OBSERVATIONS ON THE NEMATODE GENUS NEMATODIRUS, WITH DESCRIPTIONS OF NEW SPECIES.

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INTRODUCTION.

There has been in the past some confusion in regard to the identity of the species of *Nematodirus*. In 1896 Railliet described *Strongylus spathiger* from the camel and distinguished it from *Strongylus filicollis* (Rudolphi, 1802) from the sheep. Ransom in 1907 proposed the genus *Nematodirus*, with *Strongylus filicollis* Rudolphi as type, and in 1911 assigned forms found in the United States in sheep to the species *N. filicollis*. His figures of the bursa and spicules of the male agree with the description of *N. spathiger*, but the female and egg measurements do not agree. In 1912 Railliet and Henry published the following table to distinguish the species of *Nematodirus* and expressed the opinion that the American form described by Ransom as *N. filicollis* is *N. spathiger*. Later authors have been inclined to agree with them.

Table of Railliet and Henry.

	N. filicollis.	*N. spathiger.*	*N. roscidus.*
Male:			
Length of body	8–15 mm	14–19 mm	9–14 mm.
Spicules—			
Length	750–900 μ	1,000–1,200 μ	900–925 μ.
Terminal membrane.	Narrow, lanceolate.	Spatulate	Narrow, lanceolate.
Caudal bursa:			
Middle rays	Scarcely separated.	Scarcely separated.	Well separated.
Salient lobule at the level of each posterior ray.	Absent	Present	Absent.
Female:			
Length of body	12–20 mm	18–29 mm	12–18 mm.
Eggs—			
Shell	Smooth	Smooth, slightly thickened at the poles.	Alveolate.
Dimensions	145–180 μ by 75–90 μ.	200–260 μ by 100–110 μ.	160–226 μ by 80–90 μ.

[1] Resigned September 2, 1919.

In order, if possible, to clear up the existing doubt, Dr. B. H. Ransom suggested that I make a study of the *Nematodirus* material available in the Helminthological Collections of the United States National Museum. The results indicate that there exist no such clear differences between *N. spathiger* and *N. filicollis* as indicated by Railliet, and furthermore four other forms, not previously described, were found to be present.

MATERIAL AND METHODS.

In addition to the abundant material collected in the United States there were available for study specimens of both *N. spathiger* and *N. filicollis* received from Railliet, and mounted specimens of *Nematodirus* collected by O. Schnyder from cattle in Switzerland. The material collected by Railliet from a dromedary at Alfort, France, identified by him as *Strongylus spathiger*, and submitted to the Bureau of Animal Industry in 1896 (U.S.N.M. Helminthological Collections, No. 2760), contains three males and a number of females of *N. spathiger*, and four males and three females of a new species resembling *N. mauritanicus*, described by Maupas and Seurat (1912), also from a dromedary. The material collected by Railliet from *Ovis aries* in France (U.S.N.M. Helminthological Collections, No. 4027) and identified by him as *Strongylus filicollis* contains three males of *N. filicollis*, one male of *N. spathiger*, and several females which may be either. The specimens from Schnyder (U.S.N.M. Helminthological Collections, Nos. 15728 and 15739) are different from any others examined. The American material contains both *N. spathiger* and *N. filicollis*, with two additional forms not found elsewhere.

For the study of the spicules the material was cleared in phenol alcohol, while for the study of other characters specimens were either cleared in glycerol or stained and mounted in balsam. Sections were used to clear up certain points and to check up others. The spicules of nearly 800 specimens were measured. Measurements were made of the length and breadth of 350 eggs.

Genus NEMATODIRUS Ransom, 1907.

1907. *Nematodirus* Ransom, 1907*k*, p. 4.

Generic diagnosis.—Metastrongylinae: Filiform, with reproductive organs in posterior body region. Anterior part of female and entire length of male marked with longitudinal cuticular ridges depending in number on the diameter of the specimen—usually 18 to 24. Cuticula inflated in head and neck region, and in the female sometimes also between anus and posterior end. Coarse, transverse striations within the inflated area, but not elsewhere. Mouth opening oval and surrounded by six inconspicuous papillae, the two lateral papillae being largest. Buccal cavity very short. Esophagus 400 to 700 μ long, evertable in the anterior region, and armed with a

larger dorsal and two smaller latero-ventral teeth. Nerve ring near middle of esophagus. Cervical papillae minute or absent. Excretory pore large, opening on ventral side near base of esophagus and connected with two unicellular glands closely associated with the lateral lines and occupying the anterior fifth of the body. Bursa nearly terminal, with two large lateral, symmetrical lobes and two small dorsal lobes, each closely associated with a lateral lobe. No unpaired median dorsal lobe. Ventral rays of bursa slender, close together, parallel. Externo-lateral ray proximally close to medio-lateral ray, but distally curved ventrad, away from the latter. Medio-lateral and postero-lateral rays close together, diverging slightly at the tip and curving slightly dorsad. Lateral rays much thicker than others. Externo-dorsal ray very slender. Dorsal ray (one in each dorsal lobe) short, bifid at the tip, with the external branch curved toward externo-dorsal ray. Spicules slender, tubular, united by a membrane throughout part of their length. Prebursal papillae small, inconspicuous.

Females larger than males. Vulva a transverse slit located in or near the middle third of the body. Eggs large, oval. Posterior end of female truncate, provided with a short, slender, acutely pointed process.

Type species.—Nematodirus filicollis (Rudolphi, 1802) Ransom, 1907.

The genus *Mecistocirrus* Railliet and Henry, 1912, with *M. digitatus* (von Linstow, 1906) Railliet and Henry, 1912, as type species, is very closely related to *Nematodirus*. In it the vulva of the female is located near the anus.

KEY TO SPECIES OF NEMATODIRUS.

1(12). Spicules less than 2 mm. long ..... 2.
2(3). Spicules not united at tip ..... *furcatus.*
3(2). Spicules united at tip ..... 4.
4(7). Dorsal lobes of bursa not distinctly set off from lateral lobes; spicules with sharp point ..... 5.
5(6). Medio-lateral and postero-lateral rays of bursa scarcely separated; eggs with smooth shells ..... *filicollis.*
6(5). Medio-lateral and postero-lateral rays of bursa well separated; eggs with alveolate shells ..... *roscidus.*
7(4). Dorsal lobes of bursa more or less distinctly set off from lateral lobes; spicules with sharp or blunt point ..... 8.
8(9). Spicule point blunt or spatulate ..... *spathiger.*
9(8). Spicule point sharp ..... 10.
10(11). Spicules of equal length, straight at tip, with no tendency toward twisting ..... *helvetianus.*
11(10). Spicules slightly unequal in length, twisted near the tip ..... *abnormalis.*
12 (1). Spicules more than 2 mm. long ..... 13.
13(14). Vulva in anterior half of body ..... *dromedarii.*
14(13). Vulva in posterior half of body ..... 15.
15(16). Eggs large, 250 by 110 μ; spicules 5 mm. long ..... *mauritanicus.*
16(15). Eggs smaller, 175 by 85 μ; spicules 3 mm. long ..... *neotoma.*

DESCRIPTIONS OF SPECIES.

NEMATODIRUS FILICOLLIS (Rudolphi, 1802) Ransom, 1907.

Plate 31, fig. 18; plate 33, fig. 24.

1802. *Ascaris filicollis* RUDOLPHI, 1802*a*, pp. 23–25, pl. 1, fig. 1, *a*, *b*, *c* (from *Ovis aries;* Germany).

1803. *Strongylus filicollis* (Rudolphi, 1802) RUDOLPHI, 1803*a*, pp. 17–18.

1803. *Fusaria filicollis* (Rudolphi) ZEDER, 1803*a*, p. 110 (*Ascaris filicollis* Rudolphi, 1802, renamed).

1907. *Nematodirus filicollis* (Rudolphi) RANSOM, 1907*k*, p. 4.

Specific diagnosis.—Nematodirus: Species small. Male, 10 to 15 mm. long and 125 to 150 μ in maximum diameter. Bursa relatively large with thin rays. Dorsal lobes of bursa not set off from lateral lobes. Bosses large and elongated. Spicules 0.68 to 0.95 mm. long, provided with sharply pointed terminal piece. Esophagus 0.4 to 0.6 mm. long, somewhat longer in the female than in the male. Female 15 to 20 mm. long. Vulva located between anterior two-thirds and posterior one-third of body. Anus 70 to 80 μ from truncated posterior end. Eggs 130 to 200 μ by 70 to 90 μ, with smooth shell of nearly uniform thickness.

Habitat.—Small intestine of sheep, cattle, goats, and deer.

Distribution.—Europe and America.

NEMATODIRUS ROSCIDUS Railliet, 1911.

1911. *Nematodirus roscidus* RAILLIET, 1911, in Brumpt, 1911, pp. 907, 908 (in stag ("cerf"); France).

Specific diagnosis.—Nematodirus: Species small. Male, 9 to 14 mm. long. Spicules, 0.90 to 0.925 mm. long, with slender lanceolate terminal membrane. Medio-lateral and postero-lateral rays of bursa well separated. Dorsal lobes not salient. Female, 12 to 18 mm. long. Eggs, 160 to 226 μ by 80 to 90 μ; surface of eggshell alveolate. (Foregoing description taken from Railliet and Henry, 1912.)

Habitat.—Intestine of stag.

Distribution.—France.

NEMATODIRUS SPATHIGER (Railliet, 1896) Railliet and Henry, 1909.

Plate 29, figs. 2–14; plate 30, figs. 15–17; plate 32, fig. 21; plate 33, fig. 25; plate 34, fig. 26.

1896. *Strongylus spathiger* RAILLIET, 1896*m*, p. 490 (in *Camelus dromedarius;* France).

1909. *Nematodirus spathiger* (Railliet) RAILLIET and HENRY, 1909*a*, p. 87.

Specific diagnosis.—Nematodirus: Medium-sized species. Male, 10 to 15 mm. long and 125 to 175 μ in maximum diameter. Bursa relatively small. Dorsal lobes set off by indentations from lateral

lobes. Bosses few and small. Spicules, 0.70 to 1.10 mm. long, provided with spoon-shaped terminal piece. Esophagus as in *N. filicollis*. Female, 15 to 23 mm. long. Vulva and anus located as in *N. filicollis*. Eggs, 150 to 220 μ by 80 to 110 μ, with smooth shells of nearly uniform thickness.

Habitat.—Small intestine of sheep, cattle, goats, deer, camels, and rodents.

Distribution.—Almost cosmopolitan.

NEMATODIRUS ABNORMALIS, new species.

Plate 32, fig. 23; plate 34, fig. 29.

Specific diagnosis.—Nematodirus: Species considerably larger than *N. filicollis*. Male, 11 to 17 mm. long and 150 to 200 μ in greatest diameter. Bursa relatively small, with heavy rays. Dorsal lobes set off from lateral lobes by deep indentations. Externo-dorsal ray nearer edge of bursal membrane throughout median third than at its distal end. Bosses numerous, small. Spicules, 0.90 to 1.25 mm. long, provided with an asymmetrical, pointed terminal piece. Asymmetry is due to the fact that one spicule is slightly shorter than the other, and the two are twisted at the end. Length of esophagus as in *N. filicollis*. Female, 18 to 25 mm. long. Location of vulva and anus as in *N. filicollis*. Eggs, 160 to 230 μ by 85 to 115 μ, with smooth shell of nearly uniform thickness.

Habitat.—Small intestine of sheep and goats.

Distribution.—America.

Type specimens.—U.S.N.M. Helminthological Collections, No. 19303, collected from a maltese goat by E. C. Stevenson at Bethesda, Maryland, August 14, 1906.

NEMATODIRUS HELVETIANUS, new species.

Plate 31, fig. 20; plate 35, fig. 30.

Specific diagnosis.—Nematodirus: Species much like *N. abnormalis*. Rays of bursa not so heavy; dorsal rays less distinctly set off; externo-dorsal ray nearest the edge of the membrane at its distal end. Bosses few and large. Spicules, 0.90 to 1.25 mm. long, provided with a sharp, symmetrical terminal piece, much as in *N. filicollis*. Female and eggs as in *N. abnormalis*.

Habitat.—Small intestine of cattle.

Distribution.—Switzerland.

Type specimens.—U.S.N.M. Helminthological Collections, No. 15728, collected from the small intestine of an ox by O. Schnyder in Switzerland, October 17, 1905.

NEMATODIRUS FURCATUS, new species.

Plate 29, fig. 1; plate 31, fig. 19; plate 34, figs. 27–28.

Specific diagnosis.—Nematodirus: Species very small. Male, 6 to 6.4 mm. long and 65 to 70 μ in greatest diameter. Bursa resembles that of *N. filicollis*, with rays relatively thinner and longer. Bosses smaller. Spicules, 0.50 to 0.80 mm. long, separated throughout the distal third or more, each one ending as a beveled tube. Length of esophagus, 0.30 to 0.45 mm. Diameter of head without inflated cuticula, 17 to 23 μ; with inflated cuticula, up to 45 μ. Three males only available for study.

Habitat.—Small intestine of sheep.

Distribution.—Michigan.

Type specimens.—U.S.N.M. Helminthological Collections, No. 18988, collected from the small intestine of a sheep by W. L. Chandler at East Lansing, Michigan, 1919.

NEMATODIRUS NEOTOMA Hall, 1916.

1912. *Nematodirus* species HALL, 1912, p. 351.

1916. *Nematodirus neotoma* HALL, 1916, pp. 136–138, figs. 172–180 (type specimens, U.S.N.M.Helm.Coll., No. 16134, from *Neotoma cinerea rupicola*, Colorado).

Specific diagnosis.—Nematodirus: Medium-sized species. Male, 8 to 11 mm. long, with a maximum diameter of 135 μ. Bursa with stout rays. Dorsal lobes set off by wide notch from lateral lobes and united with each other by a membrane showing only a shallow median indentation. Bosses numerous and very small. Bursal membrane marked with indistinct striations. Spicules, 3 to 3.4 mm. long, ending in a blunt point not provided with a distinct terminal piece. Esophagus, 335 to 500 μ long. Female, 18 to 22 mm. long, with position of vulva as in *N. filicollis*. Anus about 120 μ from posterior end. Ovijectors longer and less muscular than in *N. filicollis*. Eggs 145 to 190 μ by 80 to 90 μ.

Habitat.—Small intestine and stomach of rodents of the genus *Neotoma*.

Distribution.—Colorado.

NEMATODIRUS MAURITANICUS Maupas and Seurat, 1912.

1912. *Nematodirus mauritanicus* MAUPAS and SEURAT, 1912, pp. 628–632, figs. 1–10 (from small intestine of dromedary, Ghardaïa, North Africa).

Specific diagnosis.—Nematodirus: Species large. Male, 13 to 15 mm. long, with maximum diameter of 167 to 170 μ. Dorsal lobes of bursa set off from lateral lobes by deep indentations and united with each other as in *N. neotoma*. Spicules, 4.5 to 5.5 mm. long, provided with a sharply pointed terminal piece in the shape of a parallelogram. Length of esophagus, 575 to 610 μ. Female, 21 to 24 mm. long, with vulva between middle and posterior third of body, and

anus 105 μ from posterior truncated end. Ovijectors very long, unequal, being, respectively, 3.2 and 1.4 mm. long, and both passing backward in body. Eggs, 220 to 280 μ by 110 to 115 μ.

Habitat.—Small intestine of dromedary.

Distribution.—Africa.

NEMATODIRUS DROMEDARII, new species.

Plate 32, fig. 22; plate 35, fig. 31.

Specific diagnosis.—Nematodirus: Species large. Male, 10 to 15 mm. long and 200 to 250 μ in maximum diameter. Bursa resembles that of *N. helvetianus*. Bosses few, containing granular substance. Striations on bursa present. Spicules, 5 to 5.36 mm. long, provided with a sharp terminal piece, as in *N. filicollis*. Esophagus, 500 to 600 μ long, slightly longer in the female than in the male. Diameter of head, 50 to 55 μ. Female, 20 to 29 mm. long, with vulva one-third of the body length from the anterior end, and anus 145 to 150 μ from the truncated posterior end. Ovijectors very long, as in *N. mauritanicus*. Maximum diameter of female 450 to 500 μ. Eggs 230 to 260 μ by 100 to 120 μ, with smooth shells of nearly uniform thickness.

Habitat.—Small intestine of dromedary.

Distribution.—France.

Type specimens.—U.S.N.M. Helminthological Collections, No. 19303, collected from a dromedary by A. Railliet in France. (Separated from No. 2760, *N. spathiger.*)

REMARKS ON MORPHOLOGY.

In an attempt to find specific differences among members of the genus *Nematodirus* besides those of the bursa and spicules of the males, various details of morphology were studied in the specimens available. In the case of the short-spiculed forms (*N. filicollis*, *N. spathiger*, *N. abnormalis*, and *N. helvetianus*), however, it was impossible to find characters whereby the females could be distinguished.

HEAD AND NECK REGION.

The cuticula of the portion of the body over the region occupied by the anterior one-third of the esophagus is frequently inflated (plate 29, figs. 1, 2). This inflation is variable within the same species, but seems to occur in all of them. The inflated portion of the cuticula is marked by superficial coarse rings, and, in stained specimens, by deeper, stainable rings. The mouth is an oval terminal opening in the cuticula covering the head, leading into a very short buccal cavity, usually not more than 5 μ in length. Surrounding the mouth opening are six circumoral papillae. The two lateral papillae are comparatively large and are easily visible in toto mounts. The ventral and dorsal pairs are much smaller and are visible in toto prepara-

tions only in favorable mounts (plate 29, fig. 7). Anteriorly the muscular esophagus ends abruptly in the buccal cavity. In end view the two latero-ventral and the dorsal muscular fields of the esophagus surround a triradiate lumen. The dorsal field is provided near its anterior end with a tooth equal to about half the diameter of the esophagus (plate 29, fig. 8). The tooth probably contains the outlet of a gland, indicated by a large nucleus at its base. The two ventral fields are each provided with a smaller tooth. The whole anterior end of the esophagus is evertable through the mouth, and when it is everted the teeth may be seen to point forward and outward (plate 29, figs. 2–4). The nerve ring is large and usually located near the middle of the esophagus (plate 29, fig. 9).

BODY.

The number of longitudinal cuticular ridges, usually stated to be 18 to 22, or even 26, was found to depend on the diameter of the body (plate 29, figs. 9–14; plate 30, fig. 15.) The ridges occupy two fields, dorsal and ventral, arising at the anterior end as two single median ridges. The ventral median ridge is interrupted by the opening of the excretory pore. The other ridges arise on both sides of the median ridges as the body increases in diameter. The median ridges always remain highest and the lateral ones lowest. The median ridges arise directly over the dorsal and ventral hypodermal thickenings, but there are no ridges corresponding to the lateral thickenings of the hypodermis. Alternating with the four lateral, dorsal, and ventral lines, or hypodermal thickenings are four muscular tracts. Each tract at the nerve ring contains two muscle cells, but later contains four or more.

The vulva was found to be a transverse slit in all of the species examined. The ovijectors in the species with short spicules are very short and stout, as described in detail by Maupas and Seurat (1912), while in the forms with long spicules they are much elongated.

EXCRETORY APPARATUS.

The excretory apparatus deserves special mention on account of its great development (plate 29, figs. 10–14.) The excretory pore is large, being easily visible in toto preparations, located at the base of the esophagus and opening through the median ventral ridge, as already stated. The excretory tube branches almost immediately, each branch passing diagonally back to its corresponding lateral field. There soon arises in connection with each of these fields a vascular thickening, which increases in diameter posteriad and becomes more or less dissociated from the lateral field to form a pyriform renette or cervical gland with one huge nucleus at its middle. The two renette cells occupy about one-fifth of the body length, one extending slightly farther back than the other. Throughout their extent the excretory tubes can not be traced, but behind them the

tubes again appear in the lateral fields. The structure of the apparatus is particularly interesting as throwing some light on the possible relation between the excretory apparatuses of parasitic and free-living nematodes.

POSTERIOR END.

The bursa of the male as found in *N. furcatus* and *N. filicollis* differs from the others mainly in the relatively greater development of the membrane as compared with that of the rays. The membrane then forms a broader margin around the rays and fills out completely the space between the externo-dorsal and dorsal rays. The minimal development of the membrane is found in *N. abnormalis*, where it little more than covers the rays, and the indentation between the externo-dorsal and dorsal rays is so deep that the externo-dorsal ray lies very close to the edge of the membrane. The size and extent of the membrane connecting the two dorsal lobes is variable, and reaches its greatest development in *N. neotoma*, where it fills out almost the entire space between the two dorsal rays, giving the appearance of an unpaired dorsal median lobe, except for the presence of a deep median notch (plate 31, figs. 18–20; plate 32, figs. 21–23).

On the inside of each lateral lobe of the bursa are a number of blisterlike, transparent elevations or bosses, already described by Hall as transparent maculae. In *N. neotoma* Hall describes them as located "around the proximal part of the lateral ray and in the area between the externo-lateral and other lateral rays." In the species from ruminants there seems to be a fundamental arrangement into two groups, either one of which may be more or less developed or even absent in a given species. One group or field extends along the edge of the membrane, slightly farther in than the ends of the rays, from the ventral rays to the postero-lateral ray. The other group has the shape of an open V, and is placed so that it forms a triangle with the first group.

The anal glands of the female were found to show no specific differences. There are in general three groups of anal gland cells and one of caudal cells, but they are variable in size and position. The anal cells are arranged as two latero-ventral groups and one median dorsal group. The caudal cells are located directly behind the dorsal anal cells, and are connected with a ventral thickening of the caudal hypoderm behind the anus (plate 30, figs. 16, 17).

DISCUSSION.

The species here described fall into three distinct groups—the *filicollis* group, the *mauritanicus* group, and the *neotoma* group. *Nematodirus neotoma* has characters that place it rather close to the genus *Mecistocirrus;* long spicules, smaller eggs and the vulva set well back.

Nematodirus mauritanicus and *N. dromedarii* differ from each other chiefly in the fact that in *N. mauritanicus* the vulva is located in the posterior body region, while in *N. dromedarii* it is in the anterior region. Although these forms have long spicules the other characters seem to show that they are not so close to *Mecistocirrus* as is *N. neotoma.* However, all forms with long spicules seem to be closely related and the establishment of the genus *Mecistocirrus* to contain some of them merely because in these forms the vulva is located within a few millimeters of the anus instead of farther forward as in the others does not seem to be at all justified. On the same ground one would have to make a new genus for *N. dromedarii*, and possibly also for *N. mauritanicus*, for in both of these forms the bulk of the reproductive organs in the female lies well back behind the vulva, both ovijectors even being placed behind the vulva instead of one on either side, as in the *filicollis* group and in *N. neotoma.* The position of the vulva seems to be the most variable character in the females of this group, and can hardly be regarded as any more than of specific value. The only other recorded character distinctive of the genus *Mecistocirrus* is the presence of cervical papillae; but minute papillae are also described for *N. mauritanicus.* In the variation in the position of the vulva and in the disposition of the female reproductive organs this group seems to be unique among the parasitic nematodes. Seurat in 1918 divided parasitic nematodes into three groups: Amphidelphs, in which the vulva is located somewhere near the middle of the body and the ovijectors are placed one in front and the other behind; Opisthodelphs, in which the vulva is anterior and the ovijectors are both behind; and Prodelphs, in which the vulva is near the anus with the ovijectors anteriad. He attached very deep phylogenetic significance to these three types. Here, however, all three are found in a single group of evidently very closely related forms.

The *filicollis* group contains the species *N. furcatus*, *N. filicollis*, *N. helvetianus*, and *N. abnormalis* in a series of possible relationships; with *N. spathiger* as a branch coming off somewhere between *N. filicollis* and *N. helvetianus.*

Some of the confusion among species in the genus is apparently due to the fact that Railliet's description of *N. spathiger* is evidently based in part on females of *N. dromedarii.* His measurements of females and eggs, consequently, were much too large for *N. spathiger.* He also described thickenings of the eggshells at the ends which, however, I have not observed in the specimens that I have examined.

As no specimens of *N. roscidus* were available for study, and as the published descriptions of this species are brief and unaccompanied by illustrations, I am unable to suggest its relationship to other species of the genus.

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EXPLANATION OF PLATES.

PLATE 29.

FIGS. 1–14. 1. NEMATODIRUS FURCATUS. ANTERIOR END SHOWING INFLATED CUTICULA, DORSAL TOOTH AND SOME CIRCUMORAL PAPILLAE. 2. N. SPATHIGER. ANTERIOR END SHOWING INFLATED CUTICULA AND EVERTED ESOPHAGUS WITH DORSAL TOOTH. 3. N. SPATHIGER. VENTRAL VIEW OF ANTERIOR END WITH ESOPHAGUS PARTLY EVERTED, SHOWING DORSAL AND LATERO-VENTRAL TEETH. 4. SAME AS FIG. 3, LATERAL VIEW. 5. LATERAL VIEW OF ANTERIOR END WITH ESOPHAGUS NOT EVERTED. SPECIMEN PARTLY CRUSHED. 6. N. SPATHIGER. JUNCTION OF ESOPHAGUS AND INTESTINE AND OPENING OF EXCRETORY PORE, SIDE VIEW. 7. N. SPATHIGER. FIRST SECTION FROM ANTERIOR END, SHOWING THE ORAL OPENING, TRIRADIATE LUMEN OF ESOPHAGUS, AND CIRCUMORAL PAPILLAE. 8. SECTION A LITTLE FARTHER BACK, SHOWING DORSAL TOOTH WITH LARGE NUCLEUS AT BASE. 9. SECTION THROUGH NERVE RING. 10. SECTION THROUGH EXCRETORY PORE. 11. SECTION THROUGH EXCRETORY BRIDGE. 12. SECTION A SHORT DISTANCE BEHIND EXCRETORY BRIDGE. 13. SECTION THROUGH NUCLEUS OF ONE OF RENETTE CELLS. 14. SECTION SHOWING DISAPPEARANCE OF RENETTE CELLS. LETTERING: *c. r.*, CUTICULAR RIDGES; *d. f.*, DORSAL FIELD; *e.*, ESOPHAGUS; *e. c.*, EXCRETORY CANAL; *e. p.*, EXCRETORY PORE; *i.*, INTESTINE; *l. f.*, LATERAL FIELD; *m. c.*, MUSCLE CELLS; *n. r.*, NERVE RING; *r. c.*, RENETTE CELLS; *t.*, TESTIS; *v. f.*, VENTRAL FIELD.

PLATE 30.

FIGS. 15–17. 15. NEMATODIRUS SPATHIGER. SECTION THROUGH BODY OF FEMALE, ABOUT ONE-THIRD OF THE WAY BACK. 16. POSTERIOR END OF FEMALE, VENTRAL VIEW. DRAWN AS TRANSPARENT OBJECT. 17. LATERAL VIEW OF SAME. LETTERING SAME AS UNDER PREVIOUS FIGURES, AND *a.*, ANUS; *c. g.*, CAUDAL GLAND; *c. p.*, CAUDAL PROCESS; *d. g.*, DORSAL GLAND; *l. g.*, LATERO-VENTRAL GLAND; *o.*, OVARY; *t. m.*, TRANSVERSE MUSCLES.

PLATE 31.

FIGS. 18–20. 18. NEMATODIRUS FILICOLLIS. SIDE VIEW OF BURSA, SPREAD OUT. 19. N. FURCATUS. SIDE VIEW OF BURSA, SPREAD OUT. 20. N. HELVETIANUS. SIDE VIEW OF BURSA, SPREAD OUT. LETTERING SAME AS UNDER PREVIOUS FIGURES, AND *b.*, BOSSES; *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.

PLATE 32.

FIGS. 21–23. 21. NEMATODIRUS SPATHIGER. SIDE VIEW OF BURSA, SPREAD OUT. 22. N. DROMEDARII. SIDE VIEW OF BURSA, SPREAD OUT. 23. N. ABNORMALIS. SIDE VIEW OF BURSA, SPREAD OUT. LETTERING SAME AS UNDER PREVIOUS FIGURES.

PLATE 33.

FIGS. 24–25. 24. NEMATODIRUS FILICOLLIS. SPICULE POINT, LATERAL AND DORSAL VIEWS. 25. N. SPATHIGER. SPICULE POINTS, LATERAL AND DORSAL VIEWS. DORSAL VIEWS SHOW SOME VARIATIONS.

PLATE 34.

FIGS. 26–29. 26. NEMATODIRUS SPATHIGER. SPICULES, ENTIRE DORSAL VIEW. 27. N. FURCATUS. SPICULES, ENTIRE VENTRAL VIEW. 28. N. FURCATUS. SPICULE POINTS, LATERAL AND VENTRAL VIEWS. 29. N. ABNORMALIS. SPICULE POINTS, LATERAL AND DORSAL VIEWS.

PLATE 35.

FIGS. 30–31. 30. NEMATODIRUS HELVETIANUS. SPICULE POINTS, LATERAL AND DORSAL VIEWS. 31. N. DROMEDARII. SPICULE POINT, DORSAL VIEW.