES OF SYNTHETOCAULUS.

1. Parallel accessory organs of male 33  $\mu$  long—*Synthetocaulus pulmonalis*, p. 163.  
Parallel accessory organs of male 50  $\mu$  long—*Synthetocaulus rufescens*, p. 166.

SYNTHETOCAULUS PULMONALIS (Froelich, 1802) Hall, 1916.

*Synonyms.*—*Filaria pulmonalis* Froelich, 1802; *Strongylus retortaeformis major* Rudolphi, 1819; *Filaria leporis pulmonalis* Rudolphi, 1819; *Capillaria pulmonalis* Rudolphi, 1819; *Strongylus commutatus* Diesing, 1851; *Filaria leporis pulmonalis* Froelich, 1802, of Diesing, 1851; *Trichosomum leporis* Dujardin, 1845, of Diesing, 1851; *Trichosomum leporis (pulmonale)* Diesing of Diesing, 1851; *Filaria terminalis* Passerini, 1884; *Synthetocaulus commutatus* (Diesing, 1851) Railliet and Henry, 1907.

*Specific diagnosis.*—*Synthetocaulus* (p. 163): Body filiform. Anterior extremity attenuated and head obtuse. Mouth with three lips and with six very small circumoral papillae. The slender esophagus is slightly dilated posteriorly. The intestine is dark brown and is lined with polygonal cells. The excretory pore opens just behind the posterior end of the esophagus (fig. 209).

Male 18 to 33 mm. long and  $100\ \mu$  thick. The esophagus is  $665\ \mu$  long. The small bursa is short and rounded and only very slightly incised dorsally (fig. 210). It is nearly transparent and readily overlooked. The arrangement of the bursal rays is that given in the generic diagnosis. The dorsal ray is 8 to  $14\ \mu$  (?) thick and has a slight depression on its posterior border. The spicules are 160 to  $170\ \mu$  long. They are flat, somewhat bent chitinous rods, somewhat broadened at

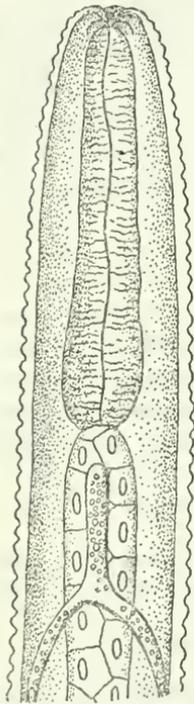


FIG. 209.—SYNTHETOCAULUS PULMONALIS. ANTERIOR EXTREMITY. ENLARGED. AFTER PASSERINI, 1884.

both ends, and the body of the spicules is marked with a distinct marbling (fig. 211). They are provided with chitinous lateral lamellae in which are chitinous rods, some simple and some distally bifurcate, set at right angles to the longitudinal axis of the spicule. The rods are thicker in the proximal portion of the spicule and always end bluntly. In the distal portion of the spicule the lamellae become wider and the rods in them become thinner, so that on the distal end they are only appreciable on the extruded spicule as very fine lines on the thin lateral lamellae. The lamellae are directed toward one another distally, but curve gradually around the spicule proximally. A long retractor muscle inserts in the proximal swelling of the spicule and proceeds anteriorly to its origin in the cuticle of the lateral body wall, while a more complex muscle serves for the

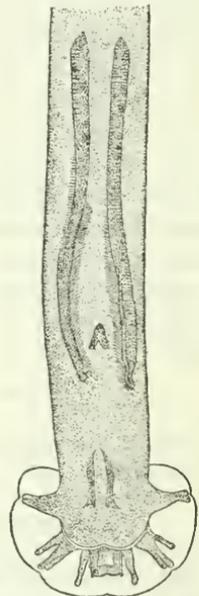


FIG. 210.—SYNTHETOCAULUS PULMONALIS. POSTERIOR EXTREMITY OF MALE.  $\times 150$ . AFTER RAILLIET, 1893.

extrusion of the spicule. With the spicules retracted, the unpaired accessory structure lies between them in their distal portion. In its general outline this structure is chevron-shaped, with the point of the chevron directed anteriorly, and consists of six to eight sickle-shaped chitinous structures projecting from a center and toothed on the inner concave side. It is a fixed structure and occupies the same position in the body regardless of whether the spicules are extruded or retracted. The paired accessory structures are located in the bursal region and are approximately parallel structures  $33\ \mu$  long.

These structures consist of a broad, slightly bent stem, terminating posteriorly in a small, thick end plate. They curve postero-ventrally and are apparently homologous with the single accessory piece of other nematodes. The body terminates posteriorly in a chitinous ring which consists of two arcs, convex postero-laterally, and meeting at an angle in a depression in the mid-dorsal line.

*Female* 28 to 58 mm. long and 135 to 154  $\mu$  thick. The tail subconical and bluntly pointed. The anus is very close to the tip of the tail (fig.

212). The vulva is just anterior of the anus and is 200 to 260  $\mu$  (?) from the tip of the tail. The vagina is 2 to 2.4 mm. (?) long. There are two convergent uteri. Eggs are elliptical, very thin shelled, and 92 to 118  $\mu$  long and 62 to 81  $\mu$  thick. They show no trace of segmentation at oviposition. The embryo has a tail prolonged by an undulate appendix.

*Host*.—*Lepus europaeus* (*Lepus timidus*).

*Location*.—Bronchi, bronchioles, and pulmonary parenchyma.

*Localities*.—France, Germany, Austria, Italy.

Following the views of most other writers, the various species of worms from the lungs of *Lepus timidus* in Europe, described as strongyles, trichosomes, or filariae, have been regarded here as *Synthetocaulus pulmonalis*. *Oryctolagus cuniculus* (*Lepus cuniculus*) has been omitted as a host, following the view expressed by Neveu-Lemaire (1912) that the occasional cases of verminous pneumonia in the domesticated rabbit were due to *Synthetocaulus rufescens*. I have accepted this view on his authority, but in the absence of any material it is impossible for me to pass on it one way or another.

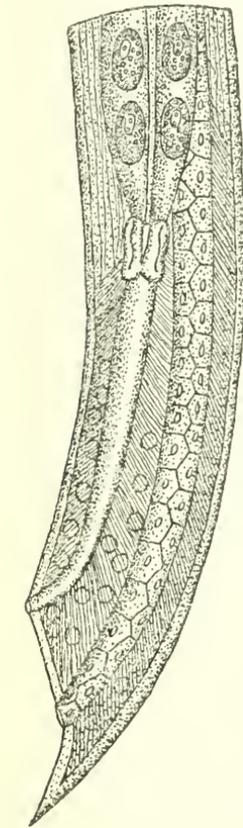


FIG. 212.—SYNTHETOCAULUS PULMONALIS. POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER PASSERINI, 1884.

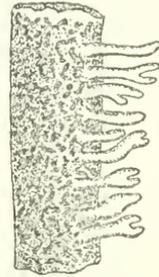


FIG. 211.—SYNTHETOCAULUS PULMONALIS. PART OF SPICULE. GREATLY ENLARGED. AFTER PASSERINI, 1884.

*Synthetocaulus pulmonalis* has received considerable study and is in need of more. Mueller (1889) and Passerini (1884) have made very interesting studies. The measurements given by Mueller and accepted as correct by Doctor (1907) are somewhat puzzling. They are expressed in terms of the symbol ( ' ' ) commonly used to denote

"lines," a line being equal to one-twelfth of an inch. If converted into metric measurements on this basis, the measurements are so obviously multiples of those given by other writers that this can not be correct. Assuming that the symbols are intended to denote millimeters, they still give figures in excess of those given by other writers, suggesting that there was a fixed error in his scale of measurements or that other writers are in error in their measurements. Where the measurements given by Mueller are cited above, they are queried. For the sake of completeness they are given in full here:

*Male* 30 to 40 ''' long and 0.12 to 0.18 ''' thick. Length of esophagus 0.32 ''. Bursa 0.1 to 0.14 ''' wide. Dorsal ray 0.004 to 0.007 ''' broad, or 0.036 ''' with its border. Spicules 0.17 to 0.18 ''' long. Paired accessory structures 0.042 to 0.05 ''' long.

*Female* 70 ''' long and 0.16 to 0.2 ''' thick. Vagina 1 to 1.2 ''' long and 0.2 to 0.26 ''' from the tip of the tail. Eggs 0.09 to 0.1 ''' long and 0.06 to 0.08 ''' thick.

Doctor (1907) has made a study of the clinical and pathological aspects of infestation with this worm. He finds the initial stages characterized by bronchitis and peribronchitis. Secondarily there occurs bronchiectasis, collapse of the alveolar groups, and atelectasis. The changes follow a pneumonic process which is different from others in that it is characterized by extended epithelial desquamation and a diffuse, progressive course, from which it may be known as a desquamative pneumonia. This may heal by a regeneration of the denuded epithelium accompanied by hyperemia. If the worm invasion was massive, or if weak respiration or absence of expectoration hinders the elimination of the exudate due to the parasite, there follows a tissue necrosis by progressive caseation, which may show as a caseous bronchitis and caseous pneumonia. This may determine extensive destruction of lung tissue or induration.

**SYNTHETOCAULUS RUFESCENS (Leuckart, 1865a) Railliet and Henry, 1907a.**

*Synonyms.*—*Nematoideum ovis (pulmonale)* Diesing, 1851; *Strongylus rufescens* Leuckart, 1865; *Strongylus minutissimus* Mégnin, 1878; *Pseudalius ovis pulmonalis* A. Koch, 1883; *Strongylus ovis pulmonalis* Diesing of Curtice, 1890; *Metastrongylus minutissimus* (Mégnin, 1878) Sluiter and Swellengrebel, 1912.

*Specific diagnosis.*—*Synthetocaulus* (p. 163): Body filiform, with a characteristic reddish-brown tint due to the coloring of the alimentary tract. Mouth with three small lips and with four circumoral papillae. No cervical alae.

*Male* 16 to 28 mm. long and 500  $\mu$  thick. The simple esophagus enlarges slightly posteriorly. The bursa is small, excised anteriorly and with two small indentations on each side (fig. 213). The spicules are 110 to 310  $\mu$  long, and are cylindrical in the anterior half and

flattened in the posterior half (fig. 214). A chitinous lamella extends along the entire spicule and the posterior half of the spicule is scalloped along its median border to form a pectinate edge. The chitinous lamellae of the posterior half of the spicules are bent around to form a tubular structure. The paired accessory structures are 50 to 52  $\mu$  long, slightly recurved at their distal extremity and presenting three or four teeth on the convexity of the curve.

*Female* 25 to 35 mm. long and 170  $\mu$  thick. The

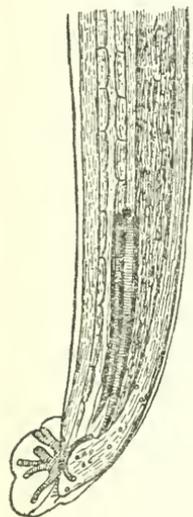


FIG. 213.—SYNTHETOCAULUS RUFESCENS. POSTERIOR EXTREMITY OF MALE.  $\times 100$ . AFTER RAILLIET, 1893.

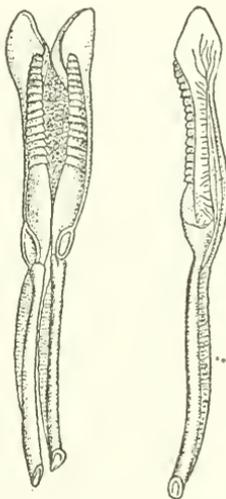


FIG. 214.—SYNTHETOCAULUS RUFESCENS. SPICULES. ENLARGED. AFTER CURTICE, 1890.

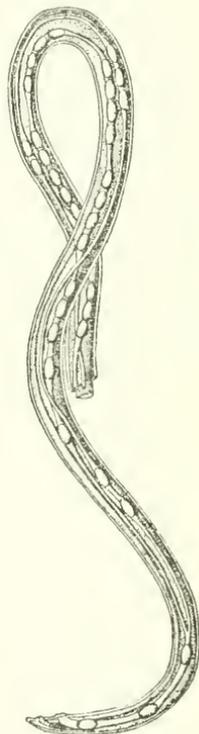


FIG. 215.—SYNTHETOCAULUS RUFESCENS. POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER CURTICE, 1890.

tail is subconical and ends in a blunt point (fig. 215). The anus is 80  $\mu$  from the tip of the tail. The vulva is just anterior of the anus and is 100  $\mu$  from the tip of the tail. The vagina proceeds anteriorly from the vulva and divides to form the convergent uteri. The eggs are ellipsoidal, 75 to 120  $\mu$  long and 40 to 85  $\mu$  thick, with no trace of segmentation when oviposited.

*Host*.—*Oryctolagus cuniculus* (*Lepus cuniculus*). (Commonly in ungnulates.)

*Location*.—Bronchioles and pulmonary parenchyma.

*Locality*.—Europe.

As noted in comment on the foregoing species, I have followed Neveu-Lemaire in accepting records of lung worm from *Lepus cuniculus* as *Syn. rufescens*.

## Subfamily RICTULARIINAE Hall, 1913.

*Synonym.*—Riticularinae Travassos, 1914*b*.

*Subfamily diagnosis.*—Metastrongylidae (p. 162): Bursa much reduced or lacking; when present, with few and atypical rays. Mouth with well-developed buccal capsule. Prominent cuticular ornamentation along entire body. Oviparous. Parasites of the digestive tract.

*Type-genus.*—*Rictularia* Froelich, 1802.

In the published diagnosis of this subfamily (Hall, 1913) I referred to it as ovoviviparous, using the word in the not uncommon sense as meaning the oviposition of eggs containing well-developed embryos. This use of the word seems hardly accurate, ovoviviparous referring more properly to the production of an embryo within a shell and the hatching of the embryo within the maternal uterus.

In the paper noted above, I stated that *Rictularia* did not have the normal strongyle bursa and that the elaborate cuticular ornamentation and the fact that the eggs contained a developed embryo when oviposited are atypical conditions among the strongyles. I stated, however, that the buccal capsule which related *Rictularia* to the strongyles excluded it from any other group. Seurat (1915*f*) has recently published the view that the buccal capsule here is not indicative of any real relationship but is merely the result of convergence due to a similar mode of life, and that the structure of the esophagus, the position of the post-cervical papillae and the excretory pore, the conformation of the ovjector, the form of the eggs, and the disposition of the genital papillae present manifest affinities with *Physaloptera* and related forms. While Seurat's suggestion merits serious consideration, the present writer does not feel in a position to pass on the relationship at this time and prefers to leave these forms with the Metastrongylidae.

## ANALYTICAL KEY TO GENERA OF RICTULARIINAE.

1. Cuticle ornamented with 2 longitudinal rows of spines.----*Rictularia*, p. 168.
- Cuticle ornamented with 3 longitudinal rows of spines.--*Rictularioides*, p. 175.

## Genus RICTULARIA Froelich, 1802.

*Synonyms.*—*Ophiostoma* Rudolphi, 1801; *Ophiostomum* Creplin, 1839; *Laphyetes* Dujardin, 1845; *Pterygodermatites* Wedl, 1861.

*Generic diagnosis.*—Rictulariinae (p. 168): Buccal capsule well developed and narrow, with its aperture more or less distinctly dorsal and surrounded by a circlet of denticles, and with its base armed with teeth and spines. Along practically the entire ventral surface of each side there are two rows of cuticular combs or spines. Male with or without bursa; the bursa when present is always small and always remains open. Two small, equal or unequal spicules. Vulva

anterior, near the posterior end of the esophagus. Oviparous, the egg containing a well-developed embryo when oviposited. Parasitic in the small intestine as a rule.

*Type-species.*—*Rictularia cristata* Froelich, 1802.

ANALYTICAL KEY TO SPECIES OF RICTULARIA.

1. Female less than 15 mm. long; about 34 cuticular combs in each row from the head to the transition point near vulva—*Rictularia coloradensis*, p. 173.  
Female more than 15 mm. long; less than 30 or more than 40 combs in the row from the head to the transition point near vulva----- 2.
2. Female with 50 combs from head to transition point—*Rictularia fallax*, p. 171.  
Female with not over 20 combs from head to transition point----- 3.
3. Female with 2 cervical alae with small spines on edges.  
*Rictularia clvirac*, p. 170.  
Female without cervical alae-----*Rictularia cristata*, p. 169.

No male of the above species is known except that of *R. coloradensis*. See Addendum for *Rictularia proni* Seurat, 1915.

RICTULARIA CRISTATA Froelich, 1802.

*Synonyms.*—*Ophiostoma cristatum* (Froelich, 1802) Rudolphi, 1819; *Ophiostomum cristatum* (Froelich, 1802) Diesing, 1851.

*Specific diagnosis.*—*Rictularia* (p. 168):

*Male* unknown.

*Female* 22 to 27 mm. long (Dujardin gives this as 16 to 66 mm. long and 400  $\mu$  to 1.32 mm. thick). Red when freshly collected. Head 280  $\mu$  in diameter. Esophagus simple, 4.3 mm. long and 300  $\mu$  thick. The head (fig. 216) terminates in a thick lip, rounded in the form of a helmet, and bears several small papillae. The mouth aperture is transverse, reniform, or semi-circular, and is 180  $\mu$  in diameter. It is bordered anteriorly by a row of a dozen small teeth and also posteriorly by a row of 12 to 15 small teeth borne on the inferior lip. The vulva is a large transverse slit located just back of the posterior end of the esophagus and a little lateral of the ventral line (fig. 217). The vagina passes posteriorly from this and is 1.3 mm. long and 260  $\mu$  thick. This bifurcates to form two convergent uteri, 150  $\mu$  long or longer, terminating in filiform ovaries. Eggs elliptical, with an inner thick shell 41  $\mu$  long and an outer thin shell 50  $\mu$  long. Eggs with well-developed embryo when oviposited. The cuticle bears from the head to the vulva two rows of 18 to 20 cuticular combs, finely striated, set close together, and not very prominent. One or more combs visible posterior of the vulva. (A row of widely spaced cuticular spines is probably present from the vulva to the posterior end of the body.) The thick conical tail is short and blunt



FIG. 216.—RICTULARIA CRISTATA. ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER FROELICH, 1802.

and terminates in a short, fine transparent point. The anus is  $400\ \mu$  from the tip of the tail.

*Hosts.*—*Apodemus sylvaticus* (*Mus sylvaticus*), *Glis glis* (*Myoxus glis*), *Dyromys nitedula* (*Myoxus nitedula*, *Myoxus dryas*), *Muscardinus axellanarius* (*Myoxus axellanarius*, *Myoxus muscardinus*).

*Location.*—Small intestine.

*Localities.*—Germany, France, Austria.

In a paper already cited (Hall, 1913) I have given the evidence indicating that *Rictularia cristata* conforms to the generic diagnosis in the possession of two rows of cuticular combs, instead of one row as given by Froelich and Dujardin. In the same paper I have noted that in species of *Rictularia* from rodents, contrary to the rule for species of this genus from carnivores, there is an abrupt transition from the elongate combs in the prevulvar region to the narrow spines in the post-vulvar region. In view of this fact, and of the expression by Dujardin of the fact that the combs themselves are not very prominent, it seems reasonably safe to assert that spines, although not so far described from the post-vulvar region, will be found present on adequate study.

I have noted above the wide range of measurements given by Dujardin for the length of this worm. Further study might show the presence of more than one species in so many host species and necessitate the designation of the typical *Rictularia cristata*.

RICTULARIA ELVIRAE Parona, 1889.

*Specific diagnosis.*—*Rictularia* (p. 168):

*Male* unknown.

*Female* 39 to 47 mm. long and 1.25 mm. thick. Two lateral alae are present in the cervical region. These are lobulate and each bears a cervical papilla a few millimeters posterior of the head (fig. 218).

On the anterior surface of the head are two short papillae  $45\ \mu$  in diameter. The mouth aperture (fig. 219) is provided with three projections on its dorsal border and three corresponding projections on its ventral border. There are two large round papilliform projections,  $14\ \mu$  in diameter, on the interior sides of the buccal capsule. The short esophagus is  $21\ \mu$  thick. The anus is near the tail. The



FIG. 217.—RICTULARIA CRISTATA. FEMALE. a, TWO-THIRDS NATURAL SIZE; b, ENLARGED. AFTER FROELICH, 1802.

tail terminates in a simple tip. There are the usual two series of cuticular spines extending from the head end to the anus. In the cervical region is a first series of 19 little spines (fig. 220). These spines are very small at first, then a little larger, and then small again. A second series of 32 pairs, spaced at distinct intervals, follows this after a short interval in which there are no spines; these increase in size posteriorly from the first, which is  $14\ \mu$  long, to the last pair. The twenty-fifth, which is one of the largest, is  $18\ \mu$  long; the distance between them increases gradually from the first to the last; there is a space of 1 mm. from the twenty-first and twenty-second pair, and

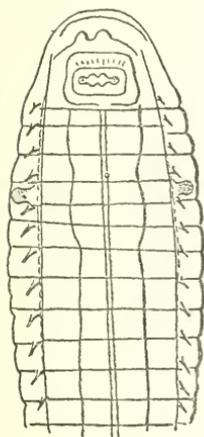


FIG. 218.—*RICTULARIA ELVIRAE*. ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER PARONA, 1889.

a space of 2 mm. from the twenty-ninth to the thirtieth; the last pair is 8.5 mm. from the tip of the tail. The eggs are 56 by  $28\ \mu$  in diameter and contain embryos when oviposited (fig. 221).  
*Host*.—*Dremomys rufigenis* (*Sciurus rufigenis*).  
*Location*.—Intestine.  
*Locality*.—Monte Mooleyit, Monti Dana, Texas-erim.

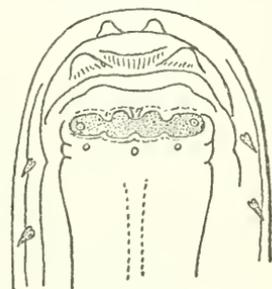


FIG. 219.—*RICTULARIA ELVIRAE*. ANTERIOR EXTREMITY, SHOWING MOUTH APERTURE. ENLARGED. AFTER PARONA, 1889.

I do not find Parona's description entirely clear. Jägerskiöld (1909) has examined Parona's types of this species and finds it a good species of unusual thickness. He states that there are 26 combs and 32 spines.

*Host*.—*Dremomys rufigenis* (*Sciurus rufigenis*).

*Location*.—Intestine.

*Locality*.—Monte Mooleyit, Monti Dana, Texas-erim.

I do not find Parona's description entirely clear. Jägerskiöld (1909) has examined Parona's types of this species and finds it a good species of unusual thickness. He states that there are 26 combs and 32 spines.

*RICTULARIA FALLAX* Jägerskiöld, 1909.

*Synonymy*.—*Rictularia plagiostoma* (Wedl, 1862) Willemoes-Suhm, 1873, of Parona, 1898.

*Specific diagnosis*.—*Rictularia* (p. 168):

*Male* unknown.

*Female* 20 mm. long with a maximum thickness of  $750\ \mu$ . Esophagus 2.960 mm. long. Nerve ring (?)  $240\ \mu$  from the anterior end of body. Anus  $200\ \mu$  from posterior end of body (fig. 222). Vulva 3.44 mm. from the anterior end of the body, and behind the posterior end of the esophagus (fig. 223). Eggs 44 by  $27\ \mu$  in diameter. Each row



FIG. 220.—*RICTULARIA ELVIRAE*. ANTERIOR EXTREMITY OF FEMALE. ENLARGED AFTER PARONA, 1889.

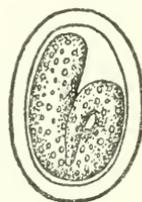


FIG. 221.—*RICTULARIA ELVIRAE*. EGG. ENLARGED. AFTER PARONA, 1889.

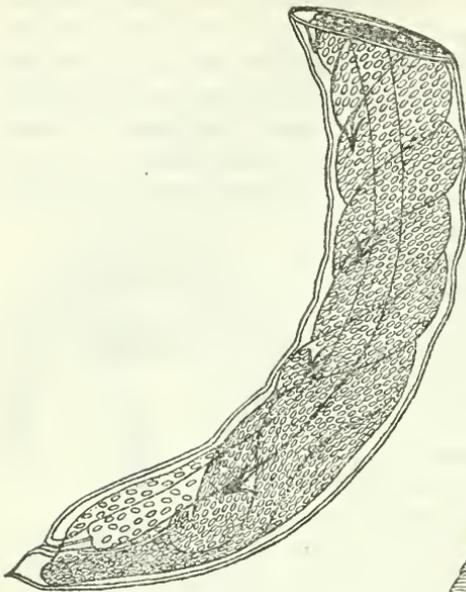


FIG. 222.—*RICTULARIA FALLAX*. POSTERIOR EXTREMITY OF FEMALE.  $\times 25$ . AFTER JÄGERSKIÖLD, 1909.

The first and largest spine is about  $150 \mu$  long.

*Host*.—*Sciurus melanogaster*.

*Location*.—Intestine.

*Locality*.—Mentawai, south of Sumatra.

This species, regarded by Parona (1898) as identical with *Rictularia plagiostoma*, has been examined by Jägerskiöld (1909) who finds it to be a new species. He gives a comparative study of *R. fallax* and *R. plagiostoma*. He states that the structure of the buccal capsule was not determined owing to the condition of material. Also he notes that the measurement for the nerve ring, given above, may be wrong owing to the opacity of the material and the difficulty of locating the nerve ring.

of euticular markings contains 50 combs and about 34 spines. The forty-second comb lies just anterior of the vulva. Posterior of the vulva are eight combs, followed by the sharper, narrower spines. The highest combs, from the sixteenth to the twenty-fourth pair, are about  $110 \mu$  high and  $110 \mu$  long. The combs lying nearest the vulva are longer,  $150 \mu$  long, but are not so high, being only  $50 \mu$  high.

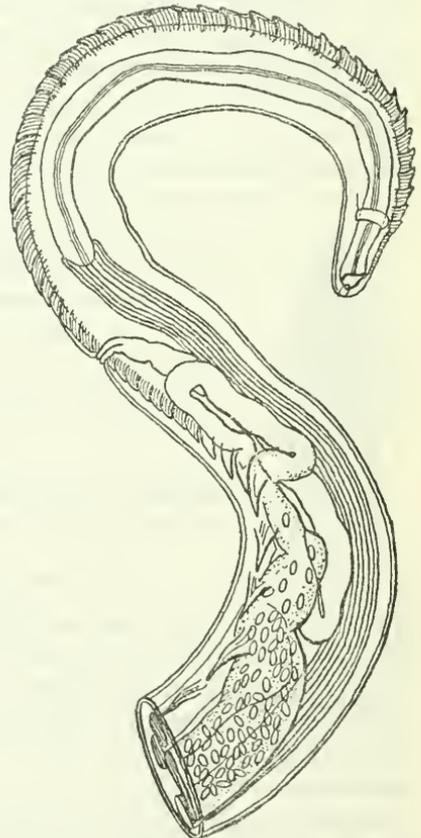


FIG. 223.—*RICTULARIA FALLAX*. ANTERIOR EXTREMITY OF FEMALE, LATERAL VIEW.  $\times 25$ . AFTER JÄGERSKIÖLD, 1909.

## RICTULARIA COLORADENSIS Hall, 1916, new species.

*Specific diagnosis.*—*Rictularia* (p. 168):

*Male* 3 mm. long with a maximum thickness of 250  $\mu$ . Dorsoventral head diameter at the base of the buccal capsule about 70  $\mu$ .

Esophagus 875  $\mu$  long. Nerve ring 100  $\mu$  from the anterior end of the body. The cuticle is transversely striate, forming annuli 7 to 16  $\mu$  wide. Striations are not visible posterior of the cloacal aperture. There are 42 pairs of combs (fig. 224), extending from the head almost to the cloacal aperture, the line of combs being continued posteriorly by a low cuticular ridge. The first comb anteriorly is 16  $\mu$ , distinctly less than its own length, posterior of the base of the buccal capsule. The maximum size is attained by the posterior combs which are about 75  $\mu$  long and 48  $\mu$  high. There are no mid-ventral fans in the posterior region, such as are observed in species of *Rictularia* from carnivores. There is no bursa. The cloacal aperture is sit-

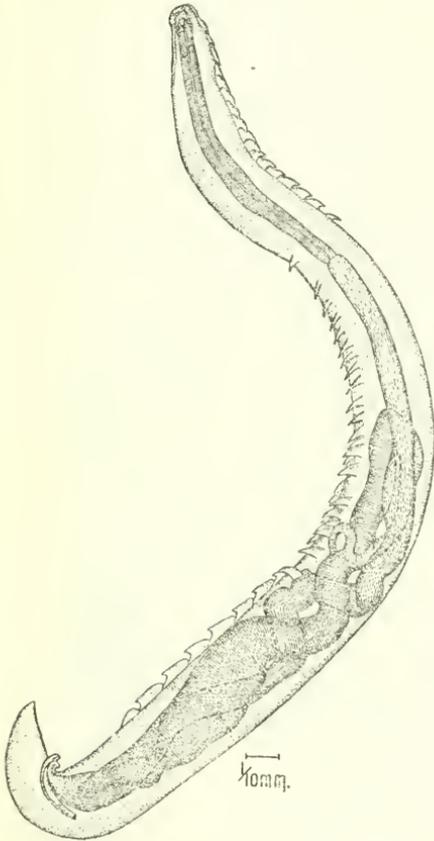


FIG. 224.—RICTULARIA COLORADENSIS. MALE.

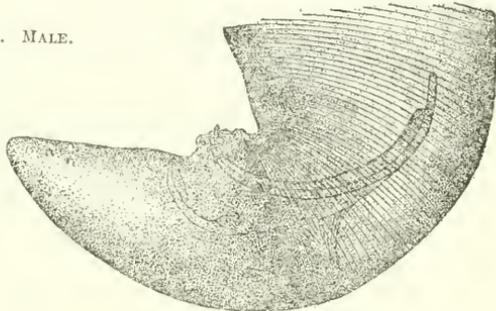


FIG. 225.—RICTULARIA COLORADENSIS. POSTERIOR EXTREMITY OF MALE. ENLARGED.

uated on an elevation and is 165  $\mu$  from the tip of the blunt, conical tail (fig. 225). There is a papilla in the median line on the anterior slope of the elevation bearing the cloacal aperture. Immediately anterior of this is a pair of papillae. Another papilla is in the median line on the posterior slope of the elevation bearing the cloacal aperture. Another pair is just posterior of this. Two more pairs are located

not far anterior of the tip of the tail. The spicules are unequal, slightly curved, the right one  $145\ \mu$  long and the left one  $180\ \mu$  long, measured in a straight line from tip to tip. The maximum thickness is 13 to  $16\ \mu$ . The mouth has the structure characteristic of the genus, but few details are visible in the specimen available.

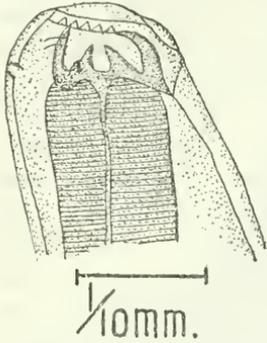


FIG. 226.—*RICTULARIA COLORADENSIS*. LATERO-DORSAL VIEW OF HEAD OF MALE.

Two large and prominent teeth, one dorsal and one ventral of the esophageal lumen, are visible in a latero-dorsal view of the head (fig. 226). These teeth are continuous with the other chitinous structures of the mouth capsule and are borne on the chitinous plate which makes up the base of the capsule and is itself a continuation of the walls of the capsule. There is apparently another tooth on each side of the large ventral tooth. The mouth aperture is surrounded by a corona radiata, a small circlet of denticles. Only the ventral head papillae are visible in the available specimen.

*Female*, estimated length about 9 to 10 mm., based on an incomplete specimen 8.463 mm. long with the posterior extremity missing. Maximum thickness  $360\ \mu$ . Thickness at vulva  $270\ \mu$ . Head  $120\ \mu$  in diameter at the base of the buccal capsule. Esophagus 1.5 mm. long. Nerve ring  $250\ \mu$  from the anterior end of the body. Vulva opposite posterior end of esophagus and therefore 1.5 mm. from anterior end of body; between the thirty-first and thirty-second comb (fig. 227). The transition from combs to spines is fairly distinct, but by no means abrupt. There are three combs posterior of the vulva, making a total of 34 combs. The post-vulvar combs are of a transitional type, combining the length of a comb with the sharp point of a spine. The anterior end of the first comb in the head region extends anterior of the base of the buccal capsule. There are 30 spines of a fairly uniform type following the combs, but as the specimen is incomplete posteriorly this does not represent the total number present in this species. The combs attain a maximum height of about  $42\ \mu$ . The

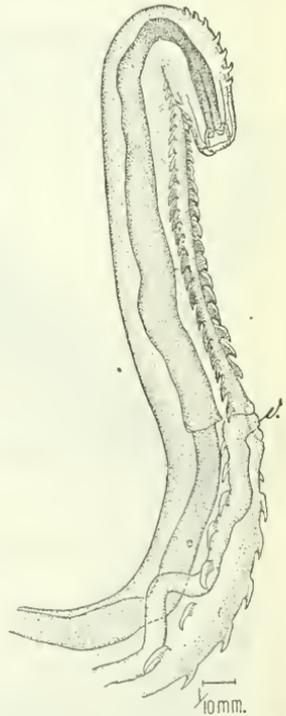


FIG. 227.—*RICTULARIA COLORADENSIS*. ANTERIOR EXTREMITY OF FEMALE. *v.*, VULVA.

spines attain a maximum length of about 75  $\mu$  from the anterior portion of the base to the end of the posteriorly directed tip. The transverse cuticular striations are 5 to 11  $\mu$  wide over most of the body, but on the outside of a curve they may be extended to 30  $\mu$  or more. The eggs are about 38 by 22  $\mu$  in diameter and contain a well-developed embryo when oviposited. There are two chitinous cutting plates borne on the base of the buccal capsule and situated one on each side of the esophageal opening (fig. 228). The lateral and dorsal head papillae are visible in the available specimen, but the ventral are not.

*Host.*—*Eutamias quadricittatus*.

*Locution.*—Small intestine (male) and stomach (female).

*Locality.*—Pagosa Springs, Colorado.

*Type-specimens.*—No. 16569, U. S. N. M. (Bureau of Animal Industry helminthological collection).

I am indebted for this material, as for other material acknowledged elsewhere, to the courtesy of Mr. E. R. Warren, of Colorado Springs, who turned over to me the host material, preserved in alcohol, from which the worms were collected.

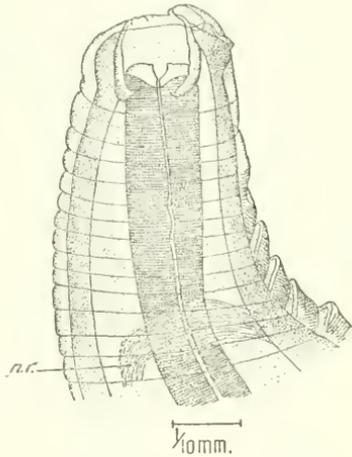


FIG. 228.—*RICTULARIA COLORADENSIS*. ANTERIOR EXTREMITY OF FEMALE. *n. r.*, NERVE RING.

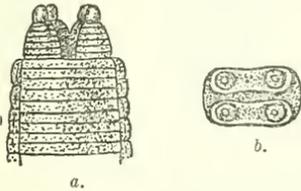


FIG. 229.—*RICTULARIOIDES AMPHIACANTHUM*. HEAD OF FEMALE. *a*, LATERAL VIEW; *b*, VIEW FROM THE FRONT. ENLARGED. AFTER DIESING, 1857.

*Generic diagnosis.*—Rictulariinae (p. 168): Head with four projecting apices united by chitinous membranes to form two equal lips (fig. 229). Female with three series of simple, posteriorly directed hooks along the body. Male unknown.

*Type-species.*—*Rictularioides amphiacanthum* (Diesing, 1851) Hall, 1916.

*RICTULARIOIDES* Hall,  
1916, new genus.

*Synonym.*—*Rictularia* Froelich, 1802, of authors, part; *Ophiostomum* Creplin, 1839, part.

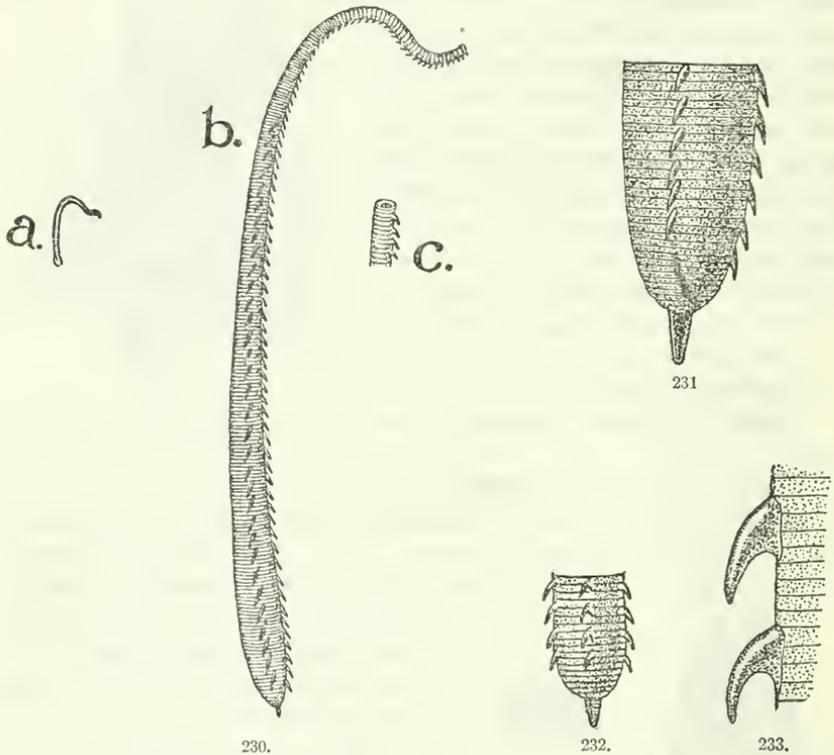
*RICTULARIOIDES AMPHIACANTHUM* (Diesing, 1851) Hall, 1916.

*Synonyms.*—*Ophiostomum amphiacanthum* Diesing, 1851; *Rictularia amphiacanthum* (Diesing, 1851) von Drasche, 1882.

*Specific diagnosis.*—*Rictularioides* (p. 175):

*Male* unknown.

*Female* 8 to 11.5 mm. long and 1 mm. thick. Body attenuate anteriorly and very much thicker posteriorly (fig. 230). The posterior extremity of the body terminates in a long, rounded, mucronate tip



FIGS. 230-233.—*RICTULARIOIDES AMPHACANTHUM*. 230, FEMALE. *a*, NATURAL SIZE; *b*, ENLARGED; *c*, PORTION OF BODY. AFTER DIESING, 1857. 231, POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER DIESING, 1857. 232, POSTERIOR EXTREMITY OF FEMALE, SHOWING 3 ROWS OF SPINES. ENLARGED AFTER DIESING, 1857. 233, PROFILE VIEW OF CUTICULAR SPINES. ENLARGED. AFTER DIESING, 1857.

(fig. 231). The cuticle bears three longitudinal series (fig. 232) of strong, posteriorly directed hooks (fig. 233).

*Host*.—*Oxymycterus rufus* (*Lemmus dasytrichus*).

*Location*.—Small intestine.

*Locality*.—Ytararé, Brazil.

Jägerskiöld (1909) has noted that if Diesing's descriptions and figures are correct, this species can not remain in the genus *Rictularia*. In view of the fact that Diesing (1857) has revised his description to cover the presence of three rows of hooks instead of two, and in view of the fact that von Drasche (1882) has examined the specimens and found no changes in the description necessary, it seems de-

*Type-species.*—*Heligmosomoides linstowi* Hall, 1916.

I am not sure that my interpretation of von Linstow's figures of the bursa is correct. The figures present some peculiarities.

HELIGMOSOMOIDES LINSTOWI Hall, 1916, new name.

*Synonym.*—*Strongylus polygyrus* Dujardin, 1845, of von Linstow, 1878*b* and 1879*a*.

*Specific diagnosis.*—*Heligmosomoides* (p. 160): Worm, reddish, spirally coiled. Mouth aperture triangular with four circumoral papillae. Cuticle dilated about head and with 16 longitudinal striations, in part wavy, along body. Transverse striations present and spaced at about the same interval as the longitudinal.

*Male* 4 mm. long and 78  $\mu$  thick. The bursa structure is that given in the generic diagnosis. The spicules are 540  $\mu$  long.

*Female* 7.2 mm. long and 96  $\mu$  thick. The anus is 98  $\mu$  from the tip of the tail, the tail ending in a fine terminal point 16  $\mu$  long. The vulva is anterior, 240  $\mu$  from the anterior end. The vagina is 720  $\mu$  long and is directed posteriorly (presumably). It joins an ovijector 180  $\mu$  long (fig. 207). At the anterior end of this is a spherical body.

Anterior of the latter is a muscular uterus 180  $\mu$  long and anterior of this is the ovary. The eggs are 75 by 43  $\mu$  in diameter.

*Life history.*—In eggs placed in moist earth embryos (fig. 208) develop in eight days. The embryo is 310  $\mu$  long and 23  $\mu$  thick. The mouth has two conical projections and the tail is awl-shaped. The esophagus is 1/2.4 and the tail 1/4.7 of the total body length.

*Host.*—*Microtus arvalis* (*Arvicola campestris*).

*Location.*—Intestine, partly in saclike depressions apparently caused by the worm.

*Locality.*—Germany.

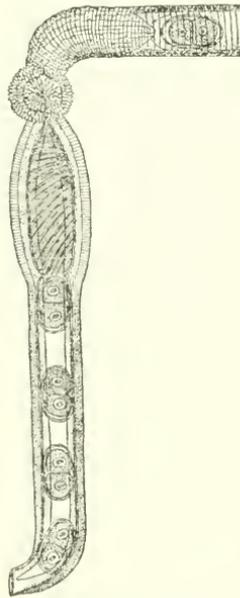


FIG. 207.—HELIGMOSOMOIDES LINSTOWI VAGINA AND OVIJECTOR. ENLARGED. AFTER VON LINSTOW, 1882.

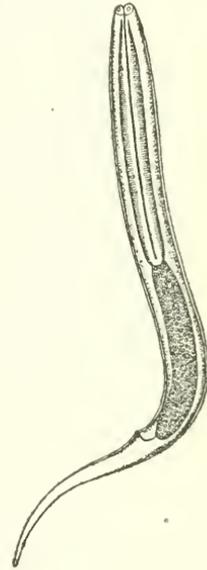


FIG. 208.—HELIGMOSOMOIDES LINSTOWI. EMBRYO. ENLARGED. AFTER VON LINSTOW, 1882.

This species is described by von Linstow (1878*b* and 1879*a*) as *Strongylus polygyrus* Dujardin, but unless the figures of other species are misleading in conveying the idea that there is one branching dorsal ray, or unless von Linstow has erred in figuring his material as having two dorsal rays and in stating that the vulva is anterior, we are bound to conclude that von Linstow's species is not even congeneric with Dujardin's. On the available evidence, I have regarded his species as new and erected a new genus for it. His terminology in regard to the female genitalia is not in accordance with present-day terminology and I have altered it accordingly in the above diagnosis. He also makes the statement that the spherical body anterior of the uterus is composed of unicellular glands which empty their secretion into the lumen. While this may be correct, it might also be noted that a somewhat spherical muscular structure is a common feature of the ends of the ovijectors.

#### Family METASTRONGYLIDAE Leiper, 1908.

*Family diagnosis.*—Strongyloidea (p. 106): Polymyarian. Buccal capsule present or absent. Bursa present or absent; when present, frequently atypical in structure and number of rays. Oviparous, with eggs in variable stages of segmentation when oviposited, or viviparous. Embryo not rhabditiform. Usually in respiratory and circulatory systems, rarely in digestive system.

*Type-genus.*—*Metastrongylus* Molin, 1861*a*.

#### ANALYTICAL KEY TO SUBFAMILIES OF METASTRONGYLIDAE.

1. Buccal capsule absent.....Metastrongylinae, p. 162.
- Buccal capsule present.....2.
2. Bursa much reduced or lacking; when present, with few and atypical rays.
- Two ovaries.....Rictularinae, p. 168.
- Bursa well developed, with typical rays. One ovary.....Ollulaninae, p. 177.

#### Subfamily METASTRONGYLINAE Leiper, 1908.

*Subfamily diagnosis.*—Metastrongylidae (p. 162): Buccal capsule absent. Male with two equal spicules and female with two ovaries. Eggs in varying stages of development when oviposited. Embryo not rhabditiform. Parasitic in the respiratory and circulatory systems.

*Type-genus.*—*Metastrongylus* Molin, 1861*a*.

The life history in this group is not as yet very well ascertained. Romanovitch and Slavine (1914) state that when eggs of *Dictyocaulus filaria* are placed in water, embryos form, two ecdyses follow, the cuticle being retained, and that such encapsuled larvae produce

infection with the adult worm when fed to sheep. This points to a direct development without intermediate host for the worms in this group. The fact that lungworms have been found in newborn animals and in the fetus, suggests that the life history is not entirely a simple one.

Genus *SYNTHETOCAULUS* Railliet and Henry, 1907.

*Synonym*.—*Strongylus* Mueller, 1780, part, of authors.

*Generic diagnosis*.—*Metastrongylineae* (p. 162): Body capillary. Mouth with three lips. Posterior extremity of the body of the male reinforced by a chitinous arc. Bursa with the ventro-ventral and latero-ventral rays close together and parallel, and with the medio-lateral and postero-lateral rays close together and parallel. The dorsal rays are united in a thick trunk of quite disproportionate size. Two punctate, striate, or pectinate spicules, slightly bent. Between the spicules and at some distance anterior of the bursa is an unpaired chitinous accessory structure forming an angle open to the rear. In the bursa region are two paired chitinous accessory structures, elongate and approximately parallel. Vulva a little in front of the anus. Uteri convergent. Eggs without a trace of segmentation when oviposited. Embryo with a tail prolonged by an undulate appendix.

*Type-species*.—*Synthetocaulus pulmonalis* (Froelich, 1802) Hall, 1916.

ANALYTICAL KEY TO SPECIES OF SYNTHETOCAULUS.

1. Parallel accessory organs of male 33  $\mu$  long—*Synthetocaulus pulmonalis*, p. 163.  
Parallel accessory organs of male 50  $\mu$  long—*Synthetocaulus rufescens*, p. 166.

SYNTHETOCAULUS PULMONALIS (Froelich, 1802) Hall, 1916.

*Synonyms*.—*Filaria pulmonalis* Froelich, 1802; *Strongylus retortaeformis major* Rudolphi, 1819; *Filaria leporis pulmonalis* Rudolphi, 1819; *Capillaria pulmonalis* Rudolphi, 1819; *Strongylus commutatus* Diesing, 1851; *Filaria leporis pulmonalis* Froelich, 1802, of Diesing, 1851; *Trichosomum leporis* Dujardin, 1845, of Diesing, 1851; *Trichosomum leporis (pulmonale)* Diesing of Diesing, 1851; *Filaria terminalis* Passerini, 1884; *Synthetocaulus commutatus* (Diesing, 1851) Railliet and Henry, 1907.

*Specific diagnosis*.—*Synthetocaulus* (p. 163): Body filiform. Anterior extremity attenuated and head obtuse. Mouth with three lips and with six very small circumoral papillae. The slender esophagus is slightly dilated posteriorly. The intestine is dark brown and is lined with polygonal cells. The excretory pore opens just behind the posterior end of the esophagus (fig. 209).

*Male* 18 to 33 mm. long and 100  $\mu$  thick. The esophagus is 665  $\mu$  long. The small bursa is short and rounded and only very slightly incised dorsally (fig. 210). It is nearly transparent and readily overlooked. The arrangement of the bursal rays is that given in the generic diagnosis. The dorsal ray is 8 to 14  $\mu$  (?) thick and has a slight depression on its posterior border. The spicules are 160 to 170  $\mu$  long. They are flat, somewhat bent chitinous rods, somewhat broadened at

both ends, and the body of the spicules is marked with a distinct marbling (fig. 211). They are provided with chitinous lateral lamellae in which are chitinous rods, some simple and some distally bifurcate, set at right angles to the longitudinal axis of the spicule. The rods are thicker in the proximal portion of the spicule and always end bluntly. In the distal portion of the spicule the lamellae become wider and the rods in them become thinner, so that on the distal end they are only appreciable on the extruded spicule as very fine lines on the thin lateral lamellae. The lamellae are directed toward one another distally, but curve gradually around the spicule proximally. A long retractor muscle inserts in the proximal swelling of the spicule and proceeds anteriorly to its origin in the cuticle of the lateral body wall, while a more complex muscle serves for the

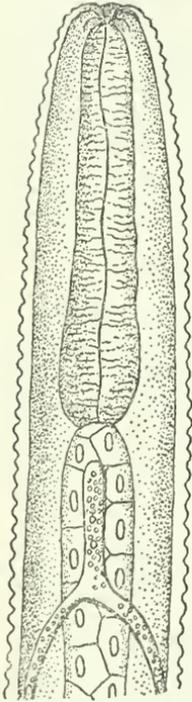


FIG. 209.—SYNTHETOCAULUS PULMONALIS. ANTERIOR EXTREMITY. ENLARGED. AFTER PASSERINI, 1884.

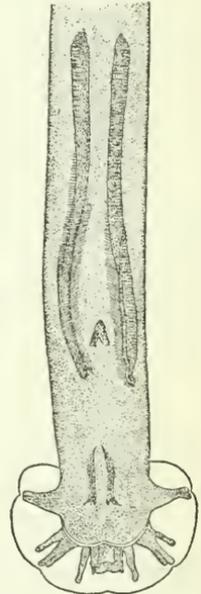


FIG. 210.—SYNTHETOCAULUS PULMONALIS. POSTERIOR EXTREMITY OF MALE.  $\times 150$ . AFTER RAILLIET, 1893.

extrusion of the spicule. With the spicules retracted, the unpaired accessory structure lies between them in their distal portion. In its general outline this structure is chevron-shaped, with the point of the chevron directed anteriorly, and consists of six to eight sickle-shaped chitinous structures projecting from a center and toothed on the inner concave side. It is a fixed structure and occupies the same position in the body regardless of whether the spicules are extruded or retracted. The paired accessory structures are located in the bursal region and are approximately parallel structures 33  $\mu$  long.

These structures consist of a broad, slightly bent stem, terminating posteriorly in a small, thick end plate. They curve postero-ventrally and are apparently homologous with the single accessory piece of other nematodes. The body terminates posteriorly in a chitinous ring which consists of two arcs, convex postero-laterally, and meeting at an angle in a depression in the mid-dorsal line.

*Female* 28 to 58 mm. long and 135 to 154  $\mu$  thick. The tail subconical and bluntly pointed. The anus is very close to the tip of the tail (fig.

212). The vulva is just anterior of the anus and is 200 to 260  $\mu$  (?) from the tip of the tail. The vagina is 2 to 2.4 mm. (?) long. There are two convergent uteri. Eggs are elliptical, very thin shelled, and 92 to 118  $\mu$  long and 62 to 81  $\mu$  thick. They show no trace of segmentation at oviposition. The embryo has a tail prolonged by an undulate appendix.

*Host*.—*Lepus europaeus* (*Lepus timidus*).

*Location*.—Bronchi, bronchioles, and pulmonary parenchyma.

*Localities*.—France, Germany, Austria, Italy.

Following the views of most other writers, the various species of worms from the lungs of *Lepus timidus* in Europe, described as strongyles, trichosomes, or filariae, have been regarded here as *Syntheticocaulus pulmonalis*. *Oryctolagus cuniculus* (*Lepus cuniculus*) has been omitted as a host, following the view expressed by Neveu-Lemaire (1912) that the occasional cases of verminous pneumonia in the domesticated rabbit were due to *Syntheticocaulus rufescens*. I have accepted this view on his authority, but in the absence of any material it is impossible for me to pass on it one way or another.

*Syntheticocaulus pulmonalis* has received considerable study and is in need of more. Mueller (1889) and Passerini (1884) have made very interesting studies. The measurements given by Mueller and accepted as correct by Doctor (1907) are somewhat puzzling. They are expressed in terms of the symbol ( ' ' ) commonly used to denote

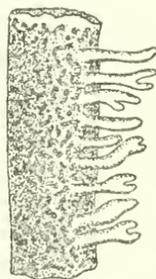


FIG. 211.—SYNTHETOCAULUS PULMONALIS. PART OF SPICULE. GREATLY ENLARGED. AFTER PASSERINI, 1884.

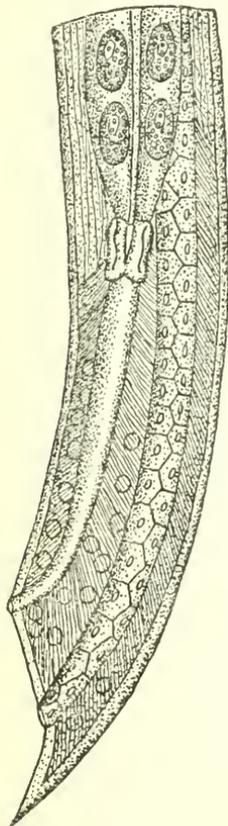


FIG. 212.—SYNTHETOCAULUS PULMONALIS. POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER PASSERINI, 1884.

"lines," a line being equal to one-twelfth of an inch. If converted into metric measurements on this bases, the measurements are so obviously multiples of those given by other writers that this can not be correct. Assuming that the symbols are intended to denote millimeters, they still give figures in excess of those given by other writers, suggesting that there was a fixed error in his scale of measurements or that other writers are in error in their measurements. Where the measurements given by Mueller are cited above, they are queried. For the sake of completeness they are given in full here:

*Male* 30 to 40 ''' long and 0.12 to 0.18 ''' thick. Length of esophagus 0.32 ''' . Bursa 0.1 to 0.14 ''' wide. Dorsal ray 0.004 to 0.007 ''' broad, or 0.036 ''' with its border. Spicules 0.17 to 0.18 ''' long. Paired accessory structures 0.042 to 0.05 ''' long.

*Female* 70 ''' long and 0.16 to 0.2 ''' thick. Vagina 1 to 1.2 ''' long and 0.2 to 0.26 ''' from the tip of the tail. Eggs 0.09 to 0.1 ''' long and 0.06 to 0.08 ''' thick.

Doctor (1907) has made a study of the clinical and pathological aspects of infestation with this worm. He finds the initial stages characterized by bronchitis and peribronchitis. Secondly there occurs bronchiectasis, collapse of the alveolar groups, and atelectasis. The changes follow a pneumonic process which is different from others in that it is characterized by extended epithelial desquamation and a diffuse, progressive course, from which it may be known as a desquamative pneumonia. This may heal by a regeneration of the denuded epithelium accompanied by hyperemia. If the worm invasion was massive, or if weak respiration or absence of expectoration hinders the elimination of the exudate due to the parasite, there follows a tissue necrosis by progressive caseation, which may show as a caseous bronchitis and caseous pneumonia. This may determine extensive destruction of lung tissue or induration.

**SYNTHETOCAULUS RUFESCENS (Leuckart, 1865a) Railliet and Henry, 1907a.**

*Synonyms.*—*Nematoideum ovis (pulmonale)* Diesing, 1851; *Strongylus rufescens* Leuckart, 1865; *Strongylus minutissimus* Ménégin, 1878; *Pseudalius ovis pulmonalis* A. Koch, 1883; *Strongylus ovis pulmonalis* Diesing of Curtice, 1890; *Metastrongylus minutissimus* (Ménégin, 1878) Sluiter and Swellengrebel, 1912.

*Specific diagnosis.*—*Synthetocaulus* (p. 163): Body filiform, with a characteristic reddish-brown tint due to the coloring of the alimentary tract. Mouth with three small lips and with four circumoral papillae. No cervical alae.

*Male* 16 to 28 mm. long and 500  $\mu$  thick. The simple esophagus enlarges slightly posteriorly. The bursa is small, excised anteriorly and with two small indentations on each side (fig. 213). The spicules are 110 to 310  $\mu$  long, and are cylindrical in the anterior half and

flattened in the posterior half (fig. 214). A chitinous lamella extends along the entire spicule and the posterior half of the spicule is scalloped along its median border to form a pectinate edge. The chitinous lamellae of the posterior half of the spicules are bent around to form a tubular structure. The paired accessory structures are 50 to 52  $\mu$  long, slightly recurved at their distal extremity and presenting three or four teeth on the convexity of the curve.

*Female* 25 to 35 mm. long and 170  $\mu$  thick. The

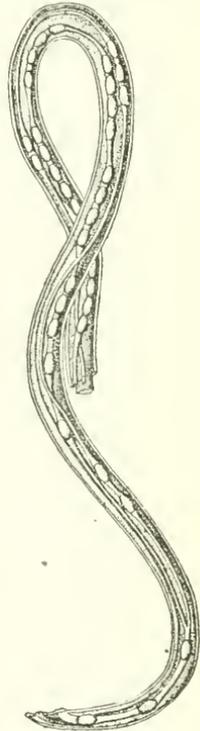


FIG. 215.—SYNTHETOCAULUS RUFESCENS. POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER CURTICE, 1890.

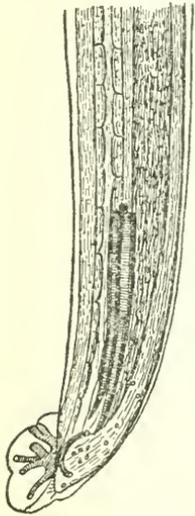


FIG. 213.—SYNTHETOCAULUS RUFESCENS. POSTERIOR EXTREMITY OF MALE.  $\times 100$ . AFTER RAILLIET, 1893.

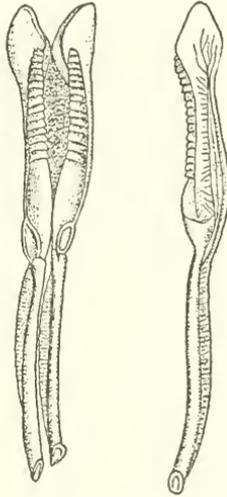


FIG. 214.—SYNTHETOCAULUS RUFESCENS. SPICULES. ENLARGED. AFTER CURTICE, 1890.

tail is subconical and ends in a blunt point (fig. 215). The anus is 80  $\mu$  from the tip of the tail. The vulva is just anterior of the anus and is 100  $\mu$  from the tip of the tail. The vagina proceeds anteriorly from the vulva and divides to form the convergent uteri. The eggs are ellipsoidal, 75 to 120  $\mu$  long and 40 to 85  $\mu$  thick, with no trace of segmentation when oviposited.

*Host.*—*Oryctolagus cuniculus* (*Lepus cuniculus*). (Commonly in ungulates.)

*Location.*—Bronchioles and pulmonary parenchyma.

*Locality.*—Europe.

As noted in comment on the foregoing species, I have followed Neveu-Lemaire in accepting records of lung worm from *Lepus cuniculus* as *Syn. rufescens*.

## Subfamily RICTULARIINAE Hall, 1913.

*Synonym.*—Riticularinae Travassos, 1914*b*.

*Subfamily diagnosis.*—Metastrongylidae (p. 162): Bursa much reduced or lacking; when present, with few and atypical rays. Mouth with well-developed buccal capsule. Prominent cuticular ornamentation along entire body. Oviparous. Parasites of the digestive tract.

*Type-genus.*—*Rictularia* Froelich, 1802.

In the published diagnosis of this subfamily (Hall, 1913) I referred to it as ovoviviparous, using the word in the not uncommon sense as meaning the oviposition of eggs containing well-developed embryos. This use of the word seems hardly accurate, ovoviviparous referring more properly to the production of an embryo within a shell and the hatching of the embryo within the maternal uterus.

In the paper noted above, I stated that *Rictularia* did not have the normal strongyle bursa and that the elaborate cuticular ornamentation and the fact that the eggs contained a developed embryo when oviposited are atypical conditions among the strongyles. I stated, however, that the buccal capsule which related *Rictularia* to the strongyles excluded it from any other group. Seurat (1915*f*) has recently published the view that the buccal capsule here is not indicative of any real relationship but is merely the result of convergence due to a similar mode of life, and that the structure of the esophagus, the position of the post-cervical papillae and the excretory pore, the conformation of the ovijector, the form of the eggs, and the disposition of the genital papillae present manifest affinities with *Physaloptera* and related forms. While Seurat's suggestion merits serious consideration, the present writer does not feel in a position to pass on the relationship at this time and prefers to leave these forms with the Metastrongylidae.

## ANALYTICAL KEY TO GENERA OF RICTULARIINAE.

1. Cuticle ornamented with 2 longitudinal rows of spines.....*Rictularia*, p. 168.
- Cuticle ornamented with 3 longitudinal rows of spines...*Rictularioides*, p. 175.

## Genus RICTULARIA Froelich, 1802.

*Synonyms.*—*Ophiostoma* Rudolphi, 1801; *Ophiostomum* Creplin, 1839; *Laphyctes* Dujardin, 1845; *Pterygodermatites* Wedl, 1861.

*Generic diagnosis.*—Rictulariinae (p. 168): Buccal capsule well developed and narrow, with its aperture more or less distinctly dorsal and surrounded by a circle of denticles, and with its base armed with teeth and spines. Along practically the entire ventral surface of each side there are two rows of cuticular combs or spines. Male with or without bursa; the bursa when present is always small and always remains open. Two small, equal or unequal spicules. Vulva

anterior, near the posterior end of the esophagus. Oviparous, the egg containing a well-developed embryo when oviposited. Parasitic in the small intestine as a rule.

*Type-species.*—*Rictularia cristata* Froelich, 1802.

ANALYTICAL KEY TO SPECIES OF RICTULARIA.

1. Female less than 15 mm. long; about 34 cuticular combs in each row from the head to the transition point near vulva—*Rictularia coloradensis*, p. 173.  
Female more than 15 mm. long; less than 30 or more than 40 combs in the row from the head to the transition point near vulva..... 2.
2. Female with 50 combs from head to transition point—*Rictularia fallax*, p. 171.  
Female with not over 20 combs from head to transition point..... 3.
3. Female with 2 cervical alae with small spines on edges.  
*Rictularia elvirae*, p. 170.  
Female without cervical alae.....*Rictularia cristata*, p. 169.

No male of the above species is known except that of *R. coloradensis*. See Addendum for *Rictularia proni* Seurat, 1915.

RICTULARIA CRISTATA Froelich, 1802.

*Synonyms.*—*Ophiostoma cristatum* (Froelich, 1802) Rudolphi, 1819; *Ophiostomum cristatum* (Froelich, 1802) Diesing, 1851.

*Specific diagnosis.*—*Rictularia* (p. 168):

*Male* unknown.

*Female* 22 to 27 mm. long (Dujardin gives this as 16 to 66 mm. long and 400  $\mu$  to 1.32 mm. thick). Red when freshly collected. Head 280  $\mu$  in diameter. Esophagus simple, 4.3 mm. long and 300  $\mu$  thick. The head (fig. 216) terminates in a thick lip, rounded in the form of a helmet, and bears several small papillae. The mouth aperture is transverse, reniform, or semi-circular, and is 180  $\mu$  in diameter. It is bordered anteriorly by a row of a dozen small teeth and also posteriorly by a row of 12 to 15 small teeth borne on the inferior lip. The vulva is a large transverse slit located just back of the posterior end of the esophagus and a little lateral of the ventral line (fig. 217). The vagina passes posteriorly from this and is 1.3 mm. long and 260  $\mu$  thick. This bifurcates to form two convergent uteri, 150  $\mu$  long or longer, terminating in filiform ovaries. Eggs elliptical, with an inner thick shell 41  $\mu$  long and an outer thin shell 50  $\mu$  long. Eggs with well-developed embryo when oviposited. The cuticle bears from the head to the vulva two rows of 18 to 20 cuticular combs, finely striated, set close together, and not very prominent. One or more combs visible posterior of the vulva. (A row of widely spaced cuticular spines is probably present from the vulva to the posterior end of the body.) The thick conical tail is short and blunt



FIG. 216.—RICTULARIA CRISTATA. ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER FROELICH, 1802.

and terminates in a short, fine transparent point. The anus is  $400\ \mu$  from the tip of the tail.

*Hosts*.—*Apodemus sylvaticus* (*Mus sylvaticus*), *Glis glis* (*Myoxus glis*), *Dyromys nitedula* (*Myoxus nitedula*, *Myoxus dryas*), *Muscardinus avellanarius* (*Myoxus avellanarius*, *Myoxus muscardinus*).

*Location*.—Small intestine.

*Localities*.—Germany, France, Austria.

In a paper already cited (Hall, 1913) I have given the evidence indicating that *Rictularia cristata* conforms to the generic diagnosis in the possession of two rows of cuticular combs, instead of one row as given by Froelich and Dujardin. In the same paper I have noted that in species of *Rictularia* from rodents, contrary to the rule for species of this genus from carnivores, there is an abrupt transition from the elongate combs in the prevulvar region to the narrow spines in the postvulvar region. In view of this fact, and of the expression by Dujardin of the fact that the combs themselves are not very prominent, it seems reasonably safe to assert that spines, although not so far described from the post-vulvar region, will be found present on adequate study.

I have noted above the wide range of measurements given by Dujardin for the length of this worm. Further study might show the presence of more than one species in so many host species and necessitate the designation of the typical *Rictularia cristata*.

RICTULARIA ELVIRAE Parona, 1889.

*Specific diagnosis*.—*Rictularia* (p. 168):

*Male* unknown.

*Female* 39 to 47 mm. long and 1.25 mm. thick.

Two lateral alae are present in the cervical region. These are lobulate and each bears a cervical papilla a few millimeters posterior of the head (fig. 218).

On the anterior surface of the head are two short papillae  $45\ \mu$  in diameter. The mouth aperture (fig. 219) is provided with three projections on its dorsal border and three corresponding projections on its ventral border. There are two large round papilliform projections,  $14\ \mu$  in diameter, on the interior sides of the buccal capsule. The short esophagus is  $21\ \mu$  thick. The anus is near the tail. The



FIG. 217.—RICTULARIA CRISTATA, FEMALE. a, TWO-THIRDS NATURAL SIZE; b, ENLARGED. AFTER FROELICH, 1802.

tail terminates in a simple tip. There are the usual two series of cuticular spines extending from the head end to the anus. In the cervical region is a first series of 19 little spines (fig. 220). These spines are very small at first, then a little larger, and then small again. A second series of 32 pairs, spaced at distinct intervals, follows this after a short interval in which there are no spines; these increase in size posteriorly from the first, which is  $14\ \mu$  long, to the last pair. The twenty-fifth, which is one of the largest, is  $18\ \mu$  long; the distance between them increases gradually from the first to the last; there is a space of 1 mm. from the twenty-first and twenty-second pair, and

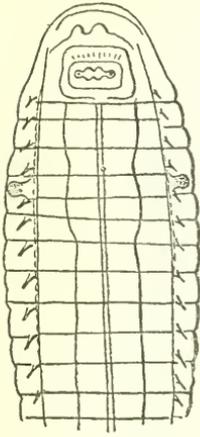


FIG. 218.—*RICTULARIA ELVIRAE*. ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER PARONA, 1889.

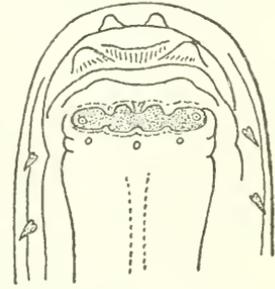


FIG. 219.—*RICTULARIA ELVIRAE*. ANTERIOR EXTREMITY, SHOWING MOUTH APERTURE. ENLARGED. AFTER PARONA, 1889.

a space of 2 mm. from the twenty-ninth to the thirtieth; the last pair is  $8.5\ \text{mm.}$  from the tip of the tail. The eggs are  $56$  by  $28\ \mu$  in diameter and contain embryos when oviposited (fig. 221).

*Host*.—*Dremomys rufigenis* (*Sciurus rufigenis*).

*Location*.—Intestine.

*Locality*.—Monte Mooleyit, Monti Dana, Texas-serim.

I do not find Parona's description entirely clear. Jägerskiöld (1909) has examined Parona's types of this species and finds it a good species of unusual thickness. He states that there are 26 combs and 32 spines.

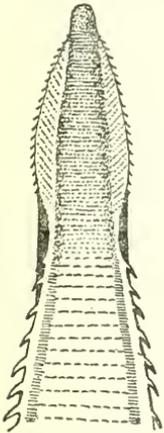


FIG. 220.—*RICTULARIA ELVIRAE*. ANTERIOR EXTREMITY OF FEMALE. ENLARGED AFTER PARONA, 1889.

*RICTULARIA FALLAX* Jägerskiöld, 1909.

*Synonym*.—*Rictularia plagiostoma* (Wedl, 1862) Willemoes-Suhm, 1873, of Parona, 1898.

*Specific diagnosis*.—*Rictularia* (*p.* 168):

*Male* unknown.

*Female* 20 mm. long with a maximum thickness of  $750\ \mu$ . Esophagus  $2.960\ \text{mm.}$  long. Nerve ring (?)  $240\ \mu$  from the anterior end of body. Anus  $200\ \mu$  from posterior end of body (fig. 222). Vulva  $3.44\ \text{mm.}$  from the anterior end of the body, and behind the posterior end of the esophagus (fig. 223). Eggs  $44$  by  $27\ \mu$  in diameter. Each row

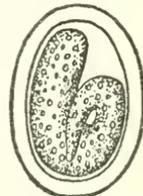


FIG. 221.—*RICTULARIA ELVIRAE*. EGG. ENLARGED. AFTER PARONA, 1889.

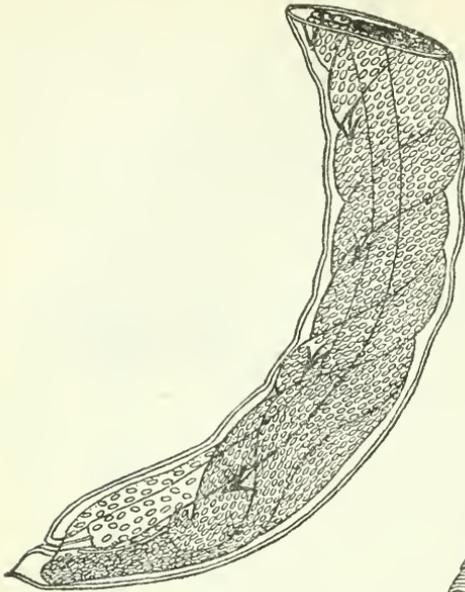


FIG. 222.—*RICTULARIA FALLAX*. POSTERIOR EXTREMITY OF FEMALE.  $\times 25$ . AFTER JÄGERSKIÖLD, 1909.

The first and largest spine is about  $150 \mu$  long.

*Host*.—*Sciurus melanogaster*.

*Location*.—Intestine.

*Locality*.—Mentawai, south of Sumatra.

This species, regarded by Parona (1898) as identical with *Rictularia plagiostruma*, has been examined by Jägerskiöld (1909) who finds it to be a new species. He gives a comparative study of *R. fallax* and *R. plagiostruma*. He states that the structure of the buccal capsule was not determined owing to the condition of material. Also he notes that the measurement for the nerve ring, given above, may be wrong owing to the opacity of the material and the difficulty of locating the nerve ring.

of cuticular markings contains 50 combs and about 34 spines. The forty-second comb lies just anterior of the vulva. Posterior of the vulva are eight combs, followed by the sharper, narrower spines. The highest combs, from the sixteenth to the twenty-fourth pair, are about  $110 \mu$  high and  $110 \mu$  long. The combs lying nearest the vulva are longer,  $150 \mu$  long, but are not so high, being only  $50 \mu$  high.

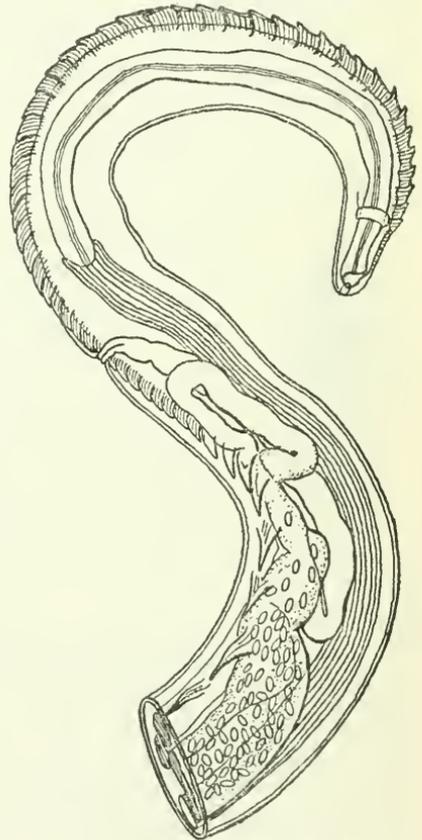


FIG. 223.—*RICTULARIA FALLAX*. ANTERIOR EXTREMITY OF FEMALE, LATERAL VIEW.  $\times 25$ . AFTER JÄGERSKIÖLD, 1909.

## RICTULARIA COLORADENSIS Hall, 1916, new species.

*Specific diagnosis.*—*Rictularia* (p. 168):

*Male* 3 mm. long with a maximum thickness of 250  $\mu$ . Dorso-ventral head diameter at the base of the buccal capsule about 70  $\mu$ .

Esophagus 875  $\mu$  long. Nerve ring 100  $\mu$  from the anterior end of the body. The cuticle is transversely striate, forming annuli 7 to 16  $\mu$  wide. Striations are not visible posterior of the cloacal aperture. There are 42 pairs of combs (fig. 224), extending from the head almost to the cloacal aperture, the line of combs being continued posteriorly by a low cuticular ridge. The first comb anteriorly is 16  $\mu$ , distinctly less than its own length, posterior of the base of the buccal capsule. The maximum size is attained by the posterior combs which are about 75  $\mu$  long and 48  $\mu$  high. There are no mid-ventral fans in the posterior region, such as are observed in species of *Rictularia* from carnivores. There is no bursa. The cloacal aperture is sit-

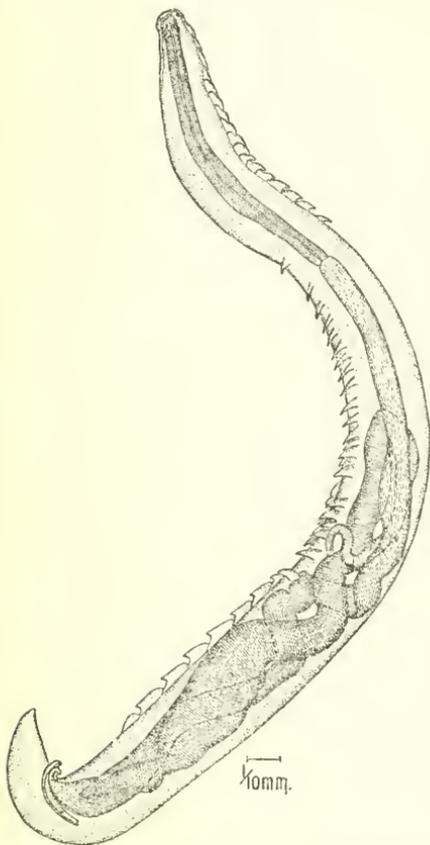


FIG. 224.—RICTULARIA COLORADENSIS. MALE.

uated on an elevation and is 165  $\mu$  from the tip of the blunt, conical tail (fig. 225). There is a papilla in the median line on the anterior slope of the elevation bearing the cloacal aperture. Immediately anterior of this is a pair of papillae. Another papilla is in the median line on the posterior slope of the elevation bearing the cloacal aperture. Another pair is just posterior of this. Two more pairs are located

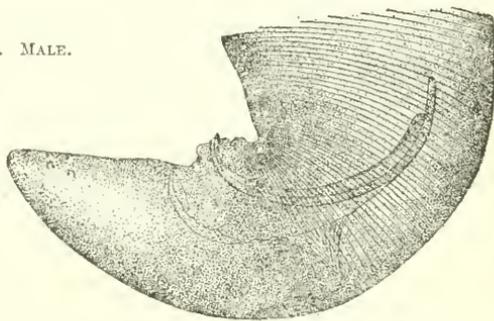


FIG. 225.—RICTULARIA COLORADENSIS. POSTERIOR EXTREMITY OF MALE. ENLARGED.

not far anterior of the tip of the tail. The spicules are unequal, slightly curved, the right one  $145\ \mu$  long and the left one  $180\ \mu$  long, measured in a straight line from tip to tip. The maximum thickness is 13 to  $16\ \mu$ . The mouth has the structure characteristic of the genus, but few details are visible in the specimen available.

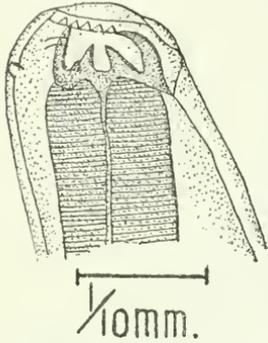


FIG. 226.—*RICTULARIA COLORADENSIS*. LATERO-DORSAL VIEW OF HEAD OF MALE.

Two large and prominent teeth, one dorsal and one ventral of the esophageal lumen, are visible in a latero-dorsal view of the head (fig. 226). These teeth are continuous with the other chitinous structures of the mouth capsule and are borne on the chitinous plate which makes up the base of the capsule and is itself a continuation of the walls of the capsule. There is apparently another tooth on each side of the large ventral tooth.

The mouth aperture is surrounded by a corona radiata, a small circlet of denticles. Only the ventral head papillae are visible in the available specimen.

*Female*, estimated length about 9 to 10 mm., based on an incomplete specimen 8.463 mm. long with the posterior extremity missing. Maximum thickness  $360\ \mu$ . Thickness at vulva  $270\ \mu$ . Head  $120\ \mu$  in diameter at the base of the buccal capsule. Esophagus 1.5 mm. long. Nerve ring  $250\ \mu$  from the anterior end of the body. Vulva opposite posterior end of esophagus and therefore 1.5 mm. from anterior end of body; between the thirty-first and thirty-second comb (fig. 227). The transition from combs to spines is fairly distinct, but by no means abrupt. There are three combs posterior of the vulva, making a total of 34 combs. The post-vulvar combs are of a transitional type, combining the length of a comb with the sharp point of a spine. The anterior end of the first comb in the head region extends anterior of the base of the buccal capsule. There are 30 spines of a fairly uniform type following the combs, but as the specimen is incomplete posteriorly this does not represent the total number present in this species. The combs attain a maximum height of about  $42\ \mu$ . The

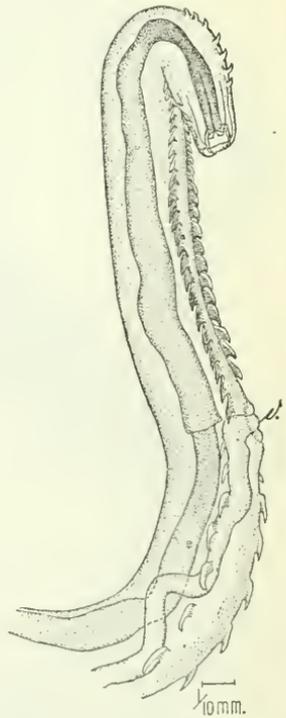


FIG. 227.—*RICTULARIA COLORADENSIS*. ANTERIOR EXTREMITY OF FEMALE. *v.*, VULVA.

spines attain a maximum length of about  $75 \mu$  from the anterior portion of the base to the end of the posteriorly directed tip. The transverse cuticular striations are  $5$  to  $11 \mu$  wide over most of the body, but on the outside of a curve they may be extended to  $30 \mu$  or more. The eggs are about  $38$  by  $22 \mu$  in diameter and contain a well-developed embryo when oviposited. There are two chitinous cutting plates borne on the base of the buccal capsule and situated one on each side of the esophageal opening (fig. 228). The lateral and dorsal head papillae are visible in the available specimen, but the ventral are not.

*Host*.—*Eutamias quadrivittatus*.

*Location*.—Small intestine (male) and stomach (female).

*Locality*.—Pagosa Springs, Colorado.

*Type-specimens*.—No. 16569, U. S. N. M. (Bureau of Animal Industry helminthological collection).

I am indebted for this material, as for other material acknowledged elsewhere, to the courtesy of Mr. E. R. Warren, of Colorado Springs, who turned over to me the host material, preserved in alcohol, from which the worms were collected.

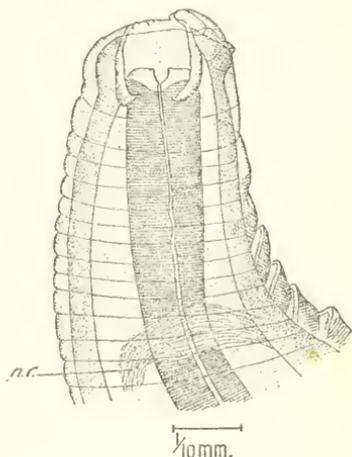


FIG. 223.—*RICTULARIA COLORADENSIS*. ANTERIOR EXTREMITY OF FEMALE. *n. r.*, NERVE RING.

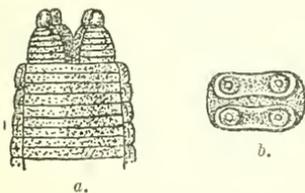


FIG. 229.—*RICTULARIOIDES AMPHIACANTHUM*. HEAD OF FEMALE. *a*, LATERAL VIEW; *b*, VIEW FROM THE FRONT. ENLARGED. AFTER DIESING, 1857.

*Generic diagnosis*.—Rictulariinae (p. 168): Head with four projecting apices united by chitinous membranes to form two equal lips (fig. 229). Female with three series of simple, posteriorly directed hooks along the body. Male unknown.

*Type-species*.—*Rictularioides amphiacanthum* (Diesing, 1851) Hall, 1916.

*RICTULARIOIDES* Hall,  
1916, new genus.

*Synonym*.—*Rictularia* Froelich, 1802, of authors. part; *Ophiostomum* Creplin, 1839, part.

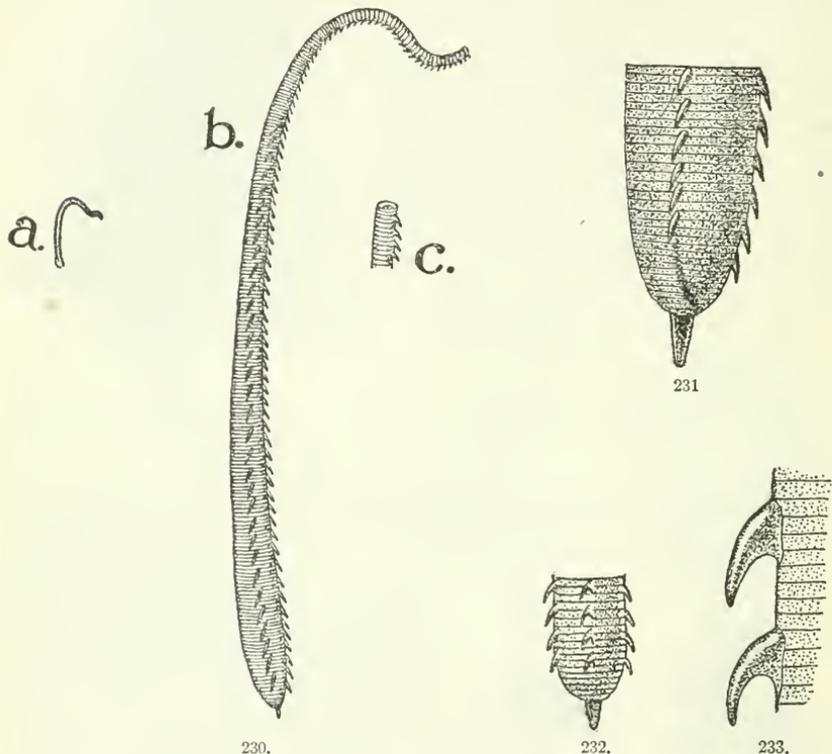
*RICTULARIOIDES AMPHIACANTHUM* (Diesing, 1851) Hall, 1916.

*Synonyms*.—*Ophiostomum amphiacanthum* Diesing, 1851; *Rictularia amphiacanthum* (Diesing, 1851) von Drasche, 1882.

*Specific diagnosis*.—*Rictularioides* (p. 175):

*Male* unknown.

*Female* 8 to 11.5 mm. long and 1 mm. thick. Body attenuate anteriorly and very much thicker posteriorly (fig. 230). The posterior extremity of the body terminates in a long, rounded, mucronate tip



FIGS. 230-233.—*RICTULARIOIDES AMPHICANTHUM*. 230, FEMALE. *a*, NATURAL SIZE; *b*, ENLARGED; *c*, PORTION OF BODY. AFTER DIESING, 1857. 231, POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER DIESING, 1857. 232, POSTERIOR EXTREMITY OF FEMALE, SHOWING 3 ROWS OF SPINES. ENLARGED AFTER DIESING, 1857. 233, PROFILE VIEW OF CUTICULAR SPINES. ENLARGED. AFTER DIESING, 1857.

(fig. 231). The cuticle bears three longitudinal series (fig. 232) of strong, posteriorly directed hooks (fig. 233).

*Host*.—*Oxymycterus rufus* (*Lemmus dasytrichus*).

*Location*.—Small intestine.

*Locality*.—Ytararé, Brazil.

Jägerskiöld (1909) has noted that if Diesing's descriptions and figures are correct, this species can not remain in the genus *Rictularia*. In view of the fact that Diesing (1857) has revised his description to cover the presence of three rows of hooks instead of two, and in view of the fact that von Drasche (1882) has examined the specimens and found no changes in the description necessary, it seems de-

sirable to separate this species from those properly assignable to the genus *Rictularia*.

OLLULANINAE Hall, 1916, new subfamily.

*Subfamily diagnosis*.—*Metastrongylidae* (p. 162): Buccal capsule well developed. Caudal bursa well developed, bilobed, and each lobe supported by six rays. Two short spicules. Vulva a short distance anterior of the anus. One ovary. Viviparous. Development with intermediate host.

*Type-genus*.—*Ollulanus* Leuckart, 1865.

Genus OLLULANUS Leuckart, 1865.

*Generic diagnosis*.—*Ollulaninae* (p. 177): Characters of the subfamily.

*Type-species*.—*Ollulanus tricuspis* Leuckart, 1865.

OLLULANUS TRICUSPIS Leuckart, 1865.

*Specific diagnosis*.—*Ollulanus* (p. 177): Small thick worms. Esophagus moderately muscular and of granular appearance.

*Male* with short, thick, almost straight spicules. Caudal bursa well developed, with two lateral lobes, each supported by six rays.

*Female* 1 mm. long. Posterior extremity terminates in three points. Vulva a short distance anterior of anus. One ovary. Viviparous. Embryos relatively large, 320  $\mu$  long and 15  $\mu$  thick, of almost uniform diameter throughout, but with the tail prolonged into a wavy appendix (fig. 234). The length of the esophagus in the embryo is equal to a half to a third of the total length of the animal.

*Host*.—*Mus musculus* (for larval worm). Adults in gastric mucosa of cat.

*Location*.—Musculature and connective tissue.

*Localities*.—Germany; Washington, District of Columbia.

*Life history*.—Of the embryos borne by the viviparous female, some are eliminated in the feces, while others emigrate from the intestine into the tissues of the host in a fashion similar to *Trichinella*. The latter form cysts 150 to 200  $\mu$  in diameter in the pleura,

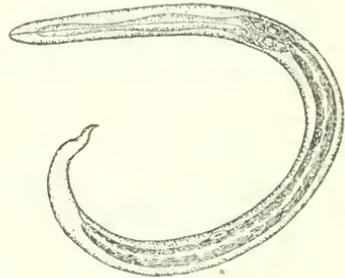


FIG. 234.—OLLULANUS TRICUSPIS. EMBRYO. ENLARGED. AFTER LEUCKART, 1876.

lungs, liver, and diaphragm, each cyst containing one or several embryos in its cavity. The presence of a number of these cysts gives the appearance of a miliary tuberculosis and causes a diffuse inflammation that may result in death. The bronchial mucus is bloody and usually contains a large number of motile embryos. The embryos do not grow in the cysts. They become opaque and granular, and finally decompose into an oval or rounded mass containing oily droplets. Obviously, then, the migration into the tissues of the primary host is an accidental matter. The embryos which escape

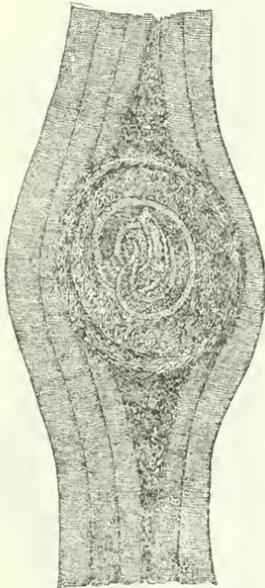


FIG. 235.—OLLULANUS TRICUSPIS. LARVAL FORMS IN MUSCLE OF MOUSE. ENLARGED. AFTER LEUCKART, 1876.

in the feces or in the bronchial mucus carry on the life cycle. Leuckart fed these to a mouse, and at the end of six weeks found the mouse infested with numerous cysts  $300\ \mu$  in diameter in the muscles of the trunk, esophagus, and heart and in the connective tissues of the cervical region (fig. 235). The cysts were round, and the worms had undergone some modifications. They were  $800\ \mu$  long and  $40\ \mu$  thick. The flesh of a mouse containing these cysts was fed to a cat, and at the end of eight days the worms were found in the cecum and colon, but not in the stomach, of the cat. They had not, however, undergone any modification, which would indicate that possibly they had not developed sufficiently previous to the feeding to be capable of infecting the primary host.

The adult worm in the cat often occurs in large numbers, causing severe inflammation and ecchymoses. The effect of the wanderings and presence of the embryos in the musculature must be very similar to that of *Trichinella*.

The fact that this worm has a single ovary and is viviparous distinguishes it from the members of such groups as the Strongyloinae, to which it might on casual inspection seem closely related.

#### Superfamily FILARIOIDEA Weinland, 1858.

*Superfamily diagnosis.*—Nematoda (p. 4): Body usually very long and slender. Mouth with two lips or without lips and surrounded by circumoral papillae. Esophagus slender, without posterior bulb. Anus subterminal. Male with a single spicule or with two unequal spicules. Tail provided with papillae, usually curved spirally, and with bursal alae present or absent. Female larger than

male. Vulva present or, less often, absent in gravid females; when present, usually anterior of the middle of the body or near the middle, rarely near posterior extremity. Two, four, or five uteri. Oviparous, ovoviviparous, or viviparous. Development in many cases, perhaps all cases, requires an intermediate host.

*Type-family*.—Filariidae Claus, 1885.

The name given here was proposed by Weinland as a family name, but it is in the form now used for the superfamily, and it was erected as a superfamily by Stiles (1907).

#### ANALYTICAL KEY TO FAMILIES OF FILARIOIDEA.

1. Mouth without lips; vulva near anterior extremity of body—Filariidae, p. 179.  
 Mouth with 2 lips; or mouth without lips in forms where vulva is near posterior extremity of body-----Spiruridae, p. 190.

#### Family FILARIIDAE Claus, 1885.

*Family diagnosis*.—Filarioidea (p. 178): Body long and filiform. Mouth without lips. Male with two spicules, usually quite dissimilar. Vulva near the anterior extremity of the body. Adults subcutaneous, in blood, or on serous surfaces.

*Type-genus*.—*Filaria* Mueller, 1787.

#### Subfamily FILARIINAE Stiles, 1907.

*Subfamily diagnosis*.—Filariidae (p. 179): Vulva anterior, near mouth. Spicules quite dissimilar. Intermediate stages, so far as known, occur in blood-sucking arthropoda.

*Type-genus*.—*Filaria* Mueller, 1787.

#### ANALYTICAL KEY TO GENERA OF FILARIINAE.

1. Adult forms -----*Filaria*, p. 179.  
 Larval forms in the blood (collective genus)-----*Microfilaria*, p. 188.

#### Genus FILARIA Mueller, 1787.

*Synonyms*.—*Filaria* Rudolphi, 1809; *Filaire* Lee, 1840; *Filariu* Magalhães, in Silva Lima, 1877; *Filoria* Calmette, 1884; *Falaria* Leidy, 1904.

*Generic diagnosis*.—Filariinae (p. 179): Caudal extremity of male forms a spiral, provided with alae. Simple body, devoid of prominent cuticular ornamentation or cervical alae. Esophagus simple, without chitinous rings or spirals.

*Type-species*.—*Filaria martis* Gmelin, 1790.

## ANALYTICAL KEY TO SPECIES OF FILARIA.

1. No description.....*Filaria leporis* (p. 187), *Filaria* species, p. 188.  
Described species..... 2.
2. Buccal cavity with strong chitinous walls. Location of parasite not given.  
*Filaria circularis*, p. 183.  
Buccal cavity without strong chitinous walls. Subcutaneous, or in pleural or peritoneal cavities..... 3.
3. Known only in larval form in subcutaneous tissue....*Filaria muricola*, p. 186.  
Adult forms..... 4.
4. Posterior end of body terminates in 2 divergent spines. Found in pleural and peritoneal cavities.....*Filaria diacantha*, p. 184.  
Posterior end of body does not terminate in 2 divergent spines. Subcutaneous..... 5.
5. Intestine pigmented black. Females over 150 mm. long and males with 12 or 13 pairs of caudal papillae.....*Filaria subcutanea*, p. 182.  
Intestine not pigmented black. Females less than 150 mm. long, or if more with males of the same species having 6 pairs of caudal papillae..... 6.
6. Female over 150 mm. long and male with 6 pairs of caudal papillae.  
*Filaria martis*, p. 180.  
Female less than 150 mm. long..... 7.
7. Female more than 125 mm. long, with thick node in front of vulva.  
*Filaria pistillaris*, p. 183.  
Female less than 50 mm. long and without node in front of vulva..... 8.
8. Head with 2 rows of 4 flat papillae in each. Conical tail end with a rounded tip prolonged into a small clawlike process.....*Filaria tinstowi*, p. 184.  
Head papillae obscure or absent. Tail simple and without clawlike process.  
*Filaria scapiceps*, p. 185.

## FILARIA MARTIS Gmelin, 1790.



236.



237.

FIGS. 236, 237.—*FILARIA MARTIS*.  
236, ANTERIOR EXTREMITY,  
LATERAL VIEW. ENLARGED.  
AFTER ALESSANDRINI, 1838.  
237, HEAD, VIEWED FROM THE  
FRONT. ENLARGED. AFTER  
SCHNEIDER, 1866.

*Synonyms*.—? *Filaria medinensis* Rosa, 1794; *Filaria mustelarum* Rudolphi, 1809; *Filaria mustelarum* Rudolphi, 1809; *Filaria mustelarum subcutanea* Rudolphi, 1819; *Filaria mustelae foinae* Creplin, 1846; *Filaria quadrispina* Diesing, 1851; *Filaria perforans* Molin, 1858b; ? *Filaria mustelae barbarae* M. C. V. Collect. Brasil. in Molin, 1858b; ? *Filaria mustela barbata* Molin 1858b; *Filaria subcutanea*? in Parona, 1894.

*Specific diagnosis*.—*Filaria* (p. 179): Body very long, slender, and white. Anterior extremity attenuated and obtuse (fig. 236). Posterior extremity very much attenuated. Cuticle not transversely striated. Mouth small, round, unarmed, and surrounded by six submedian noduliform circumoral papillae (fig. 237). In the female the ventro-submedian papillae are more anterior than the dorsal papillae; in the male the papillae are somewhat displaced.

*Male* 73 mm. long. The posterior extremity is curled in a spiral and provided with broad cuticular alae, which meet terminally at the posterior extremity (fig. 238). There are nine pairs of filiform caudal papillae, of which three pairs are pre-anal and six pairs are postanal. The first and second pairs and the third and fourth pairs are close together; the fifth and sixth pairs are near the median line. The spicules are unequal, the larger in the form of a tube, provided with broad, transversely striated lamellae, and the shorter conical.

*Female* 190 mm. long. The posterior extremity is acuminate, somewhat curved ventrad. The anus is terminal or subterminal. The vulva is very close to the mouth, almost terminal. Probably ovoviviparous. Eggs very numerous, small, elliptical, with very thick shells, and covered with very minute granulations (fig. 239). [This worm is viviparous, according to Molin, and ovoviviparous, according to Alessandrini. It appears, then, that the worm produces eggs containing embryos and gives birth to these embryos after their escape from the egg. It is, therefore, ovoviviparous in the true sense of the word.]

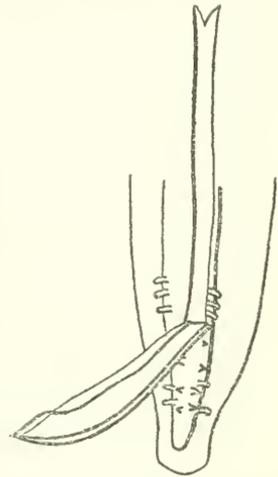


FIG. 238.—FILARIA MARTIS. POSTERIOR EXTREMITY OF MALE. X 93. AFTER SCHNEIDER, 1866.

*Host*.—*Hystrix cristata*. Usually in carnivores.

*Location*.—Subcutaneous.

*Localities*.—Italy, Austria, Eritrea (Africa), and ? Brazil.

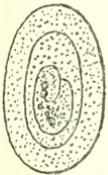


FIG. 239.—FILARIA MARTIS. EGG. ENLARGED. AFTER STOSSICH, 1866.

Some authors state that there are four papillae on the head, but Schneider (1866) has figured six for this form which he describes under the name *Filaria quadrispina*. It seems unlikely that an ovoviviparous form should have a thick-shelled egg, and one may surmise that possibly Stossich mistook a space between a vitelline membrane and a shell for a thick shell.

There is some reason for thinking that *Filaria subcutanea* von Linstow, 1899, is a synonym of *F. martis*. However, since von Linstow has figured a form with 12 or 13 pairs of caudal papillae, instead of 9 as given for *F. martis*, it is perhaps better to retain the present status, especially as von Linstow's specific name is a homonym of *Filaria subcutanea* Parona, 1894, and will have to be changed if distinct. It seems better not to change it with the existing uncertainty, and it will fall without the necessity for a change if it is identical with *F. martis*. As the type-species of the genus *Filaria*, *F. martis* has been discussed by Stiles (1907).

## FILARIA SUBCUTANEA von Linstow, 1899, not Parona, 1894.

*Specific diagnosis.*—*Filaria* (p. 179): Anterior and posterior ends rounded, the posterior end attenuated. Head with four small scarcely recognizable papillae. Intestine pigmented black.

*Male* 42 mm. long and 390  $\mu$  thick. Esophagus 875  $\mu$  long. Posterior end of body coiled several times. Spicules straight, one 110  $\mu$  long, the other 440  $\mu$  long (fig. 240). Of the six to seven pairs of preanal papillae and the six pairs of postanal papillae, those located anteriorly are larger than those located posteriorly. [In von Linstow's figure, one pair of the postanal papillae is strongly suggestive of the pores of the caudal glands.]

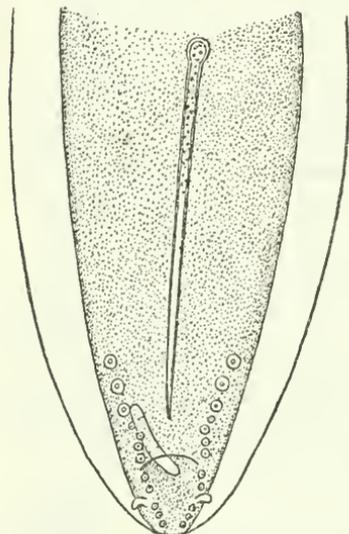


FIG. 240.—FILARIA SUBCUTANEA. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER VON LINSTOW, 1899.

*Female* 195 mm. long and 570  $\mu$  thick. The esophagus is 1.363 mm. long. The vulva is located just behind the posterior end of the short esophagus and divides the body in a ratio of 1:158. The eggs are 18 by 14  $\mu$  in diameter.

*Host.*—*Erethizon dorsatum*.

*Location.*—Subcutaneous.

*Locality.*—Berlin Zoological Garden, Berlin, Germany.

It has already been noted in the foregoing discussion of *Filaria martis* that it is perhaps identical with von Linstow's species. The lengths of the female worms are about the same; the presence of four head papillae is claimed for both; they are both recorded from species of the same genus and in the same location. There is a possibility that lack of detailed study or condition of material accounts for some of the differences, such as the number of caudal papillae. Papillae are readily overlooked, and in *F. martis* some writers claim four and some six for the head. There is apparently an error in the statement of von Linstow's measurements. He states that the esophagus in the female is 1:143 of the total body length, and that the vulva is behind the posterior end of the esophagus and divides the body in the proportion of 1:158. It is evident that the value of the first term, 1, can not be increased without diminishing the second term.

It has also been noted that *Filaria subcutanea* Parona, 1894, antedates *Filaria subcutanea* von Linstow, 1899, and that the latter homo-

nym is therefore without standing. It has not been replaced by a new name in this paper for the reason that it may be *F. martis*.

*F. martis* or *F. subcutanea* is perhaps the adult of the microfilaria recorded by Plimmer (1915):

**FILARIA PISTILLARIS** Molin, 1858b.

*Synonym.*—*Filaria sciuri* in Collect. Brazil. M. C. V. of Molin, 1858b.

*Specific diagnosis.*—*Filaria* (p. 179): Body filiform, slightly diminishing in size posteriorly and with the anterior extremity obtuse and claviform. The mouth is unarmed.

*Male* unknown.

*Female* 137.5 mm. long and 250  $\mu$  thick. The posterior extremity is straight, the apex bearing four papillae, of which the two posterior, or external, are the larger. In front of the vulva is a thick node distinct from the rest of the body.

*Host.*—*Sciurus igniventris*.

*Location.*—Subcutaneous on abdomen.

*Locality.*—Marabitanas, Brazil.

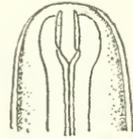


FIG. 241.—FILARIA CIRCULARIS. HEAD, LATERAL VIEW. ENLARGED. AFTER VON LINSTOW, 1899.

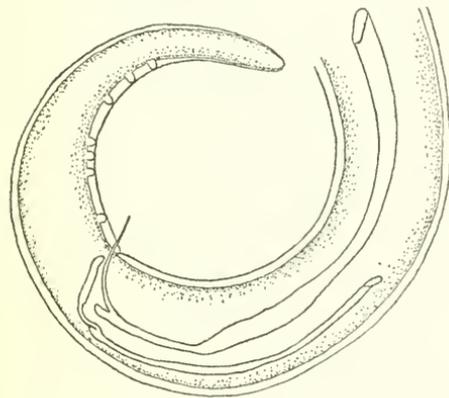


FIG. 242.—FILARIA CIRCULARIS. POSTERIOR EXTREMITY OF MALE, LATERAL VIEW. ENLARGED. AFTER VON LINSTOW, 1899.

The name *Filaria sciuri* is a synonym of *F. pistillaris*, and hence antedates and invalidates *Filaria sciuri* von Linstow, 1903. See *Filaria linstowi*.

**FILARIA CIRCULARIS** von Linstow, 1899.

*Specific diagnosis.*—*Filaria* (p. 179): Head rounded. Small buccal cavity with strong walls (fig. 241).

*Male* 20 mm. long and 120  $\mu$  thick. The esophagus is one forty-sixth and the tail one one-hundred-and-twenty-fifth of the

total body length. The posterior extremity is coiled around three times. The spicules are 260 and 190  $\mu$  long and have projections at the distal extremity (fig. 242). Seven pairs of postanal papillae present.

*Female* 65 mm. long and 250  $\mu$  thick. The esophagus is one one-hundred-and-fifth and the pointed tail one ninety-third of the total body length. The vulva is far anterior and divides the body in the proportion of 1:49. Eggs 21 by 13  $\mu$  in diameter.

*Host.*—“*Hesperomys*” species.

*Location*.—Not given.

*Locality*.—Port Alegre.

The buccal cavity is the particular feature of importance in this species.

FILARIA DIACANTHA Molin, 1858b.

*Synonyms*.—*Filaria hystrichis-prehensilis* M. C. V. of Molin, 1858b; *Filaria loncheri* M. C. V. of Molin, 1858b.

*Specific diagnosis*.—*Filaria* (p. 179): Body slightly attenuate anteriorly and very much attenuate posteriorly. Posterior extremity terminates in two divergent spinous processes. Mouth unarmed.

*Male* 25 to 44 mm. long and 167 to 250  $\mu$  thick. Posterior extremity coiled in a spiral.

*Female* 33 to 81 mm. long and 167 to 500  $\mu$  thick. Posterior extremity curved.

*Hosts*.—*Euryzygomatomys rufus* (*Loncheres rufa*), *Coendou prehensilis* (*Cercolabes prehensilis*, *Hystrix prehensilis*), *Euryzygomatomys spinosus* (?*Mesomys spinosus*).

*Location*.—Abdominal cavity and lungs.

*Locality*.—Villa Maria and Caiçara, Brazil.

The structure of the posterior extremity in this species and the presence of the parasite in the abdominal cavity suggests that this might be a species of *Setaria*, but there is not sufficient evidence at present to warrant the removal of the worm from the genus *Filaria*.

Stossich (1897) apparently makes *Mesomys spinosus* the equivalent of *Loncheres rufa*. It appears, however, that *M. spinosus* is the equivalent of *Euryzygomatomys spinosus*, not of *Eu. rufus*.

FILARIA LINSTOW Hall, 1916, new name.

*Synonym*.—*Filaria sciuri* von Linstow, 1903, not Molin, 1858b.

*Specific diagnosis*.—*Filaria* (p. 179): Head end rounded. Behind the mouth aperture two rows of four flat papillae each. Cuticle smooth.

*Male* unknown.

*Female* 28 mm. long and 650  $\mu$  thick. The short tail end is conical, with a rounded tip, which is prolonged into a small clawlike process. This tail end is one one-hundred-and-fifty-sixth of the entire length of the body. Eggs not developed.

*Host*.—*Sciurus caniceps*.

*Location*.—Subcutaneous.

*Locality*.—Aring, Kelautan, Siam.

Von Linstow had only a single specimen, an immature female, and states that since a satisfactory specific diagnosis can not be made only a provisional specific name can be given. See *Filaria pistillar*.

*FILARIA SCAPICEPS* Leidy, 1886.

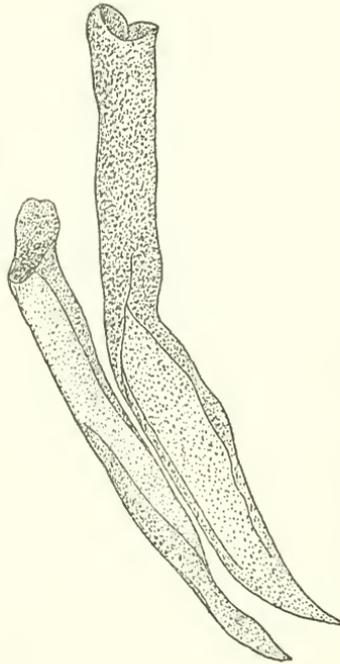
*Specific diagnosis.*—*Filaria* (p. 179): Body tapering nearly equally at both ends. Anterior extremity narrows abruptly and forms a sort of neck posterior of the head. Head without visible papillae. Mouth aperture very small. The cuticle shows a fine obscure transverse striation.

*Male* 12 to 14.5 mm. long and 310 to 375  $\mu$  thick. The head is about 100  $\mu$  in diameter. The esophagus is about 860  $\mu$  long. The testis extends anterior of the posterior extremity of the esophagus. Tail conical, curved, provided



1/10 mm.

FIG. 243.—*FILARIA SCAPICEPS*. POSTERIOR EXTREMITY OF MALE.



1/20 mm.

FIG. 244.—*FILARIA SCAPICEPS*. SPICULES.

with semielliptical alae (fig. 243), the terminal portion bearing laterally five pairs of stalked pyriform papillae, which decrease in size posteriorly to the last. There appear to be also two pairs of sessile papillae, one pair preanal and one pair postanal, near the cloacal aperture. Three pairs of papillae are preanal and two pairs are postanal. The left spicule (fig. 244) is 115 to 135  $\mu$  long and appears to be cylindrical anteriorly and flattened posteriorly and bent at the

union of the two parts. The right spicule is  $85\ \mu$  long and slightly curved.

*Female* 25 to 30 mm. long and  $750\ \mu$  thick, body usually twisted in an extended cork-screwlike spiral of two or three turns. The head is about  $135$  to  $175\ \mu$  in diameter. The esophagus is about  $980\ \mu$  long. The posterior extremity is nearly straight, conical, obtusely rounded,

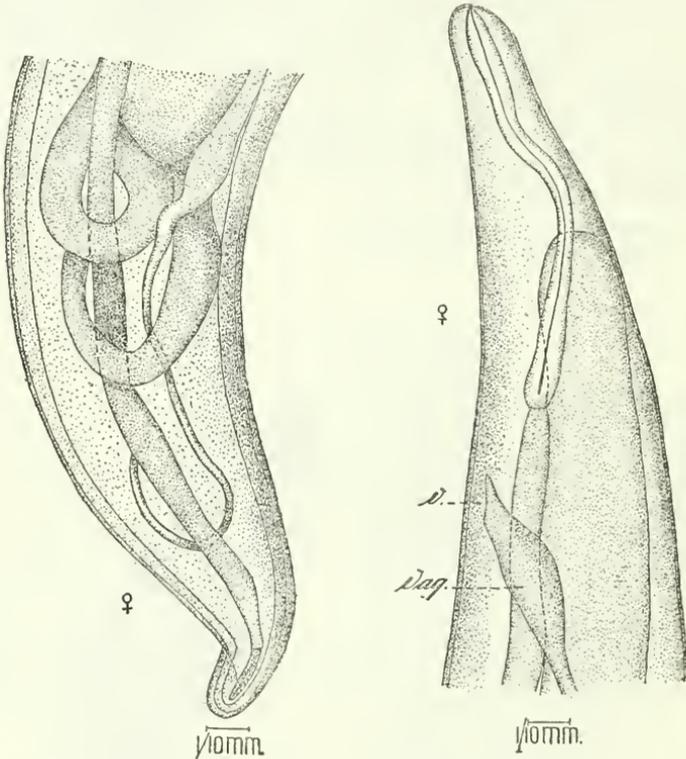


FIG. 245.—*FILARIA SCAPICEPS*. POSTERIOR EXTREMITY OF FEMALE.

FIG. 246.—*FILARIA SCAPICEPS*. ANTERIOR EXTREMITY OF FEMALE. v., VULVA; vag., VAGINA.

smooth, and devoid of appendages (fig. 245). The anus is subterminal. Coils of ovary and oviduct extend anterior of the vulva and posteriorly to near the anus. The vulva (fig. 246) is  $1.255$  to  $1.3$  mm. from the anterior extremity. From it a long narrow vagina extends posteriorly in loops; this at times forms a dilation  $345\ \mu$  long near the vulva. The embryos are very long and filiform.

*Hosts*.—*Sylvilagus floridanus alacer*, *Sylvilagus floridanus malurus* (*Lepus sylvaticus*), *Lepus campestris*.

*Location*.—Subcutaneous and under the muscular fasciae.

*Locality*.—United States (Sulphur, Oklahoma; ? Pennsylvania).

While the locality for Leidy's specimens is not given, it is likely that they were collected in Pennsylvania, or at least in the United

States. Specimens from Oklahoma are in the material collected by Mr. Douthitt. I have tentatively assumed that a cottontail from Sulphur, Oklahoma, would be *S. f. alacer*. The specimens from *Lepus campestris* were determined by Stiles and Hassall, but there is no data as to the geographic locality.

FILARIA MURICOLA (von Linstow, 1905) Hall, 1916.

*Synonym.*—*Spiroptera muricola* von Linstow, 1905.

*Specific diagnosis.*—*Filaria* (p. 179):

*Male* not known as adult.

*Female* not known as adult.

*Larva* 26 mm. long and 590  $\mu$  thick. The head end is bluntly flattened and bears four small papillae in a circle. The esophagus is one-eleventh of the entire length and is surrounded by the nerve ring 350  $\mu$  from the anterior extremity. The very short tail end is rounded and bears a very small fingerform projection. The tail is one two-hundred-and-twenty-first of the entire body length. The polymyarian musculature is powerfully developed and fills the body cavity to such an extent that it borders on the esophagus and intestine medially. The lateral lines comprise one-seventeenth of the entire circumference and are separated, as usual, by the musculature. These lateral lines are wedge-shaped in cross section. The dorsal and ventral lines are feebly developed. Sex organs are not present.

*Host.*—*Epimys surifer* (*Mus surifer*).

*Location.*—Subcutaneous connective tissue of the feet.

*Locality.*—Siam.

There is nothing in this description to warrant the belief that this species belongs in the genus *Spiroptera* as generally understood, even leaving out of consideration the fact that *Spiroptera* is a synonym of *Acuaria*. On the other hand, the location of the parasite in subcutaneous tissue points to its being a *Filaria*, a supposition that is not discordant with the description. The species has therefore been transferred to that genus.

FILARIA LEPORIS Gmelin, 1790.

*Synonym.*—*Filaria leporis* (*subcutanea*) Rudolphi of Molin, 1858b.

*Specific diagnosis.*—*Filaria* (p. 179): None given.

*Host.*—*Lepus timidus*.

*Location.*—Lumbar region.

*Locality.*—Southern Russia.

Gmelin did not describe this species and other writers, noting the species, have merely cited Gmelin. The name is therefore a *nomen nudum*.

## FILARIA species Morgan, 1863.

*Specific diagnosis.*—*Filaria* (p. 179): Long, slender white worms 76 to 127 mm. long.

*Host.*—*Castor fiber*.

*Location.*—Peritoneal cavity.

*Locality.*—United States (Michigan?).

In his work on the American beaver, Morgan (1868) states: "Large numbers of a long, slender white worm, 3'' to 5'' in length, were found in the peritoneal cavity (*Filaria*, species not known)." The size and site suggest that this worm belongs in the genus *Setaria*. Cobbold (1879) says this and other worms from the beaver, noted in Morgan's paper, were collected by Doctor Ely. I can not find that this was the case.

Collective genus MICROFILARIA Shipley and Fearnside, 1906.

*Generic diagnosis.*—Filariinae (p. 179): Larval filariae circulating in the blood.

This is a collective group and hence does not have a type species. I am not certain as to the author of the group name. It has been credited to Magalhães (1878), but he uses the term "micro-filarias" and does not use it generically. It has also been credited to Manson (1880), but he uses the form "micro-Filariæ."

## ANALYTICAL KEY TO SPECIES OF MICROFILARIA.

1. With a thick sheath or capsule. In *Nyctomys* species.
  - Without a thick sheath or capsule..... 2.
2. Well described species from *Citellus beecheyi*.....*Microfilaria rosenau*, p. 188.
  - Undescribed or little description; not from *C. beecheyi*..... 3.
3. Long, pointed forms from *Erithizon*.....*Microfilaria* species, p. 190.
  - Form from *Epimys rattus*.....*Filaria* species, p. 190.

## MICROFILARIA ROSENAUI McCoy, 1911.

*Specific diagnosis.*—*Microfilaria* (p. 188): 170 to 250  $\mu$  long (average 220  $\mu$ ) and 5.5 to 7  $\mu$  thick. No sheath present (fig. 247). The head is cylindrical, tapering to a flattened anterior extremity; the portion devoid of nuclei is usually one and a half times the diameter of the worm in length. The tail makes up about a fourth of the length of the body, and tapers gently to a rather sharp point. Cuticle with very fine transverse striations. Inside of the body is a column of nuclei more or less completely interrupted by several clear spaces. The nuclei are of two varieties: Numerous spherical nuclei, staining uniformly and deeply; and less numerous nuclei, slightly larger, not so regular in outline and not staining so deeply. The

head of the worm constitutes one of the clear spaces free from nuclei; one-fourth to one-sixth of the distance from the head to the tail is another clear space; two-thirds of the distance from the head to the tail is another clear space containing very few nuclei; and near the tail, three-fourths to seven-eighths of the distance from the head, is another. These four clear spaces are practically constant; others are sometimes present. The clear space two-thirds of the distance from the head to the tail—the third from the head of the constant clear spaces—usually contains a large number of fine granules. There are usually a few fine granules near the extreme front of the head—the first clear space—and a small number are often found in the tail. Occasionally these granules are found elsewhere. The terminal nuclei in the tail are usually oval, their long axis parallel to that of the worm.

*Host.*—*Citellus beecheyi*.

*Location.*—Blood.

*Locality.*—California (all parts east of the Sierra Nevada Mountains between Mexico and the Sacramento River).

McCoy states that this parasite was found in about 5 per cent of all host animals examined, but the search for the adult worm was unsuccessful. It apparently exerted no pathological influence of any consequence on its host, as no deleterious effects were noted.

The thickness of the parasite is said to be a little less than that of the red blood corpuscles of the host.

MICROFILARIA PLIMMERI Hall, 1916, new name.

*Specific diagnosis.*—*Microfilaria* (p. 188): Short, with a thick capsule.

*Host.*—*Nyctomys* species.

*Location.*—Blood.

*Locality.*—London (host animal from Central America).

Under the caption "Embryo filariae found in the blood of mammals," Plimmer (1913) notes the South American night-mouse as one host. This has been placed here in the collective genus *Microfilaria*, and in view of the fact that this is a collective genus made up of generally unassignable species, I have ventured to attach a specific name to Plimmer's scanty description. I am reluctant to name

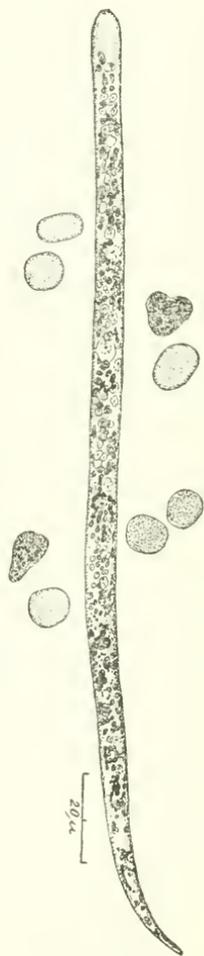


FIG. 247.—MICROFILARIA ROSENAUI. AFTER MCCOY, 1911.

poorly described species, but it occasionally seems desirable to have some brief way of designating such a record.

MICROFILARIA species Hall, 1916.

*Specific diagnosis.*—*Microfilaria* (p. 188) : Long, pointed.

*Host.*—*Erethizon dorsatum*.

*Location.*—Blood.

*Locality.*—London Zoological Gardens.

Plimmer's (1915) record: See comment under *Filaria subcutanea*.

FILARIA species Davaine, 1860, of von Linstow, 1889.

*Specific diagnosis.*—Filiform animalcules.

*Host.*—*Epimys rattus* (*Mus rattus*) (von Linstow erroneously says *Mus decumanus*).

*Location.*—Blood.

*Locality.*—France.

Chaussat (1850) has a record of the finding of filiform animalcules in the blood of the black rat (*Mus rattus*). These were present in some rats in large numbers. It appears to me likely that this is the rather common *Trypanosoma lewisi*.

Family SPIRURIDAE Oerley, 1885a.

*Synonyms.*—Spiruroidea Railliet and Henry, 1915; Spirurata Descazeaux, 1915.

*Family diagnosis.*—Filarioidea (p. 178) : Mouth with two lips; or without lips in forms where vulva is near posterior extremity of body. Male with posterior extremity of body commonly expanded and alate. Female with vulva usually in middle portion of body, exceptionally near the posterior extremity as noted above. Railliet and Henry (1915) treat this as a superfamily, the Spiruroidea.

*Type-genus.*—*Spirura* E. Blanchard, 1849.

ANALYTICAL KEY TO SUBFAMILIES OF SPIRURIDAE.

1. Undescribed or inadequately described species.....Subfamily uncertain, p. 220.  
Described species and genera..... 2.
2. Mouth without lips; vulva near posterior extremity---Gongyloneminae, p. 190.  
Mouth with 2 lips; vulva remote from extremities of body..... 3.
3. Pharynx strengthened by cuticular rings or spirals.....Arduenninae, p. 218.  
Pharynx without cuticular rings or spirals.....Spirurinae, p. 190.

GONGYLONEMINAE Hall, 1916, new subfamily.

*Subfamily diagnosis.*—Spiruridae (p. 190) : Body long and filiform. Anterior portion of body ornamented with cuticular bosses. In the median lines, immediately behind the mouth, are two semi-lunar depressions simulating suckers. The vulva of female is situated a short distance anterior of the anus.

*Type-genus.*—*Gongylonema* Molin, 1857.

The life history and the site of infestation in the primary host clearly relate this subfamily to the Spiruridae rather than to the Filariidae, in spite of the absence of lips.

Seurat (1914e, 1914f) regards *Gongylonema* as a lateral branch of the Spiruridae arising from *Protospirura*.

Genus GONGYLONEMA, Molin, 1857.

*Synonyms*.—*Filaria* Mueller, 1787; *Spiroptera* Rudolphi, 1819; *Myzomimus* Stiles, 1892.

*Generic diagnosis*.—Gongyloneminae (p. 190): Body filiform, slightly attenuated toward the two extremities. Cuticle transversely striated. Mouth small, elongated dorso-ventrally, and surrounded by six small papillae. Anterior portion of body provided with longitudinal rows of cuticular bosses. Immediately behind the mouth there is a dorsal and a ventral semilunar depression, simulating a sucker. The esophagus consists of two distinct portions, a slender anterior portion and a thicker posterior portion. The tail of the male is curved ventrally and provided with two asymmetrical alae supported by elongated, claviform papillae, mostly arranged in pairs. Vulva of female a short distance in front of anus. Eggs ellipsoidal, containing well-developed embryos when oviposited.

*Type-species*.—*Gongylonema musculi* (Rudolphi, 1819) Neumann, 1894.

ANALYTICAL KEY TO SPECIES OF GONGYLONEMA.

1. Undescribed and dubious forms.....*Gongylonema* (?) species, p. 198.  
Described and recognizable forms..... 2.
2. Males less than 10 mm. long and with 14 pairs of caudal papillae; females less than 25 mm. long.....*Gongylonema musculi*, p. 191.  
Males more than 10 mm. long and with not more than 12 pairs of caudal papillae; females more than 50 mm. long..... 3.
3. Males with 8 pairs of caudal papillae.....*Gongylonema neoplasticum*, p. 193.  
Males with 12 pairs of caudal papillae.....*Gongylonema brevispiculum*, p. 197.

GONGYLONEMA MUSCULI (Rudolphi, 1819) Neumann, 1894.

*Synonyms*.—*Filaria musculi* Rudolphi, 1819; *Gongylonema minimum* Molin, 1857.

*Specific diagnosis*.—*Gongylonema* (p. 191): Mouth orbicular. Anterior portion of body provided with cuticular bosses.

*Male* 8.8 mm. long. Anterior extremity attenuate and provided with small cuticular bosses (fig. 248). Posterior extremity curved, slightly attenuated; the ventral surface forms a large elliptical depression (fig. 249). There is a well-developed bursal membrane. Fourteen pairs of clavate papillae, of which 10 are preanal and 4 postanal. There are two spicules.

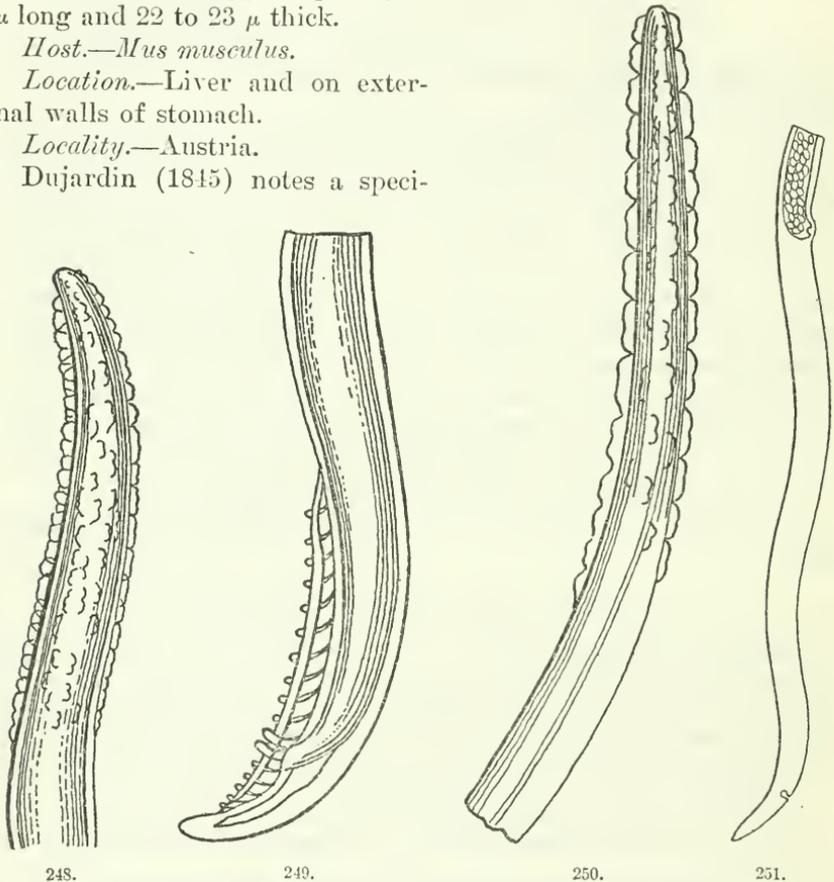
*Female* 17.5 to 21.6 mm. long with a maximum thickness of  $154\ \mu$ . Anterior extremity attenuate and provided with large cuticular bosses (fig. 250). Posterior extremity bent and abruptly attenuated. The anus is near the posterior extremity of the body (fig. 251). The vulva is in the posterior portion of the body but at some distance from the anus. Eggs elliptical,  $45\ \mu$  long and  $22$  to  $23\ \mu$  thick.

*Host*.—*Mus musculus*.

*Location*.—Liver and on external walls of stomach.

*Locality*.—Austria.

Dujardin (1845) notes a speci-



FIGS. 248-251.—*GONGYLONEMA MUSCULI*. 248, ANTERIOR EXTREMITY OF MALE. ENLARGED. AFTER MOLIN, 1857. 249, POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER MOLIN, 1857. 250, ANTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER MOLIN, 1857. 251, POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER MOLIN, 1857.

men from Vienna, from which the maximum length and the thickness noted above are taken, as having two cervical alae. This would suggest that he was not dealing with *Gongylonema*. This species, the type of the genus, is unfortunately not very well known. Dujardin states that only 2 mice were found infested in 1,264 examined.

GONGYLONEMA NEOPLASTICUM (Fibiger and Ditlevsen, 1914) Ransom and Hall, 1916.

*Synonyms.*—*Spiroptera* species Fibiger, 1913; *Spiroptera neoplastica* Fibiger and Ditlevsen, 1914; *Spiroptera* (*Gongylonema*) *neoplastica* Fibiger and Ditlevsen, 1914.

*Specific diagnosis.*—*Gongylonema* (p. 191): The anterior extremity of the body terminates in a blunt cone, the taper beginning at the excretory pore. The cuticle is finely striated transversely at intervals of 6 to 12  $\mu$ . Anteriorly, in the vicinity of the proximal portion of the esophagus, the annulations disappear and are replaced by large vesicular bosses, more or less globular, egg-shaped or sausage-shaped, of very variable size. Mouth has the shape of an equilateral triangle, but is without lips. Papillae inconspicuous. No cervical papillae observed. Lateral bands distinct, of almost uniform thickness, diminishing in size anteriorly and disappearing posteriorly in the anal region. The excretory pore is in the median line on the ventral surface, halfway between the nerve ring and the union of the two halves of the esophagus. Posterior of the mouth is a short pharynx with a thin chitinous lining. The esophagus is in two parts. The anterior portion is short and slender and passes abruptly into the posterior portion, which is much longer and thicker. This portion is about twice as thick as the anterior portion and is of fairly uniform diameter, only increasing slightly in the most posterior portion. In optical section the nerve ring shows a granular central portion surrounded by a homogenous coat and with spurs of sarcoplasma extending from the body musculature to the nerve ring. The esophagus is separated from the chyle intestine by a constriction, but the chitinous lining is traceable somewhat farther down the intestine. As far down as this lining extends, the intestine shows faint transverse striations, possibly due to muscular tissue. Posterior of this are intestinal valves, sometimes showing arrangement in two rows. The chyle intestine is about as thick as the anterior portion of the esophagus. The rectum is narrower. The anal musculature is well developed.

*Male* 15 to 20 mm. long and 110 to 130  $\mu$  thick. Cuticle 6  $\mu$  thick. The esophagus is one-fourth of the entire length. The nerve ring is 45  $\mu$  in diameter in a male 15 mm. long. The tail is spirally twisted. The average sized bursa is 462  $\mu$  long with a maximum width of 170  $\mu$ . The bursa (fig. 252) is asymmetrical, one side being a third shorter than the other and is elongate oval with a distinct constriction in the middle, more pronounced on the longer side and placed more posteriorly on the shorter side. The lower convexity is more distinct on the shorter side. The bursa narrows rapidly toward the tip of the

tail, enlarges a little just anterior of the most posterior papillae, and then forms a small round ligulate tip extending  $14\ \mu$  beyond the posterior extremity of the body proper. There are eight pairs of fungiform caudal papillae, asymmetrically placed. The four pairs of preanal papillae are the larger, being  $20\ \mu$  long, while of the four pairs of postanal papillae those nearer the cloacal aperture are the largest, and they decrease in size posteriorly, those near the tail being  $10\ \mu$  long. The spicules are very dissimilar. The short one is

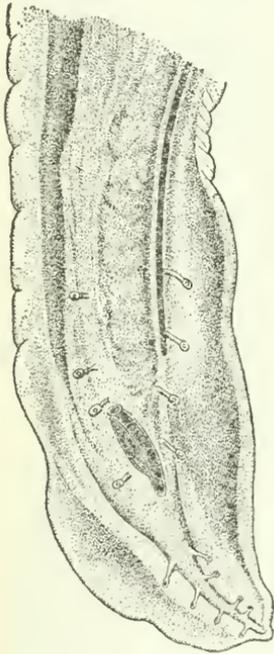


FIG. 252.—*GONGYLONEMA NEOPLASTICUM*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. ENLARGED. AFTER FIBIGER AND DITLEVSEN, 1914.

$93\ \mu$  long and the long one  $528\ \mu$  long, or almost six times as long as the short one. In profile the short one is sword-shaped with a rounded point. It attains its maximum thickness of  $9\ \mu$  at the proximal extremity. From here it curves in an even taper toward the tip. It is striated transversely and appears to be hollow throughout. Viewed dorso-ventrally, it appears to be thickest in the middle. The long spicule is of uniform thickness throughout except for a slight dilatation at the proximal end. The dilated tip is surrounded by a membranous bulb. The long spicule is commonly found protruded to half its length, the protruded distal portion being bent at right angles to the proximal portion. Each spicule is surrounded by a sheath, the surface of which is apparently chitinous and marked with fine maculae, apparently due to depressions. A third piece of sheathing, larger and thicker walled, lies between the spicules near the distal end of the small spicule, and apparently supports the entire structure and holds the two spicules at a

fixed distance. Broad muscular bands originate near the anus and extend dorso-ventrally and anteriorly or posteriorly on each side of the rectum and ductus ejaculatorius. The single testis extends straight almost to the proximal end of the esophagus, where it turns and extends parallel to its former course for a short distance, sometimes turning anteriorly again. It terminates in a retortaeform expansion. Posteriorly the testis joins the narrow vas deferens, about  $70\ \mu$  long, and this joins a dilated vesicula seminalis, a little more than 1 mm. long and often full of spermatozoa. This is continued posteriorly as the short ductus ejaculatoris. The spermatozoa are small regular globular cells.

*Female* 60 to 80 mm. long and 170 to 326  $\mu$  thick. Cuticle 9 to 12  $\mu$  thick. Lateral lines 120  $\mu$  wide. Pharynx 53  $\mu$  long and 20  $\mu$  thick in a 60 mm. long specimen. The esophagus is one-ninth of the entire length of the worm. The vulva is near the posterior extremity, at a distance of one-eighth to one-tenth of the body length, and is not prominent. The vagina extends anteriorly from the vulva for a short distance and the uteri are divergent. The anterior uterus becomes the receptaculum seminis near the posterior extremity of the esophagus and the posterior uterus becomes the receptaculum seminis posterior of the vulva. Each uterus communicates with a short curved oviduct and these in turn with the ovaries. The initial portion of the anterior ovary is directed posteriorly and the initial portion of the posterior ovary is directed anteriorly. The ovaries are very much looped, the long axis of the loops paralleling that of the body. Eggs are regularly ovoid, with a maximum size of about 60 by 40  $\mu$  in diameter. In optical section they are somewhat thickened at the poles, with a line of distinct demarcation between the thinner shell in the middle of the egg and the thicker shell at the poles. Eggs always contain embryos when oviposited. The embryo is thickest at the anterior end and diminishes in size evenly to the posterior end.

*Life history.*—Eggs passing from the female into the host epithelium around the worm are passed out in desquamation of the epithelium. They may be left in moist feces half a year without alteration. If fed to certain insects (*Periplaneta americana*, *Periplaneta orientalis*, *Blatta (Ectobia) germanica*, or *Tenebrio molitor*) or ingested naturally by these insects, the embryos escape from the eggs, the thickened polar portions of the shells being removed under the action of the digestive fluids. This embryo is 250  $\mu$  long and 13  $\mu$  thick, with the cuticle somewhat thickened anteriorly and with no internal differentiation. The day after feeding, these embryos and the empty shells are found in the intestine. The next day neither are found, and the subsequent wanderings or location of the worms is not known until they are found encapsuled in the musculature of the prothorax and of the limbs of the insect about 20 days later. The capsule is not very prominent. The larvae are coiled in a spiral, usually with the tail in the center and the head at the periphery. This larva is 792  $\mu$  to 1.215 mm. long and rather slender. It



FIG. 253.—GONGYLO-  
NEMA NEOPLASTI-  
CUM. LARVA  
FROM PROTHORAX  
OF PERIPLANETA  
AMERICANA. EN-  
LARGED. AFTER  
FIBIGER AND DIT-  
LVESEN, 1914.

tapers only slightly toward the anterior end and attenuates abruptly behind the anus to form the conical tail (fig. 253). The shape and appearance of the anterior extremity is similar to that of the adult worm. The tail often terminates in two papillalike projections of variable size. Occasionally there are three, or there may be a wing-shaped prominence with fringed or serrate edges. The pharynx is relatively longer than in the adult worm and has relatively thicker chitinous lining. The esophagus is about as long as the intestine, or even somewhat shorter, and has the two-part structure of the adult worm. For a time the anterior portion of the body and the esophagus grow faster than the posterior portion and the intestine. Later the growth rates are reversed. The nerve ring is distinct and the excretory pore is halfway between the nerve ring and the union of the two portions of the esophagus. The primordium of the genitalia appears as a small egg-shaped body, consisting of a number of cells or a syncytium with several nuclei, located near the region where the vulva will later develop in the female.

When cockroaches containing encysted larvae are fed to primary host animals, all of which are rodents, the larvae will be found to have entered the mucous membrane on the following day. They invade the mucosa of the stomach and not infrequently that of the esophagus and tongue. In the next 10 days they grow slowly and only double their length. Then they grow more rapidly and in a few weeks are ten times as long as an encysted larva. At the end of the first 10 days the larva has a tail identical with that of the adult. About this time a molt occurs and the resultant larva has a simple tail. After two months females begin to pass eggs.

In rodents these worms set up marked pathological alterations. These begin as a circumscribed or diffuse hypertrophy of the mucosa, go on to the formation of papilloma, and terminate in carcinoma with occasional metastases.

*Hosts.*—*Epimys norvegicus* (*Mus decumanus*), *Epimys rattus* (*Mus rattus*), *Mus musculus*, *Oryctolagus cuniculus* (*Lepus cuniculus*), *Cavia porcellus* (*Cavia cobaya*).

*Location.*—The squamous-celled anterior portion of the digestive tract.

*Localities.*—Denmark, Danish West Indies.

This worm is of very considerable interest from zoological and medical standpoints.

It is quite possible that Seurat (1914c) has described this species from *Dipodillus campestris* under the name of *Gongylonema brevispiculum*, a possibility which is commented on at length in the following notes on that species.

## GONGYLONEMA BREVISPICULUM Seurat, 1914c.

*Specific diagnosis.*—*Gongylonema* (p. 191): The mouth is situated in the center of a disk which projects slightly (fig. 254); the buccal cavity is shallow. The cuticle is finely striated at intervals of  $10\ \mu$ . There are 4 rows of bosses on the dorsal and 4 on the ventral surface. There are 2 lateral alae, originating about  $210\ \mu$  from the anterior end of the body and not extending beyond the region of the bosses. Immediately anterior of these alae are the 2 precervical (cervical) papillae. The excretory pore opens on the ventral surface in the posterior third of the interval from the nerve ring to the inferior limit of the muscular esophagus. There is an unpaired dorsal papilla 2 mm. posterior of the termination of the esophagus. The nerve ring is located at two-fifths of the distance from the anterior to the posterior end of the esophagus.

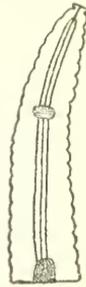


FIG. 251.—GONGYLONEMA BREVISPICULUM. ANTERIOR EXTREMITY. ENLARGED, AFTER SEURAT, 1914.

The nerve ring is located at two-fifths of the distance from the anterior to the posterior end of the esophagus.

*Male* 17 mm. long with a maximum thickness of  $190\ \mu$ . Lateral alae originate  $175\ \mu$  from the anterior end of the body. Buccal cavity  $35\ \mu$  long (?). Muscular esophagus  $530\ \mu$  long; total length of esophagus one-fourth of entire body length. The short tail is not straight but is slightly bent to the left (fig. 255). The cloacal aperture is  $180\ \mu$  from the posterior end of the body. The caudal alae are well developed and slightly unequal; the left one is the longer,  $480\ \mu$  long; the right one is  $420\ \mu$  long. There are 6 pairs of preanal papillae, all stalked, and 4 pairs of stalked and 2 of sessile postanal papillae, the latter very small and located near the tip of the tail close to the apertures of the caudal glands. The spicules are very unequal; the filiform left spicule is  $660\ \mu$  long, and the short thick right spicule is  $85\ \mu$  long and  $18\ \mu$  thick. The gorgonet (gubernaculum) is asymmetrical, being

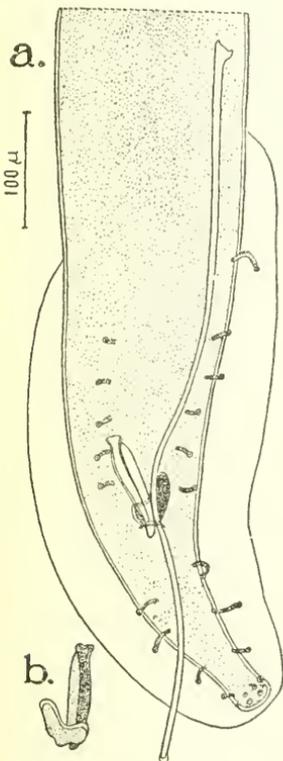


FIG. 255.—GONGYLONEMA BREVISPICULUM. a, POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW; b, RIGHT SPICULE AND GUBERNACULUM, DORSAL VIEW. AFTER SEURAT, 1914.

prolonged posteriorly on the left side to form an elongated branch.

*Female* 70 mm. long with a maximum thickness of 336  $\mu$ . The buccal cavity is 50  $\mu$  long (?). The muscular esophagus is 870  $\mu$  long; the total length of the esophagus is one-ninth of the body length. The tail is very short and conical, with the orifices of the caudal glands near its extremity. The vulva is in the posterior portion of the body, about 8 mm. anterior of the anus. The ovjector is characterized by a vestibule and a sphincter forming a cylindrical tube 1 mm. long and lined with a thick cuticle (fig. 256). This is followed by a musculo-epithelial tube 16.3 mm. long, which extends anteriorly and divides into two divergent branches. The eggs have a thick shell, 42  $\mu$  long by 25  $\mu$  wide, and contain an embryo when oviposited.

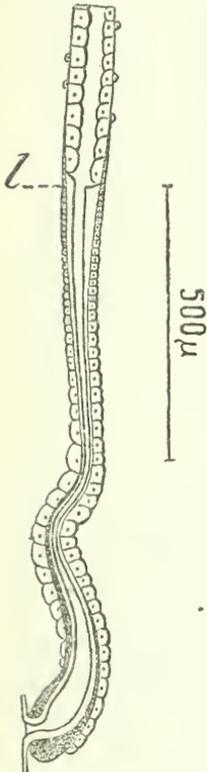


FIG. 256.—GONGYLONEMA BREVISPICULUM. VAGINA AND OVJECTOR. z, UNION OF TWO PORTIONS OF OVJECTOR. AFTER SEURAT, 1914.

*Host*.—*Dipodillus campestris* (*Dipodilla campestris*).

*Location*.—Cardiac region of the stomach, in the mucosa.

*Locality*.—Bou Saâda, Algeria.

The principal, and almost the only feature, which distinguishes this species from *Gongylonema neoplasticum* is the presence of additional caudal papillae in the male. The posterior extremity of *G. neoplasticum* is figured with the bend to the left, which also occurs in *G. brevispiculum*. It appears quite possible that Fibiger and Ditlevsen (1914), in their excellent study of *G. neoplasticum*, may have overlooked some papillae, and that a restudy will show that *G. brevispiculum* must be regarded as a synonym of *G. neoplasticum*. Until this point has been determined it will be safer to retain the two species, keeping in mind the possibility that they are identical. The fact that *G. neoplasticum* has been developed in such hosts as the rat, rabbit, and guinea pig, one of which is a notorious wanderer and cosmopolite, speaks for their identity in connection with their other features in common.

GONGYLONEMA (?) species Hall, 1916.

*Specific diagnosis*.—*Gongylonema* (?) (p. 191): Very fine filamentous worms, 8.4 cm. long.

*Host*.—*Castor fiber*.

*Location*.—Stomach.

*Locality*.—United States (Michigan?).

Morgan (1868), in his work on the American beaver, states in a footnote on page 73: "In the stomach of the beaver I have found

a very fine filamentous worm 40''' in length, species unknown." The fact that this worm was very fine,  $3\frac{1}{2}$  inches long, and located in the stomach, suggests that it might be a species of *Gongylonema*. *G. neoplasticum* is found in the stomach in rodents, and *Gongylonema verrucosum* occurs in the stomach in sheep and zebu, either free or embedded in the gastric mucosa. The fact that the worm was filamentous argues against the idea that it was an ascarid in a situation in which these worms not infrequently occur, while its presence in the stomach bespeaks its relation with the Filarioidea. Without caring to make more than a tentative assignment, the evidence suggests that the worm belongs in *Gongylonema*. (See comment on *Filaria* species Morgan, 1868.)

Subfamily SPIRURINÆ Railliet, 1915,

*Synonym*.—Phyalopterinae Railliet and Henry, 1912a, in part.

*Subfamily diagnosis*.—Spiruridae (p. 190): Females with two uteri and with vulva in the middle portion of body, not close to anterior or posterior extremities. Pharynx without cuticular rings or spirals.

*Type-genus*.—*Spirura* E. Blanchard, 1849.

ANALYTICAL KEY TO GENERA OF SPIRURINÆ.

1. Male with a circumscribing bursa continuous anteriorly, and with 2 pairs of preanal and 2 pairs of postanal stalked papillae.....*Phyaloptera*, p. 212.  
Male without a bursa continuous anteriorly, and not with 2 pairs of preanal and 2 pairs of postanal stalked papillae..... 2.
2. Mouth with 2 small integral lips without teeth.....*Spirura*, p. 199.  
Mouth with 2 large lips divided into 3 distinct lobes and provided with teeth.....*Protospirura*, p. 203.

Genus SPIRURA E. Blanchard, 1849.

*Synonym*.—*Spiroptera* Rudolphi, 1819, of authors.

*Generic diagnosis*.—Spirurinae (p. 199): Two lips, usually bearing two papillae each, and not bearing teeth. Mouth straight and limited by a chitinous ring. Esophagus long and cylindrical. Body of moderate size, attenuated toward the anterior extremity. Spicules unequal. Bursa present, but not continuous anteriorly across the ventral surface. Vulva anterior or posterior of middle of body. Two uteri.

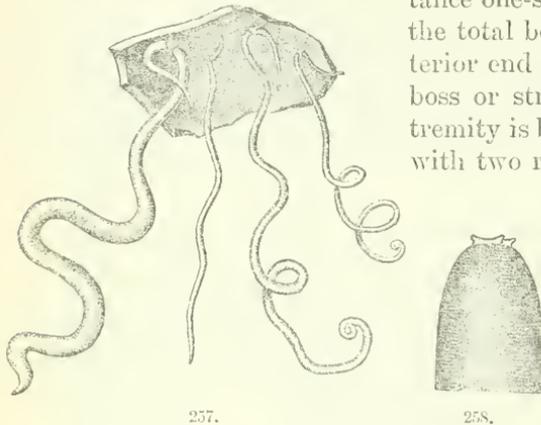
*Type-species*.—*Spirura talpae* (Gmelin, 1790) E. Blanchard, 1849.

SPIRURA TALPAE (Gmelin, 1790) E. Blanchard, 1849.

*Synonyms*.—*Ascaris talpae* Gmelin, 1790; *Ascaris strumosa* Froelich, 1791; *Fusaria convoluta* Zeder, 1803; *Spiroptera strumosa* (Froelich, 1791) Rudolphi, 1819; *Filaria rhytipleurites* Deslong-

champs, 1824; *Filaria convoluta* (Zeder, 1803) Molin, 1858b; *Filaria strumosa* (Froelich, 1791) Stossich, 1897; *Filaria rytipleures* Seurat, 1911.

*Specific diagnosis.*—*Spirura* (p. 199): Posterior portion of body decidedly thicker than anterior portion (fig. 257). Cuticle densely striated transversely. At a distance one-seventh to one-twelfth of the total body length from the anterior end is a prominent cuticular boss or struma. The anterior extremity is bluntly rounded. Mouth with two rather inconspicuous lips (fig. 258), each bearing three papillae. Esophagus narrow and cylindrical, one-fifth as long as body.



FIGS. 257, 258.—*SPIRURA TALPAE*. 257, WORMS ATTACHED TO MUCOSA. ENLARGED. AFTER NITZSCH, 1829. 258, ANTERIOR EXTREMITY, LATERAL VIEW. ENLARGED. AFTER NITZSCH, 1829.

*Male* 10 to 20 mm. long and 250  $\mu$  thick behind the boss and 360  $\mu$  thick posteriorly in specimens 15 mm. long. The head is 70

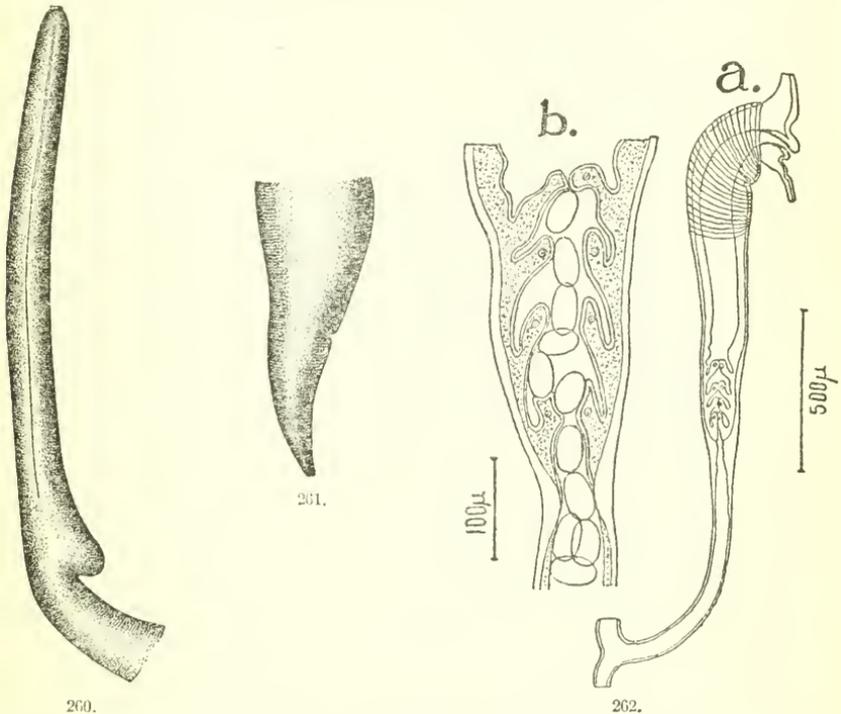
$\mu$  in diameter and the mouth 40  $\mu$  in diameter. The esophagus is  $1/3.8$  as long as the body. The tail is 600  $\mu$  long and terminates obtusely (fig. 259). It bears two bursal alae. There are four pairs of preanal papillae and five pairs of postanal papillae, of which the last two pairs are close to the posterior extremity. There is an unpaired papilla anterior of the cloacal aperture. The long spicule is 530  $\mu$  long and 18  $\mu$  thick; it is tubular, obtuse and recurved almost in a circle. The short spicule is 400  $\mu$  long, ensiform, divided longitudinally by a thickened median keel and expanded laterally in two transversely striated membranous alae.



FIG. 259.—*SPIRURA TALPAE*. POSTERIOR EXTREMITY OF MALE. ENLARGED. AFTER NITZSCH, 1829.

*Female* 20 to 32 mm. long and 300  $\mu$  thick behind the boss (fig. 260) and 620  $\mu$  thick posteriorly. The head is 109  $\mu$  in diameter and the mouth 58  $\mu$  in diameter. The esophagus is one-fifth as long as the body. The posterior extremity of the body is conical with an obtuse termination, the conical portion being concave ventrally and the anus situated at the anterior extremity of the concavity (fig. 261). The vulva is about five-eighths of the body length from the anterior extremity, or about 11.8 mm. from the posterior extremity in

large specimens. It is a large conspicuous transverse aperture limited by prominent lips. From this a short vagina extends to the infundibuliform ovijector, which has a muscular wall and a chitinous lining (fig. 262). The part nearest the vagina is the vestibule and the part most remote is the sphincter. The chitinous lining of the sphincter is in folds, forming oblique valves on the wall. The free extremity of the valves is directed toward the vulva and the vestibule, so that eggs may pass from the common trunk of the uterus



FIGS. 260-262.—*SPIRURA TALPAE*. 260, ANTERIOR EXTREMITY, SHOWING BOSS OR STRUMA. ENLARGED. AFTER NITZSCH, 1829. 261, POSTERIOR EXTREMITY OF FEMALE. ENLARGED. AFTER NITZSCH, 1829. 262, a, OVIJECTOR; b, SPHINCTER OF OVIJECTOR. AFTER SEURAT, 1912a.

into the vestibule and out, but not back. The common trunk of the uterus is a short tube, which promptly divides to form the two divergent uteri. The eggs are roundly elliptical and are 48 to 52  $\mu$  long by 36 to 38  $\mu$  thick. They are 10 to 30 in number.

*Life history.*—Eggs from this worm, if ingested by cockroaches, develop to larvae which are found encysted in the body cavity in lenticular capsules attaining a size of 2 by 3 mm. in diameter, the cysts forming from the epithelium of the tracheae. The cyst is formed of two separable membranes, the external fibrous, the internal structureless. The larva lies folded on itself inside of the

latter and is 15 mm. long. The characteristic boss shows as a cuticular fold 1.5 mm. from the anterior end on the ventral surface. Also in the midventral line, and 270  $\mu$ . from the anterior end, is the opening of a unicellular gland which lies against the esophagus. The mouth has two lips, each bearing two small papillae at its base. The vestibule is 50  $\mu$  long. The esophagus is half as long as the entire

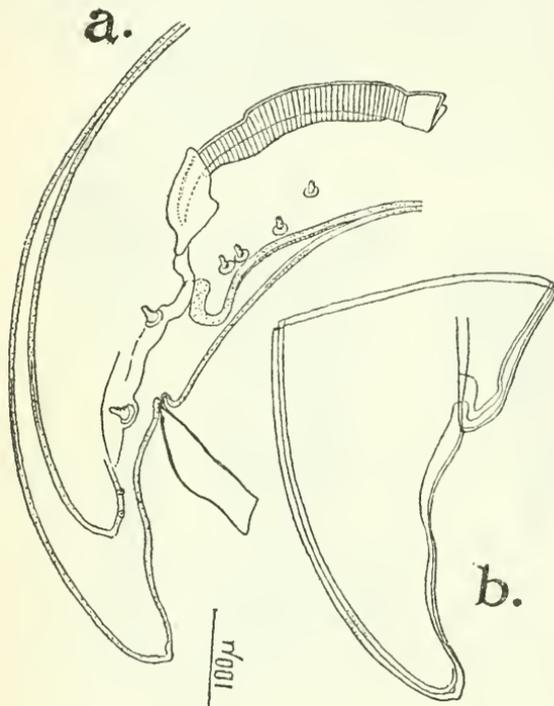


FIG. 263.—*SPIRURA TALPAE*. MALE LARVA IN FOURTH STAGE. *a*, AFTER THE ADDITION OF ACETIC ACID AND SEPARATION OF CUTICLE; *b*, BEFORE ADDITION OF ACID. AFTER SEURAT, 1912b.

body and has a trihedral lumen. Its anterior muscular part is very short, 252  $\mu$  long. It ends just behind the excretory pore and is surrounded by the nerve ring near its middle. The intestine is black. The rectum is short. The space between the rectum and the body wall is full of large round cells with conspicuous nuclei. Seurat (1911) has found as many as 15 cysts in one cockroach. Seurat (1912a) notes that after the third larval molt, and while still in the fourth larval stage, just preceding the adult stage, the larva grows consider-

ably, develops genital organs, and after it attains a certain size secretes a new cuticle under the old and forms the male bursa, spicules, and other structures (fig. 263). When the new cuticle is stripped or separated by the use of acetic acid these structures are evident.

*Host*.—*Epimys* species, "Rat" (commonly in mole).

*Location*.—Stomach (often in intestine also in usual host).

*Localities*.—France (Rennes), Germany (Greifswald, Halle), Austria (Vienna), Ireland, Italy (Padua), Brazil.

This nematode is commonly reported from the mole, but Seurat (1911) states that *Filaria rytipleurites* Deslongchamps, found adult in the rat and with larval stages in *Blatta orientalis* and *Periplaneta americana*, is identical with *Spirura talpae*.

Nitzsch (1829) states that the worm is commonly found sewed in a loop through the gastric epithelium with the boss marking the point of contact for the anterior extremity, but other writers have not found this.

Stossich (1897) states that the esophagus is distinctly divided into three parts, but gives no details and no one else mentions it. Could he have regarded the pharynx as one part?

Genus PROTOSPIRURA Seurat, 1914b.

*Synonym.*—*Spiroptera* Rudolphi, 1819, of authors.

*Generic diagnosis.*—Spirurinae (p. 199): Cuticle transversely striated. No lateral alae in adult. Mouth with two large lips, each divided into one median and two lateral lobes and each lobe bearing teeth. Four head papillae, one at the base of each of the lateral lobes. Bursal alae in male. Spicules unequal. Vulva in middle or anterior portion of body. Uteri divergent.

*Type-species.*—*Protospirura numidica* Seurat, 1914b.

The only species other than the type-species included by Seurat in his new genus is what he calls *Protospirura muris* (Werner, 1782) Seurat, 1915. I do not regard *Lumbrici muris* Werner as available. By some inadvertance Seurat in describing the type-species of his new genus states that the cloaca opens a short distance in front of the anus. It is possible that he means that the cloaca opens a short distance in front of the tail end.

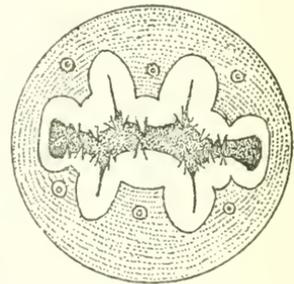


FIG. 264.—PROTOSPIRURA LABIODENTATA. HEAD, VIEWED FROM THE FRONT. ENLARGED. AFTER VON LINSTOW, 1899.

ANALYTICAL KEY TO SPECIES OF PROTOSPIRURA.

1. Maximum length of females over 75 mm. Eggs over 55  $\mu$  long.
 

*Protospirura ascaroidea*, p. 207.
- Maximum length of females less than 55 mm. Eggs not over 50  $\mu$  long---- 2.
2. Eggs less than 20  $\mu$  long-----*Protospirura labiodentata*, p. 203.
- Eggs more than 40  $\mu$  long-----*Protospirura muris*, p. 204.

Seurat (1916) adds *P. numidica* from a rodent. See Addendum, page 224.

PROTOSPIRURA LABIODENTATA (von Linstow, 1899) Hall, 1916.

*Synonym.*—*Spiroptera labiodentata* von Linstow, 1899.

*Specific diagnosis.*—*Protospirura* (p. 203): Mouth with 2 large lips, each divided into three lobes and each lobe bearing one large tooth and two smaller teeth (fig. 264). A papilla is situated at the base of each lobe.

*Male* unknown.

*Female* 42 mm. long and 1.3 mm. thick. The esophagus is  $1/8.9$  of the total body length. The conical pointed tail is  $1/80$  of the total body length. The very thick shelled eggs are small,  $15.6 \mu$  long and  $6.5 \mu$  thick.

*Host*.—*Mus navalis* (sic).

*Location*.—Intestine.

*Locality*.—Ambukohl, Egypt.

Von Linstow states that the host name given above is a manuscript name and not identifiable. [This might possibly have been *Microtus nivalis*.]

PROTOSPIRURA MURIS (Gmelin, 1790) Seurat, 1915h.

*Synonyms*.—*Lumbrici muris* Werner, 1782; *Ascaris muris* Gmelin, 1790; *Ascaris obtusa* Froelich, 1791; *Fusaria muris* (Gmelin) 1790, Zeder, 1803; *Spiroptera obtusa* (Froelich, 1791) Rudolphi, 1809; *Filaria obtusa* (Froelich, 1791) Schneider, 1866; *Spiroptera* (*Filaria*) *obtusa* Rudolphi of Parona, 1898; *Filaria muris* (Gmelin, 1790) Stossich, 1897; *Spiroptera brauni* von Linstow, 1897.

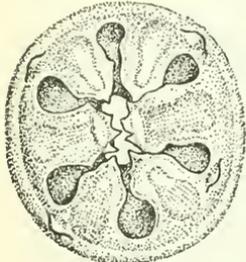


FIG. 265.—PROTOSPIRURA MURIS. HEAD, VIEWED FROM THE FRONT.  $\times 150$  AFTER SCHNEIDER, 1866.

*Specific diagnosis*.—*Protospirura* (p. 203): Rather thick worms with relatively small heads. There are two large lips deeply incised to form six lobes arranged in two parallel rows of three each (fig. 265). When these lips are closed and viewed en face, the central dorsal

and ventral lobes are obviously larger than the others and show in this view a rather square outline. The four other lobes are roughly conical. The two large central lobes bear on their inner faces a long central tooth and two smaller teeth on each side. These lobes terminate at the extremities of their squared distal ends in two papilliform elevations. The four smaller lobes each bear on their inner face one long tooth and on each side of this a series of much smaller serrations. There are four large papillae, one at the base of each small lobe near its union with the large central lobe. The mouth cavity at the base of the lips opens by a wide aperture into the prominent pharynx which is heavily lined with chitin. Numerous bands suspend the pharynx from the body walls. The esophagus is long and gradually enlarges in diameter posteriorly. It has a trihedral lumen. It connects with the intestine by a valve. The cuticle is prominently marked with conspicuous transverse striations, and between the conspicuous striations are numerous fine striations.

*Male* 14 to 28 mm. long with a maximum diameter of over 1 mm.

The head attains a maximum diameter of about  $240\ \mu$ . The pharynx is about twice as long as it is thick, attaining a length of  $140\ \mu$  and a lumen diameter of  $70\ \mu$ . The esophagus attains a length of 3.27 mm. and a maximum thickness of about  $235\ \mu$ . The nerve ring is located far anterior on the esophagus, about  $430\ \mu$  from the anterior extremity in large specimens. The excretory pore is posterior of the nerve ring and  $560\ \mu$  from the anterior extremity of the body. The simple intestine is straight and of fairly uniform diameter from its anterior origin to its union with the cloaca. The posterior extremity of the body is coiled in a spiral and bears two bursal alae (fig. 266). The alae are well developed and rugose, with heavy, wavy, transverse markings. The left one is much longer and wider than the right. There are four pairs of preanal papillae, of which the posterior pair are nearly opposite the cloacal aperture, and two pairs of postanal papillae. There is an unpaired papilla on the anterior edge of the cloacal aperture. The spicules are unequal, the right spicule being longer, thicker, and more uniform in its curvature. It attains a length of about 1.2 mm. and a thickness near its middle of  $30\ \mu$ . The distal extremity terminates in a blunt end beset with very small spiny processes. The left spicule has a more irregular curvature, tending to abrupt bends, and has a chitinous lamella. It attains a length of about 1 mm. and a thickness, inclusive of the lamella, of about  $30\ \mu$ , as in the other spicule, or of  $17\ \mu$  for the body of the spicule exclusive of the lamella. Both spicules have an infundibular dilation proximally. In the bursal region, the ventral surface of the body is marked by elongate cuticular elevations formed by longitudinal depressions cutting into the prominent transverse cuticular annulations. The tail ends bluntly. The distance from the cloacal aperture to the tip of the tail is about  $690\ \mu$  in large specimens. The testis extends forward to a distance equal to about twice the length of the esophagus from the anterior end of the body.

*Female* 15 to 40 mm. long with a maximum thickness of about 1.75 mm. The thick posterior portion of the body terminates in a very blunt rounded end just behind the anus, the most posterior portion being toward the dorsal surface. The maximum head diameter is about  $260\ \mu$ . The esophagus attains a maximum length of about 4.3 mm., which is  $1/9.3$  of the total body length for the speci-

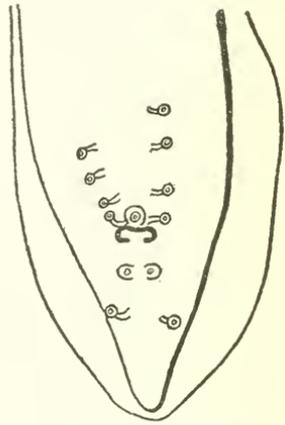


FIG. 266.—*PROTOSPIRURA MURIS*.  
BURSA.  $\times 34$ . AFTER  
SCHNEIDER, 1866.

men, and a maximum thickness of about  $450\ \mu$ . It communicates with the intestine by a large valve. An occasional constriction of the intestine posterior of this valve gives rise to an appearance of the anterior intestine which simulates an esophageal bulb. The nerve ring is far forward on the esophagus as in the male. The anus is about  $520\ \mu$  from the tip of the wedge-shaped dorsal termination of the tail. The vulva is a little anterior of the middle portion of the body, and is a rather elliptical depression. From the vulva the vagina extends in general posteriorly, though it is somewhat looped. The maximum length of the vagina and ovijectors to the bifurcation where the uterine branches originate is about 1 mm. The uteri are divergent. The anterior uterus extends forward about to the posterior end of the esophagus. The elliptical eggs attain a maximum diameter

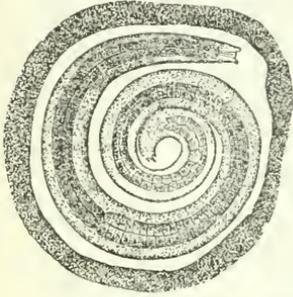


FIG. 267.—PROTOSPIRURA MURIS. ENCAPSULATED LARVA FROM MEAL WORM. AFTER LEUCKART, 1876.

of about  $56$  by  $30\ \mu$ , with a shell about  $4$  to  $5\ \mu$  thick. They contain an embryo when oviposited.

*Life history.*—Leuckart (1867) and Marchi (1871) have described the life history of this worm. The eggs in the feces of the mouse are eaten by meal worms, *Tenebrio* species, and the embryos escape and make their way to the body cavity. In five weeks they develop to encapsulated larvae (fig. 267) very similar to the larvae of species of *Gongyloinema*.

*Hosts.*—*Mus musculus*, *Epimys norvegicus* (*Mus decumanus*), *Epimys rattus* (*Mus rattus*), *Epimys alexandrinus* (*Mus alexandrinus*), *Epimys siporanus* (*Mus siporanus*), *Apodemus sylvaticus* (*Mus sylvaticus*).

*Location.*—Stomach.

*Localities.*—Austria (Vienna), Galicia, Germany (Berlin, Breslau, Greifswald), France (Rennes), Madagascar, island of Mentawai, Brazil, Algeria, United States (Washington, District of Columbia; Idabel, Oklahoma; Colorado Springs, Colorado).

This species often occurs in mice in large numbers. Cobbold (1879) states that he has seen a mouse so heavily infested that it was unable to run. I have seen one case in which the empty stomach was distended by a number of these worms which ballooned the stomach walls as so many clock springs might have done.

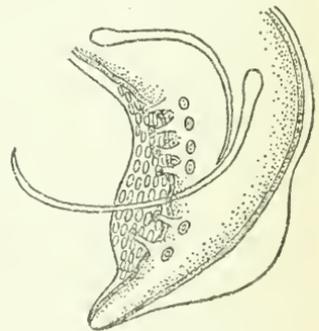


FIG. 268.—PROTOSPIRURA MURIS [SPIROPTERA BRAUNI]. BURSA. ENLARGED. AFTER VON LINSTOW, 1897.

*Spiroptera brauni* von Linstow, 1897 (fig. 268), has been regarded here as a synonym of *Protospirura muris*. This species was recorded from *Epimys rattus* (*Mus rattus*) in Madagascar. It corresponds without conflict with *Protospirura muris*.

**PROTOSPIRURA ASCAROIDEA**

Hall, 1916, new species.

*Specific diagnosis.*—*Protospirura* (p. 203): Large thick worms superficially resembling ascarids. The two large lips have a heavy chitinous investment and are each deeply incised to form three lobes. On the median face each lobe bears a series of teeth, the middle tooth in each series being the largest and most prominent (fig. 269). On each side of this large tooth there are three or four smaller teeth in the middle lobe of each lip and two or three on the two outer lobes of each lip. These teeth are formed by differentiation from a continuous

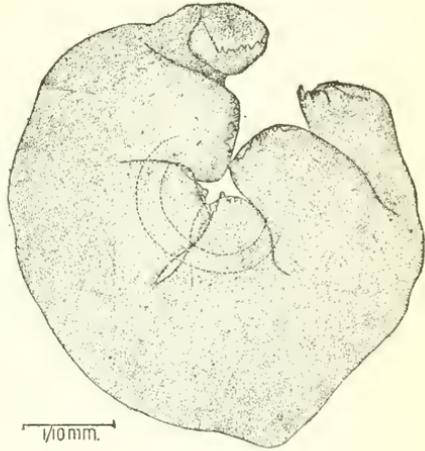


FIG. 269.—PROTOSPIRURA ASCAROIDEA. LIPS, VIEWED FROM THE FRONT.

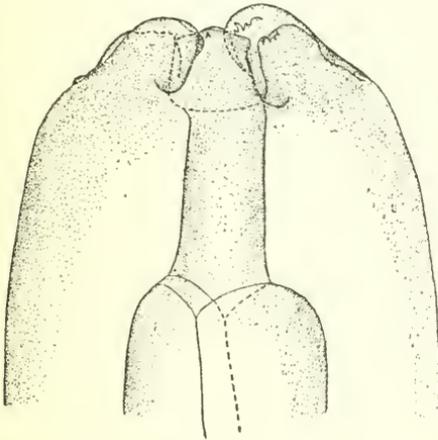


FIG. 270.—PROTOSPIRURA ASCAROIDEA. ANTERIOR EXTREMITY, LATERAL VIEW.

cutting edge between the teeth. Individual teeth may be notched to form secondary denticles. There are four large papillae, one at the base of each small lobe near its union with the large central lobe. There is a large cylindrical pharynx heavily lined with chitin (fig. 270). This chitinous lining is continuous with that covering the lips. Behind this is an esophagus which may be somewhat dilated at its anterior extremity, in which case it quickly diminishes in diameter and then gradually

increases posteriorly, diminishing slightly at its union with the intestine. There is a valve at the union, the posterior portion of the esophagus being prolonged into the middle of the intestinal lumen. The cuticle is annulated with prominent transverse striations, and between these are numerous fine transverse striations.

*Male* 3.5 to 4.5 cm. long and 1 to 1.5 mm. thick (fig. 271). The head attains a maximum diameter of about 260  $\mu$ . The pharynx is about 130  $\mu$  long and the lumen is 60  $\mu$  wide. The esophagus attains a maximum length of about 4.3 mm. and a maximum thick-

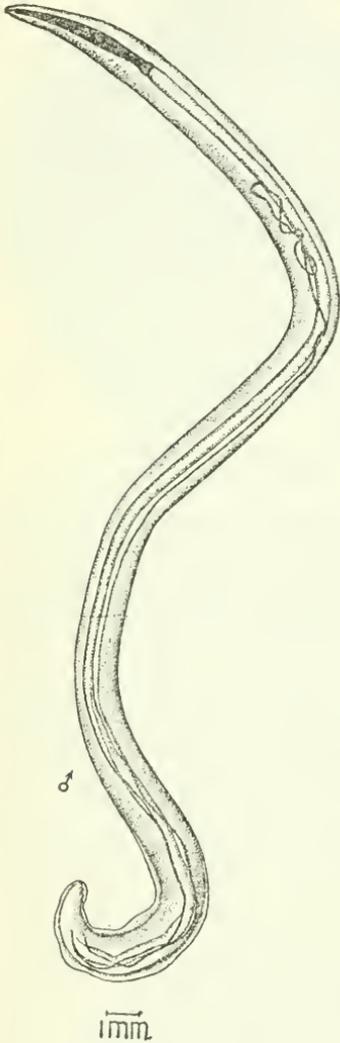


FIG. 271.—*PROTOSTIRURA ASCARIOIDEA*.  
MALE.

ness of 380  $\mu$ . The nerve ring is situated near the anterior extremity of the esophagus, about 450  $\mu$  from the anterior extremity of the body. The intestine constricts near its posterior extremity to form a piriform rectum which connects with the cloaca. There are two bursal alae, of which the left is over three times as long as the right. The ventral surface in the bursal region shows the presence in the superficial structure of numerous refractive bodies. It also presents the usual rounded oblong cuticular markings of this genus and related genera (fig. 272). The spicules are unequal. They present a somewhat irregular curvature and are narrow with a dilated proximal extremity. The right one is 1.29 to 1.43 mm. long and the left is 775 to 860  $\mu$  long, the short one being shorter and the long one longer than the corresponding spicules in *P. muris*. There is a chitinous accessory piece in the vicinity of the cloacal aperture. The cloacal aperture is on an elevation 860  $\mu$  to 1.11 mm. from the posterior extremity of the body. The posterior portion of the body is coiled in one or two turns and is much more rigid than the anterior portion. It terminates in a rounded end from which the bursal alae recurve posteriorly and then turn anteriorly.

There are four pairs of large pre-anal papillae, which are increasingly larger from the one nearest to the cloacal aperture to the one farthest away, and two pairs of large postanal papillae, of which the posterior pair, about midway between the cloacal aperture and the end of the tail,

is the largest and most prominent of the caudal papillae. The testis extends anteriorly to a point more than twice the length of the esophagus from the anterior end. The transformation from the vas deferens to the vesicula seminalis is strongly marked.

*Female* 7.5 to 8.5 cm. long with a maximum thickness of over 2 mm. (fig. 273). The posterior extremity of the body terminates in a blunt cone which rounds off almost hemispherically. The head attains a maximum diameter of about 350  $\mu$ . The pharynx is about

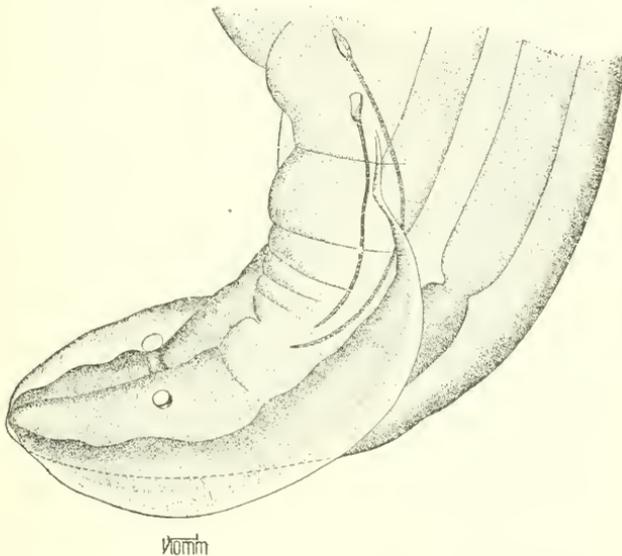


FIG. 272.—PROTOSPIRURA ASCAROIDEA. POSTERIOR EXTREMITY OF MALE.

155  $\mu$  long and the lumen is about 95  $\mu$  wide. The esophagus has a maximum length of about 5.2 mm. and a maximum thickness of about 575  $\mu$ . The nerve ring is situated near the anterior extremity of the esophagus, about 380  $\mu$  from the anterior extremity of the body. The intestine is constricted near its posterior extremity and then expanded in a discoid structure which connects by a short narrow tube with the anus (fig. 274). The anus is 1.37 to 1.46 mm. from the tip of the tail. The vulva is a little anterior of the union of the anterior and middle third of the body. The short muscular vagina (fig. 275) extends posteriorly from the vulva for a distance of about 515  $\mu$ , where it meets a not so clearly delimited sphincter region about 260  $\mu$  long. From this the common trunk of the uterus, distended with eggs, extends a distance of 2.24 mm. and forms the two divergent uterine branches. The anterior uterus

extends forward to the posterior extremity of the esophagus, and the posterior uterus extends back almost to the anus.

The eggs are 55 to 60  $\mu$  by 32 to 35  $\mu$  in diameter and contain an embryo when oviposited (fig. 276).

*Host.*—*Geomys breviceps*.

*Location.*—Stomach.

*Locality.*—Norman, Oklahoma.

*Type material.*—No. 17942, U. S. N. M. (Bureau of Animal Industry helminthological collection).

I am indebted for this material, as well as for much other material not yet described, to the courtesy of Mr. Herman Douthitt, of the University of Chicago.

It should be noted that the type-species of this genus has two cervical papillae, the esophagus is a third to a fifth as long as the body, the vulva is near the middle of the body, the bursal alae are equal, and each lobe of the lips bears only three teeth. It does not appear, however, that these differences between the type-species and the species included here can be looked on as of more than specific value in view of the consistent resemblance in other respects.

*P. ascaroidea* is a decidedly larger species than *P. muris*, but corresponding structures

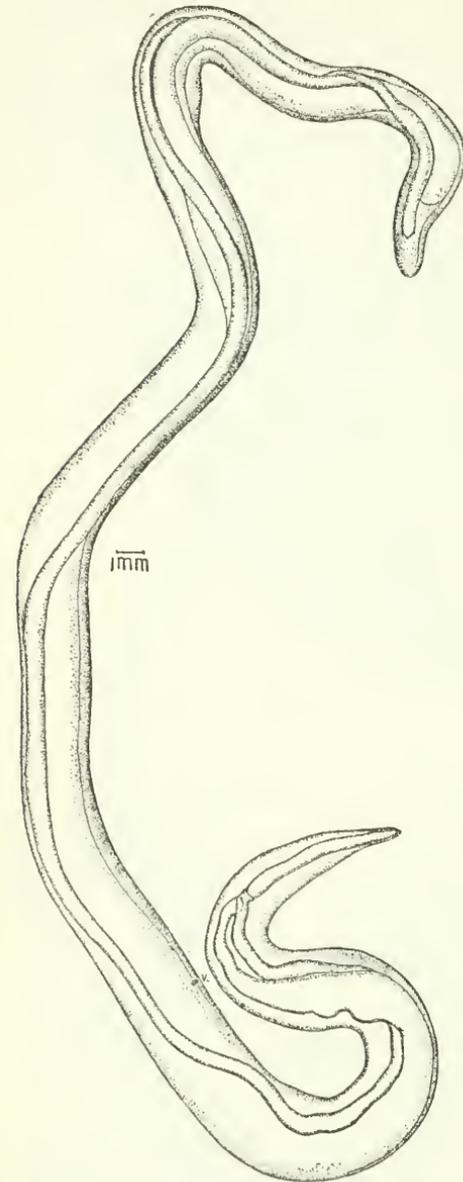


FIG. 273.—*PROTOSPIRURA ASCAROIDEA*, FEMALE.  
v., VULVA.

in the two species are very similar, and the two species are very closely related.

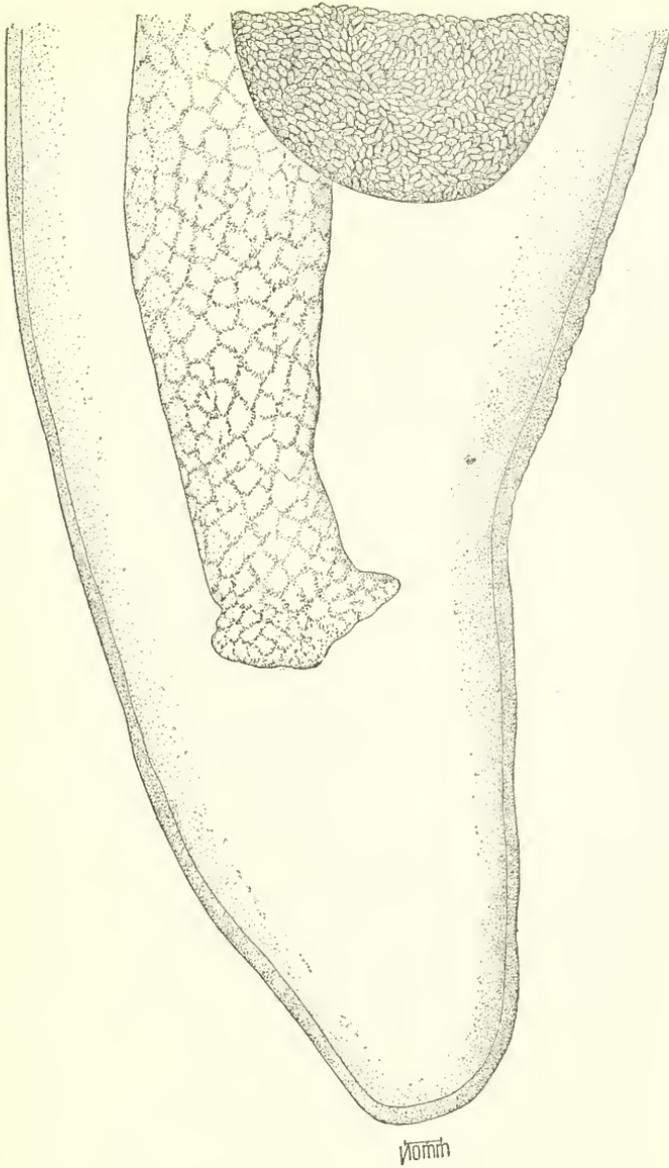
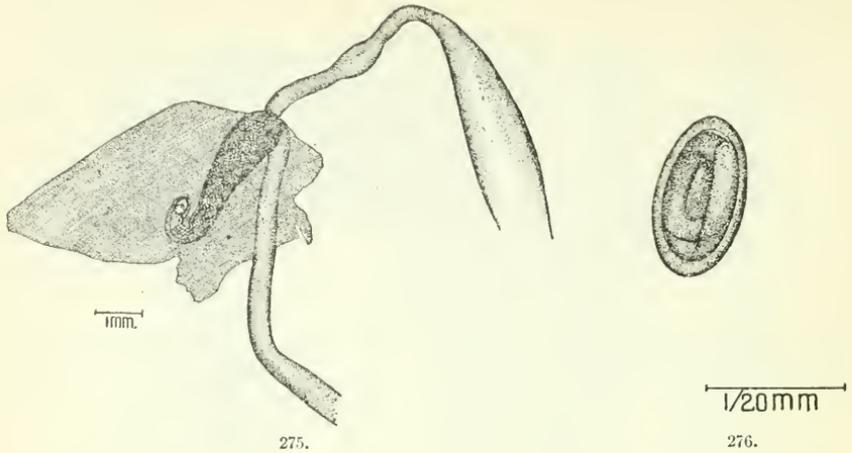


FIG. 274.—PROTOSPIRURA ASCARIOIDEA. POSTERIOR EXTREMITY OF FEMALE.



FIGS. 275, 276.—*PROTOSPIRURA ASCAROIDEA*. 275, TERMINAL GENITALIA OF FEMALE. 276, EGG.

Genus *PHYSALOPTERA* Rudolphi, 1819.

*Generic diagnosis*.—Spirurinae (p. 199): Mouth with two equal lips, each with three papillae and armed with teeth. Variable cuticular expansions posterior of the lips. Caudal bursa formed by a cuticular border of the deeply excavated posterior extremity and with this border continuous anteriorly across the ventral surface and connecting the lateral borders. Many caudal papillae of which four pairs, two preanal and two postanal, are stalked. Two unequal or subequal spicules. Two ovaries. Vulva toward the anterior portion of the body. Oviparous. Parasitic in the digestive canal, especially the stomach, of mammals, birds, and reptiles.

*Type-species*.—*Physaloptera clausa* Rudolphi, 1819.

ANALYTICAL KEY TO SPECIES OF *PHYSALOPTERA*.

1. Male 6 mm. long. Female unknown.....*Physaloptera spirula*, p. 213.  
Male, where known, 9 mm. long or longer. Females known..... 2.
2. Females 7 to 13 mm. long. Males unknown.....*Physaloptera citilli*, p. 213.  
Females 14 mm. long or longer. Males known..... 3.
3. Males over 20 mm. long. Females over 33 mm. long.  
*Physaloptera muris-braziliensis*, p. 213.  
Males less than 20 mm. long. Females less than 33 mm. long..... 4.
4. Males 15 mm. long or longer and with a pair of postanal papillae close to the tip of the tail. Eggs spherical, 16 to 22  $\mu$  in diameter.  
*Physaloptera sciuri*, p. 217.  
Males less than 15 mm. long; or if that long, with the last pair of postanal papillae relatively remote from the tip of the tail. Eggs elliptical and with a maximum diameter exceeding 22  $\mu$ ..... 5.
5. Males 15 mm. long or longer. Females over 20 mm. long.  
*Physaloptera circularis*, p. 215.  
Males less than 10 mm. long. Females less than 20 mm. long..... 6.
6. Bursa margin with numerous scallops. Of the sessile caudal papillae there are 1 large unpaired preanal and 1 large unpaired postanal, and 2 pairs of postanal.....*Physaloptera ruwenzorii*, p. 216.

Bursa margin not scalloped. Of the sessile caudal papillae there are 1 unpaired preanal, 1 pair of preanal, and 5 pairs of postanal.

*Physaloptera abbreviata*, p. 214.

PHYSALOPTERA SPIRULA Hemprich and Ehrenberg, 1828.

*Specific diagnosis.*—*Physaloptera* (p. 212): Head continuous with body. Mouth papillate.

*Male* 6 mm. long. Caudal extremity of the body provided with closed bursal alae.

*Female* unknown.

*Hosts.*—*Procavia syriaca* (*Hyrae syriacus*), (?) *Procavia capensis* (*Hyrae capensis*).

*Location.*—Large intestine.

*Localities.*—Syria and Arabia.

This species has been left in the genus *Physaloptera* because it was put in that genus and there is no evidence to show where it belongs. At the same time, the head structure, the size of the male, and the site of infestation suggest that this is not a species of *Physaloptera* within the present limits of the genus. Molin (1860c) has listed this species, apparently erroneously from *Hyrae capensis* (= *Procavia capensis*).

PHYSALOPTERA CITILLI (Rudolphi, 1819) Hall, 1916.

*Synonym.*—*Spiroptera citilli* Rudolphi, 1819.

*Specific diagnosis.*—*Physaloptera* (p. 212): Body curved. Anterior extremity very slightly attenuated. Head rounded, continuous with the body, and with the cuticle inflated. Mouth with two large lips. Six head papillae, of which there are two conical papillae situated on each side near the angle of contact of the two lips, and one spherical papilla at the base of each lip. Cuticle densely striate transversely.

*Male* unknown.

*Female* 7 to 13 mm. long and 400  $\mu$  thick. Posterior extremity obtuse. Vulva in anterior portion of body.

*Host.*—*Citellus citellus* (*Arctomys citillus*).

*Location.*—Stomach.

*Locality.*—Not given.

Molin (1860a) has intimated that this species belongs in the genus *Physaloptera*, and, inasmuch as the evidence favors this view and the genus *Spiroptera*, to which Rudolphi assigned it, is without standing, it has accordingly been transferred to *Physaloptera*.

PHYSALOPTERA MURIS-BRAZILIENSIS Diesing, 1861.

*Synonym.*—*Spiroptera bilabiata* Molin, 1860a, not *Spiroptera bilabiata* (Creplin, 1829) Dujardin, 1845.

*Specific diagnosis.*—*Physaloptera* (p. 212): Body attenuated anteriorly and enlarged posteriorly. There are two large lips, each with

a large flat papilla (fig. 277). The lips bear a small obtuse tooth externally and some leaflike inner teeth. The body is annulated with prominent transverse striations.

*Male* 24 to 30 mm. long. There are one unpaired preanal papilla and one pair of preanal papillae, and one unpaired postanal papilla and three pairs of postanal papillae (fig. 278). The unpaired preanal papilla is situated on the anterior edge of the cloacal aperture, and the unpaired postanal papilla is situated between the first and second pairs of postanal papillae.



FIG. 277.—*PHYSALOPTERA MURIS-BRAZILIENSIS*. LIP, LATERAL VIEW. ENLARGED. AFTER VON DRASCHE, 1883.

*Female* 34 to 45 mm. long. Caudal extremity straight and very obtuse. Anus close to tip of tail.

*Host*.—"Mus braziliensis."

*Location*.—Stomach and small intestine.

*Locality*.—Brazil.

This species was restudied by von Drasche (1882).

Diesing uses this name in the form *Physaloptera muris braziliensis*. It is apparently binomial in intent and has been retained here with the addition of the hyphen to conform to present usage.

*PHYSALOPTERA ABBREVIATA* Rudolphi, 1819.

*Synonym*.—*Physaloptera abbreviata* Rudolphi of Parona, 1909.

*Specific diagnosis*.—*Physaloptera* (p. 212): Body broad and compressed. Cuticle thick and strongly undulant. Two thorn-shaped cervical papillae,

one in the dorsal and one in the ventral line. Mouth with two large lips, each bearing a large wedge-shaped tooth and on the inner face a number of small teeth (fig. 279). Each lip bears three papillae. The esophagus is one-twelfth as long as the entire body.

*Male* 9 mm. long and 600  $\mu$  thick. The bursa has a scalloped edge (fig. 280). The ventral surface of the body in the bursal region bears numerous conical cuticular points in longitudinal rows. There are one pair of sessile preanal papillae and one unpaired preanal papilla, and five pairs of postanal sessile papillae. The three preanal papillae and the first two pairs of postanal papillae are situated close to the

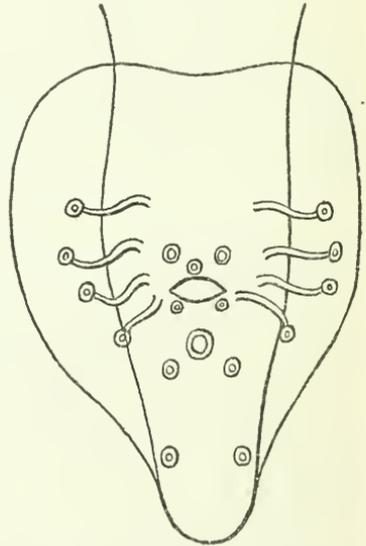


FIG. 278.—*PHYSALOPTERA MURIS-BRAZILIENSIS*. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. ENLARGED. AFTER VON DRASCHE, 1883.

cloacal aperture. The spicules are long and bent. The larger spicule is 2.7 mm. long. The tail is one-twenty-seventh as long as the entire body.

*Female* 18 mm. long and 870  $\mu$  thick. The rounded tail end is one-forty-seventh as long as the entire body. The vulva is in the anterior portion of the body and divides the body in the ratio of 8:31. The thick-shelled eggs are elliptical and are 36 by 20  $\mu$  in diameter.

*Host.*—*Graphiurus murinus*.

*Location.*—Stomach.

*Locality.*—Bhuinga, Africa.

This species was described from reptiles and has been reported from reptiles. Von Linstow (1883) has reported it as a pseudo-parasite in the stomach of *Ciconia alba*, in which case it was apparently to be referred to snakes forming part of the diet.

Parona (1909) reports it from *Graphiurus murinus*, under the name *Ph. abbrejyata*, which is apparently a misprint for *Ph. abbreviata*. He states that there were two males and three females, but makes no comment of any sort. The record is strongly suggestive of an error of some sort. If there is no error, then the record, or a record of anything quite out of the ordinary, should carry some comment to relieve the reader of the suspicion that there is an error of some sort.

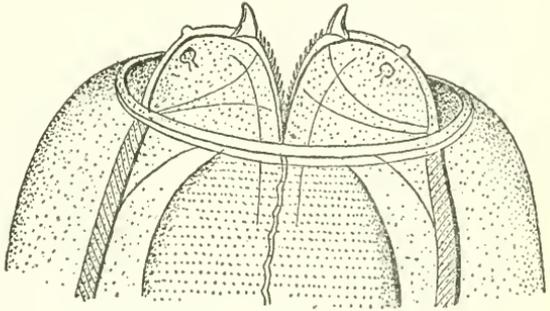


FIG. 279.—PHYSALOPTERA ABBREVIATA. ANTERIOR EXTREMITY. ENLARGED. AFTER VON LINSTOW, 1883.

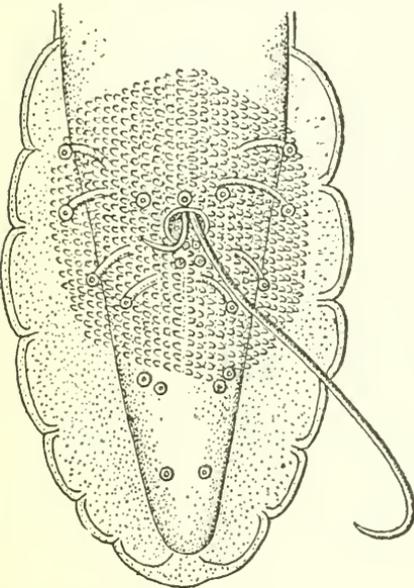


FIG. 280.—PHYSALOPTERA ABBREVIATA. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. ENLARGED. AFTER VON LINSTOW, 1883.

PHYSALOPTERA CIRCULARIS  
von Linstow, 1897.

*Specific diagnosis.*—*Physaloptera* (p. 212): The head is

surrounded by a cuticular fold. There are two lips, each projecting forward in a small cone and bearing two rounded swellings on the inside and three papillae on the outside. The cuticle is deeply striated transversely at intervals of 44  $\mu$ .

*Male* 15.2 mm. long and 800  $\mu$  thick. The esophagus is  $1/4.3$  of the entire body length and the tail is  $1/15.4$  of the entire body length. The cloacal aperture is surrounded by a circular cuticular fold (fig. 281). There are a pair of sessile preanal papillae close to the cloacal aperture anteriorly, and an unpaired sessile postanal papilla close to the cloacal aperture posteriorly. There are also three pairs of sessile postanal papillae, the last of which is remote from the posterior extremity of the body, and the first two of which are close together.

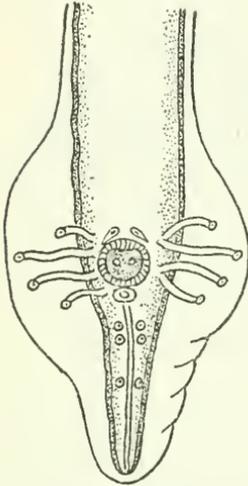


FIG. 281.—PHYSALOPTERA CIRCULARIS. POSTERIOR EXTREMITY OF MALE, VENTRAL VIEW. AFTER VON LINSTOW, 1897.

*Female* 24 mm. long and 1.9 mm. thick. The tail is one-sixty-first of the entire body length. The very thick-shelled eggs are elliptical and 49 by 33  $\mu$  in diameter.

*Host.*—*Epimys rattus* (*Mus rattus*).

*Location.*—Stomach.

*Locality.*—Madagascar.

Von Linstow, in his description of this species, notes that the caudal papillae are different from those in *Ph. muris-braziliensis*.

PHYSALOPTERA RUWENZORII Parona, 1907.

*Specific diagnosis.*—*Physaloptera* (p. 212):

Body attenuated for a short space anteriorly.

Head with lips limiting the large buccal

aperture with small papillae on each and without lateral membranous lobes (fig. 282). The teeth are large, conical, and mammilated. The esophagus is one-sixth or more of the entire body length. The intestine is straight.

*Male* 9 to 9.5 mm. long. The copulatory bursa (fig. 283) is large. It comprises a large circular expansion anteriorly, prolonged posteriorly by a conical portion. The circular anterior portion bears a large sessile unpaired preanal papilla and a large sessile unpaired postanal papilla. The conical posterior portion bears two pairs of large sessile postanal papillae. The spicules are straight except for a slight curve at the distal extremity. The spicule sheath is imbutiform, with a circular aperture posteriorly (fig. 283). The testis extends forward to the level of the posterior extremity of the esophagus. Posterior of this point it is looped, but it becomes straight at the anterior origin of the posterior third of the body.



FIG. 282.—PHYSALOPTERA RUWENZORII. HEAD, LATERAL VIEW. ENLARGED. AFTER PARONA, 1909.

*Female* 14 to 17 mm. long. The tail is long, attenuating toward the extremity. The vulva is at the union of the anterior and middle third of the body. It has an elevated margin and is surrounded by

papillae (fig. 284). The anterior ovary extends forward as far as the posterior extremity of the esophagus. The very numerous eggs are large, elliptical, and thick shelled, and not well developed when oviposited.

*Hosts.*—*Arvicanthus abyssinicus*, *Epimys ugandae* (*Mus ugandae*).

*Location.*—Intestine.

*Locality.*—Fort Portal, Africa.

Parona (1909) states that there are two small papillae posterior of the cloacal aperture, but his figure is not in harmony with this. He also says that the body is not striated, but this is contradicted by his figures and is contrary to the condition customary in *Physaloptera* and related genera.

I have assumed in the key that eggs stated as "large" exceed  $22\ \mu$  in diameter. That these eggs should not be well developed at oviposition is rather surprising.

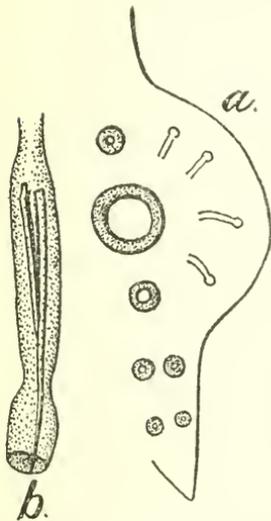


FIG. 283.—*PHYSALOPTERA RUWENZORII*. *a*, POSTERIOR EXTREMITY OF MALE; *b*, SPICULES. ENLARGED. AFTER PARONA, 1909.

*PHYSALOPTERA SCIURI*  
Parona, 1898.

*Specific diagnosis.*—*Physaloptera* (p. 212):  
Mouth with two large lips



FIG. 284.—*PHYSALOPTERA RUWENZORII*. VULVA. ENLARGED. AFTER PARONA, 1909.

of circular contour. Each lip bears leaflike external teeth and has two papillae at its base (fig. 285). There is a large cuticular ring at the base of the head. The cuticle is transversely striated.

*Male* 16 mm. long and  $500\ \mu$  thick. The head is  $13\ \mu$  in diameter at the level of the cuticular ring. The cuticular striations are at intervals of  $25\ \mu$  and are more distinct in the posterior portion of the body. The bursa is large and lanceolate in outline (fig. 286). No sessile preanal papillae observed. There are three pairs of sessile postanal papillae and one unpaired sessile postanal papilla. This latter is close to the cloacal aperture. The posterior pair of postanal papillae are close to the tip of the tail and the other two pairs of postanal papillae are near the margin of the bursa and approximately midway between the posterior pair and the unpaired papilla. There are numerous cuticular elevations in the postanal region, a prominent series extending from the last pair of postanal papillae to the last pair of stalked papillae. The cloacal aperture is large and circular and has a scalloped, elevated margin.

*Female*.—17 to 32 mm. long and 1 mm. thick. The posterior extremity is obtuse. The vulva is not prominent and is located near the union of the anterior and middle thirds of the body. The small eggs are spherical and are 16 to 22  $\mu$  in diameter.

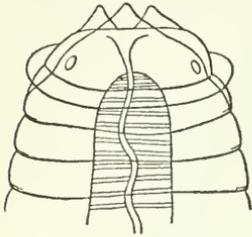


FIG. 285.—PHYSALOPTERA SCIURI. ANTERIOR EXTREMITY, LATERAL VIEW. ENLARGED. AFTER PARONA, 1898.

*Host*.—*Sciurus melanogaster*.

*Locotion*.—Stomach and intestine.

*Locality*.—Island of Mentawai.

Parona (1909) states that there is a single uterus extending posteriorly from the vulva, "L'utero ad un solo tubo e che si estende all'indietro." This can hardly be accepted as correct, even on Parona's authority. His figures indicate that this is a species of *Physaloptera*, and it is more likely that one branch of a uterus has been overlooked, a very simple matter, than that we have here a species with the other characteristics of *Physaloptera*, but with a single uterus. Incidentally it may be noted that the shape of the eggs is unusual, and correlated with the small size it suggests that the eggs observed were immature.

Subfamily ARDUENNINAE Railliet and Henry, 1911.

*Subfamily diagnosis*.—Spiruridae (p. 190): Mouth with two lips leading into a pharynx, which is strengthened by cuticular ridges in the form of rings or spirals. Spicules unequal, the longer several times the length of the shorter. Four pairs of pre-anal papillae. Eggs containing embryos when oviposited.

*Type-genus*.—*Arduenna* Railliet and Henry, 1911.

Genus PHYSOCEPHALUS Diesing, 1861.

*Generic diagnosis*.—Arduenninae (p. 218): Body elongated, tapering slightly anteriorly. Head marked off from the remainder of the body by a cuticular inflation ending abruptly in a circular line a short distance anterior of the posterior end of the pharynx. Extending from the base of the cuticular inflation to about the middle of the body are six lateral alae, three on each side, the middle wing of each side being wider than the others. Mouth with two lips, each incised to form three lobes and each lobe bearing one papilla. The mouth communicates with an inconspicuous buccal cavity which is without teeth, and this in turn opens into a relatively long and

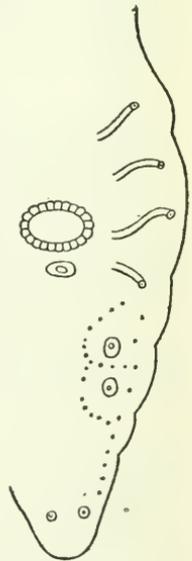


FIG. 286.—PHYSALOPTERA SCIURI BURSA. ENLARGED. AFTER PARONA, 1898.

wide pharynx. The walls of the pharynx are marked by cuticular ridges in the form of both spirals and rings and extending the length of the pharynx. The tail of the male is twisted spirally and furnished with a narrow symmetrical bursa supported by four pairs of preanal papillae. Spicules long and unequal, the left spicule about five times as long as the right. Vulva somewhat posterior of the middle of the body. Eggs smooth, with thick shells, and containing embryos when oviposited. Endoparasitic in the stomach of Suidae and rodents.

*Type-species*.—*Physocephalus sexalatus* (Molin, 1860a) Diesing, 1861.

**PHYSOCEPHALUS MEDIOSPIRALIS** (Molin, 1860a) Hall, 1916.

*Synonyms*.—*Spiroptera mediospiralis* Molin, 1860a; *Spiroptera tapiri-americanum* in M. C. V. of Molin, 1860a; *Spiroptera caviae aguti* in M. C. V. of Molin, 1860a; *Spiroptera chrisoptera* Molin, 1858a, of von Drasche, 1882.

*Specific diagnosis*.—*Physocephalus* (p. 218): Body twisted spirally in the middle, attenuate anteriorly and enlarged posteriorly. Head distinct from body and with inflated cuticle (fig. 287). Pharynx with

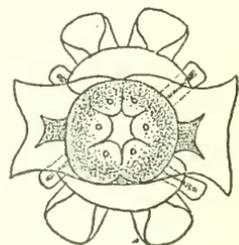


FIG. 287.—PHYSOCEPHALUS MEDIOSPIRALIS. HEAD, VIEWED FROM THE FRONT.  $\times 280$ . AFTER VON DRASCHE, 1884.

rings and spirals. Anterior extremity gradually attenuate and truncate at head end. Three lateral alae on each side, the median the larger, and all transversely striated. Posterior extremity thickened.

*Male* 26 to 36 mm. long and 400  $\mu$  thick. Posterior extremity twisted in a spiral of three turns and terminating obtusely. Bursal membrane sustained by four papillae. One spicule is long, thick, and tubular; the other spicule not noted.

*Female* 40 to 46 mm. long and 500  $\mu$  thick. Posterior extremity thickened and only slightly bent; terminates in an obtuse, umbonate tip. Anus near the tip of the tail. Vulva not observed.

*Host*.—*Dasyprocta aguti* (*Dasyprocta agouti*).

*Location*.—Stomach.

*Locality*.—Brazil.

In the above description the statement that the pharynx has rings and spirals is based on a statement that the body is so marked. It is very easy to get the impression that the markings of the pharynx are on the body in mounts of *Physocephalus* and *Arduenna*. Moreover, such spiral markings would be highly exceptional in the body, whereas they fit with the rest of the description if regarded as pharyngeal markings.

Von Drasche (1882) regards *Spiroptera mediospiralis* Molin, 1860a, and *Spiroptera chrisoptera* Molin, 1858a, both of which species have been reported from *Tapirus americanus*, as identical.

If this view is correct, the specific name used here is the wrong one. Von Drasche examined the material for both species. On the other hand, Molin (1860a) groups these species in two different groups in his monograph of the genus *Spiroptera*, regarding *S. mediospiralis* as armed and *S. chrisoptera* as unarmed. In view of the fact that modern parasitologists have confused *Arduenna strongylina* and *Physocephalus sexualatus* from swine in recent years, it would not be surprising if two different species looked alike to von Drasche. Accordingly, *S. mediospiralis*, which is the one of the two species in question which has the characteristic six lateral alae and is the one reported from *Dasyprocta agouti*, is transferred to *Physocephalus*, leaving the possible identity of *Spiroptera chrisoptera* to be determined, if possible, by a reexamination of the original material or a study of new material from the hosts in question.

*Physocephalus mediospiralis* is described as having a head with four tubercles in cruciform arrangement and with pointed apices, and with an orbicular, large, bare mouth. This hardly conforms to the generic characteristics of *Physocephalus*, but in view of the agreement on other points it seems likely that further study would result in a better statement of the lip and mouth structure which would conform with the generic characteristics.

#### Subfamily uncertain.

#### ANALYTICAL KEY TO UNPLACED SPECIES OF SPIRURIDAE.

1. Found in urinary bladder.....*Spiroptera rattii*, p. 221.  
Not found in urinary bladder..... 2.
2. Adult worms with 4 lateral alae in cruciform arrangement.  
*Spiroptera quadrialata*, p. 221.  
Adults or larvae without lateral alae..... 3.
3. Adult worms with a bifid tail; found in liver.....*Filaria bifida*, p. 221.  
Adults without a bifid tail, or larvae; not found in liver..... 4:
4. Adult worms found in the body cavity.....*Filaria conica*, p. 222.  
Larval, or probably larval, worms..... 5.
5. Undescribed species found in esophageal nodules...*Spiroptera hystriehis*, p. 222.  
Not found in esophageal nodules..... 6.
6. In abdominal cavity, stomach, walls of stomach, and in cecum of *Scarturus tetradactylus* (*Dipus tetradactylus*).  
*Nematoideum dipodis-tetradactyli*, p. 223.  
Not reported from *Scarturus tetradactylus* (*Dipus tetradactylus*)..... 7.
7. Undescribed species from stomach of *Mus* species (*Mus minimus*).  
*Spiroptera* species von Linstow, p. 223.  
Described species from cysts in walls of digestive tract of rat.  
*Spiroptera* species Gerstaecker, p. 223.

It is quite possible that some of the species listed in this key are not properly referable to the Spiruridae or even to the Filarioidea. In the absence of adequate data, the judgment and authority of the

person proposing the name is all we have on which to assign species to higher taxonomic groups.

SPIROPTERA RATTI Diesing, 1851.

*Specific diagnosis.*—None.

*Host.*—*Epimys rattus* (*Mus rattus*).

*Location.*—Urinary bladder.

*Locality.*—Germany (Berlin).

This species was proposed for a nematode recorded by Gurlt with no data other than the host, location, and locality, and must be regarded as a *nomen nudum*. The worm may or may not have been *Trichosomoides crassicauda*.

SPIROPTERA QUADRIALATA Molin, 1860a.

*Specific diagnosis.*—Spiruridae (?) (p. 190): Head continuous with body. Mouth aperture triangular and provided with papillae. No lips or buccal cavity. Anterior extremity abruptly attenuate, with truncate tip. Body with four broad lateral alae arranged in cruciform fashion.

*Male* unknown.

*Female* 8 mm. long and 200  $\mu$  thick. Posterior extremity of body gradually attenuates to form a long and very sharp cone. The anus is remote from the tip of the tail. The vulva is in the posterior portion of the body. It has two lips and bears papillae anteriorly and posteriorly in the median line.

*Host.*—*Mus musculus*.

*Location.*—Stomach.

*Locality.*—Brazil.

The above description suggests that there is an error here. While the site of infestation and the claim that the vulva is in the posterior portion of the body would bear out the assignment of this species to the genus *Spiroptera*, other things throw considerable doubt on this. The structure of the tail and position of the anus suggest *Oxyuris*, and, in view of the alae, this worm is probably *Oxyuris tetraptera*, erroneously reported from the stomach of its customary host. The record as to the position of the vulva is probably due to an error in observation.

FILARIA BIFIDA Molin, 1858b.

*Synonyms.*—*Filaria muris-scandentis* of Molin, 1858b (label name); *Dicheilonema bifidum* (Molin, 1858b) Diesing, 1861.

*Specific diagnosis.*—Spiruridae (?) (p. 190): Body attenuated at both extremities, with a very short bifid tail tip. Mouth elliptical, with two small unarmed lips.

*Male* 50 mm. long. Posterior extremity spirally enrolled.

*Female*.—Posterior extremity curved.

*Host*.—*Kannabateomys amblyonyx* (*Dactylomys amblyonyx*).

*Location*.—Liver.

*Locality*.—Brazil (Majo and Ypanema).

This is one of the species placed by Diesing (1861) in his genus *Dicheilonema*. This genus is based on a rather uncertain set of characters. In his generic diagnosis he states that there are usually two ovaries in the female, but occasionally more. The type-species, *Dicheilonema labiatum* (Creplin, 1825) Diesing, 1861, selected by Stiles and Hassall (1905), has five ovaries. Since it is more unlikely that *Filaria bifida* has five ovaries than that it has two, the genus *Dicheilonema* has been left out of consideration in this paper.

FILARIA CONICA Molin, 1858b.

*Synonym*.—*Dicheilonema conicum* (Molin, 1858b) Diesing, 1861.

*Specific diagnosis*.—Spiruridae (?) (p. 190): Filiform body attenuated anteriorly and posteriorly but increasing slightly in diameter in the vicinity of the mouth. Mouth elliptical, with two small conical unarmed lips.

*Male* unknown.

*Female* 42 mm. long and 500  $\mu$ . thick. Posterior extremity curved, with a mucronate tip.

*Hosts*.—*Dasyprocta aguti* (*Dasyprocta agouti*), *Myoprocta acouchy* (*Cavia acushy*).

*Location*.—Abdominal cavity.

*Locality*.—Brazil.

As in the case of *Filaria bifida*, this species has been placed by Diesing (1861) in his genus *Dicheilonema*, but that genus has not been held to apply in this case for the reasons given in discussing the foregoing species. The incomplete description does not permit of placing the species in any other genus.

SPIROPTERA HYSTRICHIS (Rudolphi, 1809) Rudolphi, 1819.

*Synonym*.—*Strongylus hystrichis* Rudolphi, 1809.

*Specific diagnosis*.—None.

*Host*.—*Hystrix cristata*.

*Location*.—In nodules in the esophagus.

*Locality*.—Italy.

The finding of this worm was recorded by Redi (1708). The name given by Rudolphi is entirely unaccompanied by descriptive data and is a *nomen nudum*. There is no evident reason why the

worm should be transferred from the genus *Strongylus* to *Spiroptera*, but in default of any contradictory indications his latest choice is followed instead of the earlier one.

NEMATOIDEUM DIPODIS-TETRADACTYLI Creplin, 1844.

*Specific diagnosis*.—None.

*Host*.—*Scarturus tetradactylus* (*Dipus tetradactylus*).

*Location*.—In abdominal cavity, the stomach, the walls of the stomach, and the cecum.

*Locality*.—Germany (Breslau).

This record is placed here on the chance that it might be a larval member of the Filarioidea. There is no more likelihood of this, probably, than there is that it is a member of the Strongyloidea. The name *Nematoideum* is noncommittal, as it is a collective group name without generic status or type species, and is erected for the reception of species that can not be referred to any existing genera.

SPIROPTERA species von Linstow, 1901.

*Specific diagnosis*.—None.

*Host*.—*Mus* species (“*Mus minimus*”).

*Location*.—Stomach.

*Locality*.—Nyassa Lake, German East Africa.

Von Linstow states in comment that the material covered by this record was sexually undeveloped.

SPIROPTERA species Gerstaecker, 1866.

*Synonyms*.—*Spiroptera* species Bakody, 1866; *Trichina bakodyi* Cobbold, 1879.

*Specific diagnosis*.—Spiruridae (?) (p. 190): Cysts 640 to 700  $\mu$  long and 520  $\mu$  thick. The coiled-up worm in the cyst occupies a lumen 350 to 370  $\mu$  in diameter, while the cyst wall is 100 to 120  $\mu$  thick (fig. 288). The larva is 1.4 mm. long and 100 to 110  $\mu$  thick. The body appears compressed rather than slender. It narrows close to the anterior end and attenuates to form a conical termination posterior of the anus. The cuticle is transversely striated. On each side of the mouth aperture the head projects in a small, pointed, conical, sharply contoured papilla (fig. 289). The anal aperture is ventral, but it lies toward the periphery in the coiled-up worm in the cyst and so gives the impression of being dorsal. The tail ends in a knob-shaped process bearing on its surface small conical spines (fig. 290). One specimen shows seven of these on the

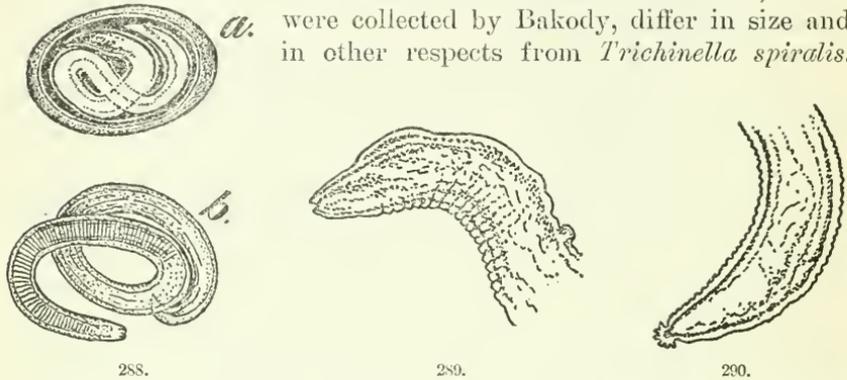
terminal edge and five or six on the upper surface of the knob. The posterior portion of the intestine is slightly bent in an S shape.

*Host.*—*Epimys* species, "rat."

*Location.*—Encysted in walls of the digestive tract.

*Locality.*—Hungary (Budapest).

Gerstaecker notes that these worms, which were collected by Bakody, differ in size and in other respects from *Trichinella spiralis*.



FIGS. 288-290.—SPIROPTERA SPECIES. 288, *a*, WORM IN CYST; *b*, REMOVED FROM CYST. AFTER GERSTAECKER, 1866. 289, ANTERIOREXTREMITY. ENLARGED. AFTER GERSTAECKER, 1866. 290, POSTERIOREXTREMITY. ENLARGED. AFTER GERSTAECKER, 1866.

It might also be noted that they do not agree with the larval *Ollulanus*, which might also be considered as a possibility in this case. The posterior extremity does agree with that of larval members of the Filarioidea, such as the larval *Habronema muscae* described by Ransom (1913).

There are some minor discrepancies in the measurements given for the cysts in the above description.

## ADDENDUM.

Seurat (1916: Compt. rend. Soc. de biol., Par., v. 79 (2), pp. 64-68, figs. 1-3) has recently divided *Oxyuris* as follows: *Oxyuris* Rudolphi, type *O. equi* (Schrank); *Passalurus* Dujardin, type *P. ambiguus* (Rudolphi); *Syphacia* Seurat, type *S. obvelata* (Rudolphi); and *Fusarella* Seurat, type *F. vermicularis* (Linnæus). Railliet and Henry (1916: Ibidem, v. 79 (3), pp. 113-115) follow him with a paper dividing the Oxyuridae into five groups as follows: (1) Those forms with a single spicule, no gubernaculum, and the vulva anterior to posterior in location; (2) those with one spicule and a gubernaculum, vulva anterior or posterior; (3) those with two equal spicules, no gubernaculum, and vulva in the middle or posterior; (4) those with two equal spicules and a gubernaculum, and the vulva in the middle or rarely anterior; (5) those with two unequal spicules and a gubernaculum, and with the vulva near the anus. The species included in the present paper would fall for the most part in the genus *Syphacia*, which is in the second group; *O. triradiata* apparently remains in the restricted genus *Oxyuris*, in the first group; and some may fall in *Enterobius* (of which *Fusarella* and *Oxyurias* are synonyms) in the first group. The genus *Welcomea* Sambon, 1907, founded on the eversion of the vagina, may need to be considered with a view to differentiating its species from those of *Syphacia*.

Seurat (1916: Ibidem, v. 79 (3), pp. 143-146, figs. 1-5) notes that *Protospirura numidica* Seurat, 1915, originally described from *Felis ocreata*, is a pseudo-parasite in that host and a normal parasite of *Arvicanthis barbarus*. *P. numidica* is smaller than *P. ascaroidea*, since the female attains a maximum length of not over 35 mm.; the lobes of the lips have fewer denticles (2 to 4) than *P. muris*; and the eggs are much larger (52  $\mu$  long) than those of *P. labiodentata*. Reported from Algeria.

Seurat (1916: Ibidem, v. 79 (3), pp. 146-149, figs. 1-2) has noted that *Rictularia proni* Seurat, 1915, described from *Herpestes ichneumon* is likewise a pseudo-parasite with *Arvicanthis barbarus* as its normal host. This species is larger than *R. coloradensis*, since the female attains a maximum length of 39.7 mm., and can be differentiated from the other species of *Rictularia* from rodents by the fact that the vulva is in the region of the thirty-fourth pair of combs. Reported from Algeria.



# LIST OF HOSTS AND THEIR PARASITES.

## RODENTIA.

### Family MURIDAE.

- Apodemus sylvaticus*:  
*Trichuris muris*.  
*Trichosoma muris-sylvatici*.  
*Oxyuris obvelata*.  
*Oxyuris stroma*.  
*Oxyuris tetraptera*.  
*Heligmosomum laerc*.  
*Heligmosomum minutum*.  
*Viannata polygyra*.  
*Rictularia cristata*.  
*Protospirura muris*.
- Arvicantis abyssinicus*:  
*Trichuris muris*.  
*Physaloptera ruwenzorii*.
- Arvicantis barbarus*:  
*Oxyuris obvelata*.  
*Rictularia proni*.  
*Protospirura numidica*.
- Arvicantis pulchellus*:  
*Strongylus minutoides*.
- Arvicola amphibius*:  
*Trichosomum lemni*.  
*Trichuris muris*.  
*Oxyuris obvelata*.  
*Strongylus lemni* [?].
- Arvicola arvalis*. See *Microtus arvalis*.
- Arvicola campestris*. See *Microtus arvalis*.
- Arvicola glareolus*. See *Erotomys glareolus*.
- Arvicola rubidus*. See *Erotomys glareolus*.
- Arvicola subterraneus*. See *Pitymys subterraneus*.
- Cricetomys gambianus*:  
*Heterakis spumosa*.
- Cricetus cricetus*:  
*Trichinella spiralis*.  
*Oxyuris tetraptera*.
- Cricetus frumentarius*. See *Cricetus cricetus*.
- Cricetus vulgaris*. See *Cricetus cricetus*.
- Dipodilla campestris*. See *Dipodillus campestris*.
- Dipodillus campestris*:  
*Allodapa elongata*.  
*Heligmosomum laerc*.  
*Gongylonema brevispiculum*.
- Epimys alexandrinus*:  
*Hepaticola hepatica*.  
*Protospirura muris*.
- Epimys norvegicus*:  
*Strongyloides papillosus*.  
*Capillaria annulosa*.  
*Capillaria schmidti*.  
*Hepaticola hepatica*.  
*Trichosomoides crassicauda*.  
*Trichinella spiralis*.  
*Heterakis spumosa*.  
*Heligmosomum brazilense*.  
*Strongylus* species.  
*Gongylonema ucoplasticum*.  
*Protospirura muris*.
- Epimys rattus*:  
*Capillaria annulosa*.  
*Capillaria papillosa*.  
*Trichuris muris*.  
*Trichosomoides crassicauda*.  
*Heterakis spumosa*.  
*Oxyuris obvelata*.  
*Gongylonema ucoplasticum*.  
*Protospirura muris*.  
*Physaloptera circularis*.  
*Spiroptera ratti*.  
*Filaria* species.
- Epimys siporanus*:  
*Protospirura muris*.
- Epimys surifer*:  
*Filaria muricola*.
- Epimys ugandae*:  
*Trichuris muris*.  
*Oxyuris obvelata*.  
*Physaloptera ruwenzorii*.
- Epimys* species (reported from "rat"):  
*Spirura tatpac*.  
*Spiroptera* species.

## RODENTIA—Continued.

## Family MURIDÆ—Continued.

- Erotomys glarcolus:*  
*Oxyuris obrclata.*  
*Erotomys rutilus:*  
*Oxyuris obrclata.*  
*Fiber zibethicus.* See *Ondatra zibethica.*  
*Hesperomys leucogaster.* See *Onychomys leucogaster.*  
*Hesperomys nasutus.* See *Peromyscus nasutus.*  
*Hesperomys physodes.* See *Holochilus physodes.*  
*Hesperomys species:*  
*Filaria circularis.*  
*Holochilomys brasiliensis.* See *Holochilus brasiliensis.*  
*Holochilus brasiliensis:*  
*Trichuris muris.*  
*Oxyuris obrclata.*  
*Holochilus physodes:*  
*Trichuris muris.*  
*Oxyuris obrclata.*  
*Leggada minutoides.* See *Mus minutoides.*  
*Lemmus amphibius.* See *Arvicola amphibius.*  
*Lemmus arvalis.* See *Microtus arvalis.*  
*Lemmus dasytrichus.* See *Oxymycterus rufus.*  
*Lemmus rutilus.* See *Erotomys rutilus.*  
*Micromys minutus:*  
*Oxyuris obrclata.*  
*Microtus arvalis:*  
*Trichuris muris.*  
*Oxyuris obrclata.*  
*Heligmosomum costellatum.*  
*Heligmosomum minutum.*  
*Viannaia polygyra.*  
*Heligmosomoides liustowi.*  
*Mus albus:*  
*Trichinella spiralis.*  
*Mus alexandrinus.* See *Epimys alexandrinus.*  
*Mus amphibius.* See *Arvicola amphibius.*  
*Mus arvalis.* See *Microtus arvalis.*  
*Mus brasiliensis:*  
*Physaloptera muris-brasiliensis.*  
*Mus capensis.* See *Georychus capensis.*  
*Mus decumanus.* See *Epimys norvegicus.*  
*Mus minimus.* See *Mus species.*  
*Mus minutoides:*  
*Ascaris species.*  
*Oxyuris obrclata.*  
*Mus minutus.* See *Micromys minutus.*  
*Mus musculoides:*  
*Oxyuris obrclata.*  
*Mus musculus:*  
*Capillaria bacillata.*  
*Trichuris muris.*  
*Trichosoma muris-musculi.*  
*Trichinella spiralis.*  
*Oxyuris obrclata.*  
*Oxyuris tetraptera.*  
*Strongylus lemni* [?].  
*Ollulanus tricuspis.*  
*Gongylonema musculi.*  
*Gongylonema neoplasticum.*  
*Protospirura muris.*  
*Spiroptera quadrialata.*  
*Mus musculus albus:*  
*Oxyuris obrclata.*  
*Mus navalis:* [Possibly *Microtus nivalis*.]  
*Protospirura labiodentata.*  
*Mus norvegicus.* See *Epimys norvegicus.*  
*Mus rattus.* See *Epimys rattus.*  
*Mus siporanus.* See *Epimys siporanus.*  
*Mus species:*  
*Spiroptera species.*  
*Mus surifer.* See *Epimys surifer.*  
*Mus sylvaticus.* See *Apodemus sylvaticus.*  
*Mus ugandae.* See *Epimys ugandae.*  
*Neotoma cinerea rupicola:*  
*Nematodirus neotoma.*  
*Neotoma desertorum:*  
*Nematodirus neotoma.*  
*Neotoma floridana baileyi:*  
*Nematodirus neotoma.*  
*Neotoma mexicana fallax:*  
*Oxyuris obrclata.*  
*Nematodirus neotoma.*  
*Nyctomys species:*  
*Microfilaria plimмери.*  
*Ondatra zibethica:*  
*Capillaria ransomia.*  
*Trichostrongylus fiberius.*  
*Trichuris opaca.*

RODENTIA—Continued.

Family MURIDAE—Continued.

<p><i>Onychomys leucogaster:</i>  <i>Oxyuris obvelata.</i>  <i>Otomys irroratus:</i>  <i>Strongylus caralli.</i>  <i>Uncinaria muridis.</i>  <i>Otomys irroratus tropicalis:</i>  <i>Strongylus caralli.</i>  <i>Uncinaria muridis.</i>  <i>Oxymycterus nasutus:</i>  <i>Oxyuris obvelata.</i></p>	<p><i>Oxymycterus rufus:</i>  <i>Rictularioides amphicanthum.</i>  <i>Peromyscus nasutus:</i>  <i>Oxyuris obvelata.</i>  <i>Pitymys subterraneus:</i>  <i>Oxyuris obvelata.</i>  <i>Heligmosomum laeve.</i>  <i>Heligmosomum minutum.</i></p>
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Family GEOMYIDAE.

<p><i>Geomys breviceps:</i>  <i>Protospirura ascaroidea.</i></p>	<p><i>Thomomys fossor:</i>  <i>Trichuris fossor.</i>  <i>Heligmosomum reccillatum.</i>  <i>Ransomus rodentorum.</i></p>
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Family OCTODONTIDAE.

<p><i>Ctenodactylus gundi:</i>  <i>Oxyuris hilgerti.</i>  <i>Scuratum tacapense.</i>  <i>Nematodirus spathiger.</i>  <i>Dactylomys amblyonyx.</i> See <i>Kannabatcomys amblyonyx.</i>  <i>Echinomys antricola.</i> See <i>Thrichomys apercoides.</i>  <i>Euryzygomatomys rufus:</i>  <i>Filaria diacantha.</i>  <i>Euryzygomatomys spinosus:</i>  <i>Filaria diacantha.</i>  <i>Isothrix bistriata:</i>  <i>Trichuris muris.</i>  <i>Isothrix pachyura.</i> See <i>Thrichomys pachyurus.</i></p>	<p><i>Kannabatcomys amblyonyx:</i>  <i>Filaria bifida.</i>  <i>Loucheres bistriata.</i> See <i>Isothrix bistriata.</i>  <i>Loucheres rufa.</i> See <i>Euryzygomatomys rufus.</i>  <i>Mesomys spinosus.</i> See <i>Euryzygomatomys spinosus.</i>  <i>Myocastor coypus:</i>  <i>Oxyuris hamata.</i>  <i>Myopotamus coypus.</i> See <i>Myocastor coypus.</i>  <i>Thrichomys apercoides:</i>  <i>Trichuris muris.</i>  <i>Thrichomys pachyurus:</i>  <i>Strongylus isotrichis.</i></p>
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Family DASYPROCTIDAE.

<p><i>Agouti paca.</i> See <i>Cuniculus paca.</i>  <i>Cavia acushy.</i> See <i>Myoprocta acouchy.</i>  <i>Cavia agouti.</i> See <i>Dasyprocta aguti.</i>  <i>Cavia paca.</i> See <i>Cuniculus paca.</i>  <i>Coccygnys paca.</i> See <i>Cuniculus paca.</i>  <i>Cuniculus paca:</i>  <i>Subulura uncinata.</i>  <i>Strongylus sedccimradiatus.</i>  <i>Dasyprocta agouti.</i> See <i>Dasyprocta aguti.</i></p>	<p><i>Dasyprocta aguti:</i>  <i>Trichuris gracilis.</i>  <i>Heterakis verrucosa.</i>  <i>Eucyathostomum copulatum.</i>  <i>Filaria conica.</i>  <i>Physoccephalus mediospiralis.</i>  <i>Myoprocta acouchy:</i>  <i>Filaria conica.</i></p>
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Family ERETHIZONTIDAE.

<p><i>Cercolabes prchensilis.</i> See <i>Cocndou prchensilis.</i>  <i>Coendou prchensilis:</i>  <i>Filaria diacantha.</i></p>	<p><i>Erethizon dorsatum:</i>  <i>Oxyuris evoluta.</i>  <i>Strongylus simplex.</i>  <i>Filaria subcutanea.</i>  <i>Microfilaria species.</i></p>
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## RODENTIA—Continued.

## Family ERETHIZONTIDÆ—Continued.

- |   |   |
|---|---|
| <i>Erethizon epixanthum:</i><br><i>Oxyuris evoluta.</i><br><i>Hystrix dorsata.</i> See <i>Erethizon dorsatum.</i> | <i>Hystrix prchensilis.</i> See <i>Coendou prchensilis.</i> |
|---|---|

## Family HYSTRICIDÆ.

- |   |  |
|---|--|
| <i>Acanthion brachyura:</i><br><i>Oxyuris evoluta.</i><br><i>Hystrix brachyura.</i> See <i>Acanthion brachyura.</i> | <i>Hystrix cristata:</i><br><i>Trichuris ovis.</i><br><i>Trichuris infundibulus.</i><br><i>Oxyuris stossichi.</i><br><i>Filaria martis.</i><br><i>Spiroptera hystrichis.</i> |
|---|--|

## Family SCIURIDÆ.

- |  |   |
|--|---|
| <i>Ammospermophilus leucurus cinnamomeus:</i><br><i>Oxyuris triradiata.</i><br><i>Arctomys citellus.</i> See <i>Citellus citellus.</i><br><i>Arctomys citillus.</i> See <i>Citellus citellus.</i><br><i>Arctomys marmota.</i> See <i>Marmota marmota.</i><br><i>Arctomys monax.</i> See <i>Marmota monax.</i><br><i>Allantoæcrus getulus:</i><br><i>Dermatoxys getula.</i><br><i>Oxyuris pallaryi.</i><br><i>Callospermophilus latralis:</i><br><i>Oxyuris triradiata.</i><br><i>Citellus beecheyi:</i><br><i>Microfilaria roseaui.</i><br><i>Citellus citellus:</i><br><i>Trichuris leporis.</i><br><i>Oxyuris obrclata.</i><br><i>Physaloptera citilli.</i><br><i>Citellus elegans:</i><br><i>Citellinema bifurcatum.</i><br><i>Dremomys rufigenis:</i><br><i>Rictularia elviræ.</i><br><i>Eutamias amoenus operarius:</i><br><i>Heteroxymema cucullatum.</i><br><i>Eutamias quadrivittatus:</i><br><i>Warrenius quadrivittati.</i><br><i>Rictularia coloradensis.</i><br><i>Euxerus erythropus:</i><br><i>Subulura boucti.</i><br><i>Funiseiurus carruthersi:</i><br><i>Strongylus cavalli.</i> | <i>Geosciurus capensis:</i><br><i>Oxyuris polyoon.</i><br><i>Marmota marmota:</i><br><i>Ascaris pigmentata.</i><br><i>Marmota monax:</i><br><i>Ascaris lacris.</i><br><i>Sciurus aberti minus:</i><br><i>Trichostrongylus delicatus.</i><br><i>Sciurus atrodorsalis:</i><br><i>Oxyuris sciuri.</i><br><i>Sciurus caniceps:</i><br><i>Filaria linstowi.</i><br><i>Sciurus igniventris:</i><br><i>Filaria pistillaris.</i><br><i>Sciurus melanogaster:</i><br><i>Rictularia fallax.</i><br><i>Physaloptera seiuri.</i><br><i>Sciurus rufigenis.</i> See <i>Dremomys rufigenis.</i><br><i>Sciurus species:</i><br><i>Subulura andersoni.</i><br><i>Sciurus vulgaris:</i><br><i>Oxyuris acutissima.</i><br><i>Oxyuris ungula.</i><br><i>Spermophilus citellus.</i> See <i>Citellus citellus.</i><br><i>Spermophilus citillus.</i> See <i>Citellus citellus.</i><br><i>Xerus erythropus.</i> See <i>Euxerus erythropus.</i><br><i>Xerus getulus.</i> See <i>Allantoæcrus getulus.</i><br><i>Xerus sctosus.</i> See <i>Geosciurus capensis.</i> |
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## RODENTIA—Continued.

## Family JACULIDAE.

<i>Dipus jaculus.</i> See <i>Jaculus jaculus.</i>	<i>Jaculus sagitta:</i>
<i>Dipus sagitta.</i> See <i>Jaculus sagitta.</i>	<i>Oxyuris tetraptera.</i>
<i>Dipus tetradactylus.</i> See <i>Scarturus</i>	<i>Scarturus tetradactylus:</i>
<i>tetradactylus.</i>	<i>Nematoideum dipodis - tetradac-</i>
<i>Jaculus jaculus:</i>	<i>tyli.</i>
<i>Oxyuris tetraptera.</i>	

## Family BATHYERGIDAE.

" <i>Gcorhychos illigeri.</i> " See <i>Georychus</i>	<i>Georychus capensis:</i>
<i>capensis.</i>	<i>Trichuris contorta.</i>
<i>Georychus capensis.</i> See <i>Georychus</i>	<i>Trichuris muris.</i>
<i>capensis.</i>	

## Family MUSCARDINIDAE.

<i>Dyromys nitedula:</i>	<i>Myoxus arellanarius.</i> See <i>Muscardi-</i>
<i>Rictularia cristata.</i>	<i>nus arellanarius.</i>
<i>Eliomys quercinus:</i>	<i>Myoxus dryas.</i> See <i>Dyromys nitedula.</i>
<i>Trichosomum myoxi-nitclae.</i>	<i>Myoxus glis.</i> See <i>Glis glis.</i>
<i>Heligmosomum laerc.</i>	<i>Myoxus muscardinus.</i> See <i>Muscardi-</i>
<i>Glis glis:</i>	<i>nus arellanarius.</i>
<i>Heligmosomum gracile.</i>	<i>Myoxus nitedula.</i> See <i>Dyromys nitc-</i>
<i>Rictularia cristata.</i>	<i>dula.</i>
<i>Graphiurus murinus:</i>	<i>Myoxus nitella.</i> See <i>Eliomys querc-</i>
<i>Physaloptera abbreviata.</i>	<i>cinus.</i>
<i>Muscardinus arellanarius:</i>	
<i>Rictularia cristata.</i>	

## Family CAVIIDAE.

<i>Cavia aperca:</i>	<i>Hydrochocrus capibara.</i> See <i>Hydro-</i>
<i>Subulura uncinata.</i>	<i>chocrus hydrochacris.</i>
<i>Cavia aperca.</i> See <i>Cavia aperca.</i>	<i>Hydrochocrus capybara.</i> See <i>Hydro-</i>
<i>Cavia cobaya.</i> See <i>Cavia porcellus.</i>	<i>chocrus hydrochacris.</i>
<i>Cavia porcellus:</i>	<i>Hydrochocrus hydrochacris:</i>
<i>Trichinella spiralis.</i>	<i>Oxyuris obesa.</i>
<i>Paraspidodera uncinata.</i>	<i>Viannaia hydrocheri.</i>
<i>Gongylocoma neoplasticum.</i>	

## Family CASTORIDAE.

<i>Castor fiber:</i>	
<i>Trichoccephalus castoris.</i>	
<i>Ascaris castoris.</i>	
<i>Strongylus</i> species.	
<i>Filaria</i> species.	
<i>Gongylocoma</i> (?) species.	

## Family, genus, and species unknown.

"Large rodent:"	
<i>Acheilostoma simpsoni.</i>	
<i>Trachypharynx nigeriae.</i>	

## LAGOMORPHA.

## Family LEPORIDÆ.

- Lepus arcticus:*  
*Oxyuris ambigua.*
- Lepus brasiliensis.* See *Sylvilagus brasiliensis.*
- Lepus californicus melanotis:*  
*Dermatoxys veligera.*
- Lepus campestris:*  
*Filaria scapiceps.*
- Lepus cuniculus.* See *Oryctolagus cuniculus.*
- Lepus cuniculus domesticus.* See *Oryctolagus cuniculus.*
- Lepus cuniculus ferus.* See *Oryctolagus cuniculus.*
- Lepus europæus:*  
*Trichuris leporis.*  
*Trichinella spiralis.*  
 (?) *Hepaticola hepatica.*  
*Oxyuris ambigua.*  
*Strongylus leporum.*  
*Trichostrongylus retortaeformis.*  
*Graphidium strigosum.*  
*Synthetocaulus pulmonalis.*
- Lepus glacialis.* See *Lepus arcticus.*
- Lepus kabilicus:*  
*Dermatoxys veligera.*
- Lepus nigricollis:*  
*Trichostrongylus pigmentatus.*
- Lepus species:*  
*Oxyuris ambigua.*
- Lepus sylvaticus.* See *Sylvilagus floridanus mallurus.*
- Lepus timidus* (See also *Lepus europæus*):  
*Trichuris leporis.*  
*Filaria leporis.*
- Lepus variabilis.* See *Lepus timidus.*
- Oryctolagus cuniculus:*  
*Strongyloides papillosus.*  
*Trichuris leporis.*  
*Trichinella spiralis.*  
*Oxyuris ambigua.*  
*Strongylus leporum.*  
*Trichostrongylus retortaeformis.*  
*Graphidium strigosum.*  
*Synthetocaulus rufescens.*  
*Gongylonema neoplasticum.*
- Sylvilagus auduboni baileyi:*  
*Dermatoxys veligera.*
- Sylvilagus brasiliensis:*  
*Dermatoxys veligera.*
- Sylvilagus floridanus:*  
*Trichuris leporis.*
- Sylvilagus floridanus alacer:*  
*Filaria scapiceps.*
- Sylvilagus floridanus mallurus:*  
*Trichuris leporis.*  
*Oxyuris ambigua.*  
*Trichostrongylus calcaratus.*  
*Filaria scapiceps.*
- Sylvilagus nuttalli pinctis:*  
*Dermatoxys veligera.*

## HYRACOIDEA.

## Family PROCAVITIDÆ.

(It is understood that the above names can not both stand, but as both are in present use they are used here pending an agreement as to the nomenclature in this group.)

- Heterohyrax mossambica.* See *Procapia brucei.*
- Hyrax capensis.* See *Procapia capensis.*
- Hyrax syriacus.* See *Procapia syriaca.*
- Procapia brucei:*  
*Strongylus (Delctrocephalus) brachylaincus.*
- Procapia capensis:*  
*Crossophorus collaris.*  
*Crossophorus tentaculatus.*  
*Physaloptera spirula.*
- Procapia syriaca:*  
*Crossophorus collaris.*  
*Oxyuris flagellum.*  
*Oxyuris pugio.*  
*Physaloptera spirula.*

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